Assessing the Impact of Problem-based Learning in University Students

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Authors' contributions

This work was carried out in collaboration between all authors. Author EMR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EMR and RDR managed the analyses of the study. Author ROR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The study presents the evaluation of an educational innovation methodology based on Problem Based Learning. Specifically, we have evaluated the impact on student perceptions of their competence development and methodological variables that promote it.
Study Design: Instrumental and transversal study.
Place and Duration of Study: Educational Science Faculty, between September 2012 and February 2013.
Methodology: 222 students of Educational Psychology have participated (71.8% women), who filled out the *Problem Based Learning Impact Assessment Scale* (α = .99).
Results: Descriptive results show a high level of self-perception about: development of pre-professional competences, transfer of knowledge, satisfaction and achievement, and adequacy between time and effort. The linear regression outcomes show that the potential of transfer and the

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adaptation and transversality of learning are the most influential factors in the development of pre-professional competences.

Conclusion: These results help introduce improvements in teaching methodology.

1. INTRODUCTION

Nowadays the process of change of university education, aside of any socio-political analysis, has meant for some professors a true opportunity to accomplish changes which stem from the real needs of the society, to assure adequacy in the global world and in today's society [1]; a society in which aspects such as autonomy, personal and social responsibility, entrepreneurship, leadership and solidarity have become key developmental elements [2,3]. This aim implies that some of the modifications have a bearing, directly, in teaching. A transformation of the teaching-learning process is expected, so that the University staff may go beyond the traditional methodology, which is intended for the sole transmission of knowledge, without much control nor evaluation regarding what the student really acquires and is capable of using; thus, promoting changes in mentality, attitudes and behavior, fomenting in students what has become to be called "competence" [4]. Beyond the fact that the use and abuse of such concept is becoming polysemous, there is no doubt that when the objective of teaching is specified as the search for general and specific competences with regards to that which the student should be able to know and do, substantial changes are being proposed and executed concerning the teachers objectives and methodology, when re-structuring teaching strategies which are activated, and concerning the learning results which are sought. Education, at a University level, must meet the challenge of preparing new generations, so that they might be capable of using and selecting knowledge and learning in several contexts and throughout life itself, in order for them to adapt this which has been learned to new situations [5,6,7].

In this line, Problem Based Learning (PBL) is an active didactic methodology, which its positive results regarding students' competence development have been demonstrated [8,9,10,11]. The purpose of the PBL heads towards the creation of contexts of potential learning which allow students to develop the necessary abilities to apply the knowledge in an effective way, at the time in which the learning is occurring and particularly, after graduate studies are concluded, when they can take over the professional tasks for which they are presumed to be competent. The defining characteristics of the PBL are the following: a) learning should be directed by the student; b) learning should take place in a social context, similar to those in which problems make sense; c) the professor or tutor should be the facilitator or a guide for the learning process conceived as autonomous; d) during the learning process the main aim is the search for authentic problems that will connect the learning context to the social context in which it would actually occur; e) after locating and identifying the problems found, these are used as tool-guides, to reach the knowledge and the necessary abilities for the solution of such; f) the new information is to be acquired through a self-directed learning process [12,13].

Evaluation acquires a main role, to find out, with a certain degree of certainty, which accomplishments are being achieved and thanks to what processes. This evaluation could bring us to the improvement of the future teaching staff. In other words, it is important to incorporate to the teaching area what is known as Evidence Based Practice [14], which is already doing professional of Medicine and that is extended, more each time, to other professional realms [15]. This takes us to acknowledge that any education action taken should be accompanied by control measures which would allow us to affirm or not its value. In this sense, the initial studies on PBL have been centered mainly on proving the effectiveness of this instructional methodology against those of traditional character; in order to produce useful knowledge for very complex professional practice, as is the practice of Medicine [12]. Nowadays, investigation is directed, not as much, as to finding out if the students are learning, but into knowing what is happening during the learning process and what enhances it or makes it more difficult [16,17]. Several studies place emphasis on pointing out as potential aspects of PBL: the construction of broad base of knowledge, the development of competence to resolve professional problems in

an effective way, the acquisition of abilities to learn in a self-directed manner and throughout life, as well as, the potential of cooperative work and the intrinsic motivation towards what is learned [18,19]. In this sense, the study of cooperative work, as well as cognitive and motivational components which take place, have become the aim of more recent studies [20,21,22]. Fernández, García, Caso, Fidalgo and Arias [23] established four factors which may be explaining the effects of the PBL: the emotional component (motivation and satisfaction), practical execution (resources and dedication of time and effort), the effects of learning (self-directed and active), and the transfer potentiality (generalizing that which is learned to other academic and professional realms). The results of the validity of the questionnaire on Evaluation of University Practice (EPU), designed from these four factors, were not conclusive [24]. Nevertheless, recent investigations establish the need to elaborate theories and instruments which may explore, in a systematic way, the multiple variables that might be influencing learning when the PBL focus is put into practice [25,26].

This study presents a double aim: a) to examine the students' perception and assessment regarding their competence development after the process of educational innovation has been put into practice, and b) to explore which variables are influencing the students' competence development.

2. MATERIALS AND METHODS

2.1 Participants

The sample was made up of 222 students (71.8% women) registered for the subject of Educational Psychology of the University of Cordoba, with ages from 21 to 52 years old ($M =$ 23.75, SD = 4.58), although 90% of the sample was between ages of 21 and 27. The 62.2% had attended the morning session with classroom practice and 37.8% had attended the afternoon session with semi-classroom practice.

2.2 Instruments

The questionnaire for the Evaluation of the Impact of Learning Based on Problems (EVIA), elaborated ad hoc, consists of 29 items distributed in 2 parts of questions; the first is made up of 20 items and includes aspects related to the methodology used. The second

refers to the level of acquisition of the competences of the subject. A Likert scale of five points was adapted, being "1" in much disagreement and "5" agreeing very much. The scale showed an excellent internal consistency of .99 [27]. The instrument consists of five scales: transfer potentiality ($α$ = .89), pre-professional competence ($α$ = .87), adequacy and transversality ($α$ = .83), satisfaction and accomplishment ($α$ = .85) y adequacy of the format with regards to time and effort ($α$ = .697).

2.3 Procedure

The project is directed towards discovering tasks and problems that the professional in teaching must assume. Therefore, the didactic methodology put into practice, based on the PBL through pre-professional projects, should begin with the selection of a relevant problem (common, new or possible) which occurs in the professional scenery of formal or non-formal education, focused on learning and its difficulties; it requires reasonable study allowing the student to advance from his/her knowledge to what he/she will be able to know, and from there, to what he/she is expected to know how to do. The project is approached by forming small groups from 3 to 5 persons. Once justified, it should include possible, original and innovative ways to reduce the questions of the educational problem. The main line of the pre-professional projects includes justification of the need to approach the problem, analysis of contributing theories and program keys already designed, contextualization, definition of objectives, professionals involved, design of intervention keys, chronogram and evaluation instruments with regards to the quality of the answer. The method is directed towards the promotion of a strategic context, which promotes the process of making decisions and the regulation of learning. The role of the professor is guiding and orienting the process of taking decisions, although the student assumes the control of the task. A timetable is established previously to coverage the project. Classroom and virtual tutoring, at individual and group level, become a basic element for this proposed methodology.

The procedure of data collection was performed after the course had ended, through the implementation of a self-report. The questionnaire was administered in the University classrooms, by the authors of the study, voluntarily and anonymously.

2.4 Data Analysis

The EVIA scale was validated. An Exploratory Factorial Analysis (AFE) was performed, using the main components method with Varimax rotation; and further on, it was used a Factorial Confirmation Analysis (AFC), from the considerations described by Hu and Bentler [28] and Hair et al. [27]. Finally, descriptive and multivariate analyses of lineal regression (successive steps method) were performed. The analysis programs used were SPSS and AMOS in their 18.0 version.

3. RESULTS

3.1 Exploratory Factor Analysis

Values of skewness (maximum -1.171) and for kurtosis (maximum 2.238) were optimal, according to the values found suspect by Curran, West and Finch [29], below 2.0 for skewness and 7.0 for kurtosis.

For the AFE, the simple adequacy measurement of Kaiser-Meyer-Olkin (KMO) showed a value of .93 and the Barlett test resulted statistically significant ($p <$ .001). These results allow the assumption that the factorial analysis results, a priori, as pertinent. It was excluded one item with factorial charge lower than .40, reducing the numbers of items to 29. Five factors were obtained with self-value greater than "1", which explains the total variance of 62.40% (see Table 1).

The first factor, transfer potentiality, explains 17.87% of the variance and is made up of seven variables which refer to the transfer of what has been learned to other problems of academic and/or professional nature. The second factor, pre-professional competence, is composed of nine variables, related to the ability to search and use the information, as well as, for evaluating and designing programs of psycho-educational intervention. This factor explains 15.39% of the variance. The third factor, adequacy and transversality, is made up of six variables which explain 12.97% of variance and refers to interpersonal abilities, autonomous work, and the adequacy of the work system in class. A fourth factor, which explains 9.16% of the variance, is composed of five variables and is denominated satisfaction and achievement with regards to didactic methodology. Finally, a fifth factor, adequacy of time and effort format, is made up of two items and it explains 6.99% of the variance.

3.2 Confirmatory Factor Analysis

A CFA of the model was done with five factors. The parameters of the model were estimated following the criteria of maximum likelihood. The adjustment results of the model were the following: p = .247; χ^2/gl = 1.354; RMSEA = .040; RMR = .006; CFI = .998; TLI = .994; GFI = .991; ECVI = .124. The rates of adjustment clearly proved that the data adjusted to the model of five factors [28].

3.3 Descriptive Analysis

Results show that working through PBL provides the potential to transfer what has been learned to other educational and professional contexts ($M =$ 4.06; $SD =$ 0.66). Similar results are observed in the development of pre-professional competence ($M =$ 3.75%; $SD =$ 0.57), in transversal and adequacy areas ($M =$ 3.79; $SD =$ 0.67), in the perception of satisfaction and achievement ($M =$ 3.91; $SD =$ 0.71), and when considering time adequacy and the effort put into the practice in this methodology ($M =$ 3.72; $SD =$ 0.86). No statistically significant differences have been observed by age and sex (see Table 2).

3.4 Linear Regression Analysis

In order to respond to the aim of exploring which variables are more influential in the competence development of students, an analysis of linear regression was done, using as variable criteria pre-professional competence factor. The mean obtained for each factor was considered. Results show that transfer potentiality and adequacy and transversality are the most determining factors with regards to the competence development in students; model that explains the 58% of its variability (R^2 = .58), $F_{2, 222}$ = 156.083, $p <$ .001 (see Table 3).

To determine which variables influence the most in competence development, an analysis of lineal regression was performed, taking into consideration all the items of the instrument with relation to the same criteria variable. Results show that the variability of the values of this type of competences is affected by a model composed of seven variables which explains 64% of the changes in criteria variable: motivation attitude, dealing with professional challenges, putting into practice interpersonal abilities, learning covered expectations, motivation to perform autonomous work, use of

theoretical contents and the potential to learn to learn ($F_{7, 222} = 56.923$, $p < .001$). And precisely, the first of them shows the highest ratio ($R^2 = .49$) (see Table 4). If these variables are related with the factor they belong, it is observed that

adequacy and transversality, in union with transfer potentiality are determinant factors for students' competence development. Also, it is important that the student sees his/her learning expectations fulfilled.

Table 1. Rotated components matrix (EVIA)

EVIA (α = .99)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1. What I have learned is useful for my professional future	.766				
2. Promotes strategies to approach future professional challenges	.714				
3. Promotes significant learning	.712				
4. Facilitates the approach to real problems in my profession	.700				
5. I have learned useful contents and strategies applicable to other subjects	.632				
6. Empowers learning to learn	.613				
7. Allows to find usefulness to theoretical contents	.562				
8. Diagnostic strategies that will facilitate people's knowledge; and from there, design and develop the appropriate and opportune psycho-educational intervention knowledge		.735			
9. Knowledge of innovative E/A process, in order to deal with diversity		.709			
10. Knowledge of cognitive, emotional, and affective processes in learning		.654			
11. Attitude of openness and collaboration with educational and professional institutions		.599			
12. Ability to evaluate innovative and intervention programs in the psycho-educational field.		.581			
13. Integrate, incorporate, and adjust the investigation results into the practice		.574			
14. Sound basic psychology knowledge for the profession		.531			
15. Ability to recover analysis information from different sources		.469			
16. Ability to apply theory to practice		.420			
17. We learn in team work			.661		
18. Working in an autonomous way has motivated me			.645		
19. Rating of the general evaluation is suitable			.595		
20. I have developed an attitude of motivation towards new challenges and the ability to adapt to innovative experiences in the psycho-educational field			.514		
21. I would recommend it for other subjects			.501		

22. I have put into practice interpersonal abilities of empathy, ability to listen actively, fluent communication, and permanent collaboration		.494			
23. I liked the working environment in class			.680		
24. I am satisfied with the work I have done			.632		
25. I feel that I have learned			.578		
26. My expectations with regards to my learning have been met			.541		
27. The methodology used has motivated me to work			.475		
28. The time taken to carry out the project has been adequate					.862
29.The effort required for it to be carried out has been adequate					.778
Percentage of variance explained	17.87	15.39	12.97	9.16	6.99

Table 2. Mean (typical deviation) of student perception by sex

	Female	Male	Total
Transfer potentiality	4.09 (0.66)	3.99 (0.69)	4.06 (0.66)
Pre-professional competence	3.76 (0.58)	3.74 (0.53)	3.75 (0.57)
Adequacy and transversality	3.79 (0.65)	3.74 (0.73)	3.78 (0.67)
Satisfaction and achievement	3.93 (0.73)	3.86 (0.66)	3.91 (0.71)
Adequacy time and effort	3.81 (0.84)	3.51 (0.87)	3.72 (0.86)

Table 3. Rates on lineal regression per factor for pre-professional competence

	β	t	Sig.	Beta	C.I. at 95% for Exp (β)	
					Inferior L.	*Superior L.*
Adequacy and transversality	.395	7.510	.000	.463	.291	.499
Transfer potentiality	.313	5.924	.000	.365	.209	.417

Table 4. Rates on linear regression for pre-professional competences and variables

Number of item	Factor	β	t	Sig.	Beta	C. I. at 95% for Exp (β)	
						Inferior L.,	*Superior L.*
20 (Motivational attitude)	3	.216	4.954	.000	.291	.130	.302
2 (Professional challenges)	1	.080	1.998	.047	.117	.001	.159
22 (Interpersonal abilities)	1	.140	3.588	.000	.185	.063	.217
26 (Expectations covered)	3	.091	2.519	.013	.128	.020	.162
18 (Motivation to autonomy)	3	.066	2.082	.038	.105	.004	.128
7 (Usefulness of theory)	1	.075	2.140	.033	.120	.006	.144
6 (Learn to learn)	4	.085	2.045	.042	.118	.003	.167

4. DISCUSSION

Revision of the scientific literature shows that there is a notable need to use active methodology for promoting autonomous work and competence development [30,31]. In an effort to find a possible link between the perception of the methodology used and the development of competence shown by the students, there have been findings that help us understand what might be the key that would support the benefit of PBL. In this sense, we have observed the important role played by the motivation for the development of pre-professional competences. This result confirms the value of the motivation, recognized in

different areas, such as self-regulated learning [32,33] or academic achievement [9,34]. On the other hand, a methodology based on the development of effective interpersonal abilities is a second key element. Numerous studies point out that cooperative learning and development of socio-emotional competence present more benefits than individual activity [35,36,37,38]. In the same way, perceiving that learning expectations have been covered becomes an influential variable in student's competence development. This result can be understood if we consider that motivation to the search for an increase in capabilities influence positively the effects on learning [39]. The importance of expectations in the results suggests that the student has been motivated by one's own learning, rather than other external goals. A fourth variable coincides with the main cognitive theories on learning [40,41], referred to the perception of the usefulness of the theoretical contents. It is essential to find sense and usefulness to what is being done to make learning meaningful. And this is precisely the sense of PBL, being that information emerges from the need to solve a specific psycho-educational problem, so the sense and usefulness of it are guaranteed. Furthermore, this methodology allows to learn not only to solve a specific problem, but to develop strategies to successfully meet any type of situation, in short, this is what has been called learning to learn, that in this study is the fifth factor of influence in the skills development of the students. Another important variable in the search in competence development is to promote student learning to enable them to deal with future challenges and to prepare them under professional profile demand in today's labor market [6]. Finally, autonomous work motivation becomes a successful key of this methodology, being that to take the lead role in the learning management becomes an attractive element for students [29,42]. In PBL, the pupil participates actively in the process of making decisions about his / her own learning process and teacher assumes the role of a guide in this process. This educational situation is substantially differentiated from traditional methodologies in which the student is limited to being a receptor of transmitted knowledge. However, it is still necessary to strengthen classroom this change in role taking [25].

These results should be interpreted in a number of limitations that in turn become future research. First, the sample is reduced, so it would be necessary to extend the study population to other subjects and academic studies, which would confirm the factor structure of the instrument used and the results obtained. On the other hand, it would be of great interest not only to collect information at the end of the course, but after a long time, in which students have been able to verify if they really make use of such competences who affirm to have acquired.

5. CONCLUSION

Working PBL through pre-professional projects is a methodology that offers benefits in this sense. The initial aim of this study was centered in knowing students' perception about PBL model and its competence development, as well as exploring what variables could be influencing the development of competences in Educational Psychology students. For this purpose, a questionnaire was designed and validated which has evaluated student perception concerning five factors: the development of pre-professional competence, transfer potentiality of learning, transversal character of learning and its adequacy, satisfaction and achievement obtained and time and effort spent. Results indicate that the students have a positive perception with regards to their competence development, that can lead us to think that this type of methodology not only promotes competences at a pre-professional level, but also is linked to the development of metacognitive abilities which allow the students to be aware of and reflect on their own learning [43].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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