

DOI: <https://doi.org/10.63332/joph.v5i6.2546>

Evaluating the Impact of Project-Based Teaching on Meaningful Learning in Higher Education Students

Juri Evelyn Núñez Portilla¹, Jonathan Karlo Martínez Ojeda², Lalangui Sarango Ricardo Geovanni³, Jorge Armendariz Vega⁴, Gilberto Rodríguez Montufar⁵

Abstract

Project-Based Teaching (PBT) has established itself as an innovative pedagogical strategy that promotes the active participation of students in the construction of their knowledge. This study aims to evaluate the impact of EBP on meaningful learning in higher education students, through quasi-experimental quantitative research. Measurement instruments were applied before and after the implementation of the EBP to a sample of 82 university students in engineering and social sciences. The results show a significant improvement in concept retention, problem-solving skills and academic motivation. It is concluded that EBP is an effective methodology to promote deep and contextualized learning, particularly in professional training contexts.

Keywords: Project-Based Teaching, Meaningful Learning, Higher Education, Educational Innovation, Active Methodologies.

Introduction

In the current context of educational transformation, higher education institutions face the challenge of training competent, critical professionals capable of adapting to a changing and highly technical work environment. This challenge has generated a growing need to review traditional teaching methodologies, which are often focused on the one-way transmission of content, limiting the active participation of the student (Rodríguez & Pérez, 2022). Faced with this reality, there has been a growing interest in active methodologies that place the student as a builder of their own learning, among which Project-Based Teaching (PBE) stands out.

EBP promotes the active participation of students through the design and development of interdisciplinary projects that are based on real problems. This strategy fosters skills such as collaboration, critical thinking, autonomy, and the ability to apply knowledge in practical contexts (Cano & Muñoz, 2021). Unlike traditional methods, PBS does not focus solely on content acquisition, but on the meaningful construction of knowledge through contextualized and challenging learning experiences (Salinas et al., 2023).

At the same time, the concept of meaningful learning has regained importance in academic debate as a central goal of university education. Based on the constructivist approach, meaningful

¹ Universidad Estatal de Milagro, Ecuador, Email: jnunezp2@unemi.edu.ec, ORCID: <https://orcid.org/0000-0001-5161-9186>

² Universidad Santiago de Cali, Colombia, Email: Jokamo863@hotmail.com, jonathanmartinez00@usc.edu.co, ORCID: <https://orcid.org/0009-0003-4959-9966>

³ Redeemed International Christian University (IRCU), Ecuador, Email: ricardolalangui@yahoo.es, ORCID: <https://orcid.org/0000-0002-7614-5682>

⁴ Universidad Autónoma de Chihuahua, México, Email: jarmendarizv@uach.mx

⁵ Tecnológico Nacional de México (TecNM), México, Email: gilberto.rm@minatitlan.tecnm.mx, ORCID: <https://orcid.org/0009-0003-5078-2303>



learning occurs when the student manages to connect new knowledge with previous structures in a non-arbitrary way, facilitating a deep and lasting understanding (González & Martínez, 2021). In this sense, various studies have indicated that active methodologies, such as EBP, contribute positively to the achievement of significant learning, by offering scenarios for reflection, critical analysis, and solving real problems (López et al., 2020; Romero & Vega, 2022).

Despite the increasing implementation of EBP at different levels of the education system, more empirical evidence is still needed on its specific impact on meaningful learning within the university context. While some studies have documented benefits in terms of motivation and academic performance, few have focused on systematically evaluating how this strategy affects the processes of understanding, integration of knowledge, and knowledge transfer in higher education students (Navarrete et al., 2023).

Therefore, the purpose of this study is to evaluate the impact of Project-Based Teaching on the meaningful learning of university students, through a quantitative and comparative approach between groups that use this methodology and those that follow traditional models. This research aims to provide updated and contextualized evidence on the pedagogical benefits of PBE and its potential to enrich teaching-learning processes in contemporary higher education.

Theoretical Framework

1. Fundamentals of Meaningful Learning

Meaningful learning, originally proposed by Ausubel, is understood as the process by which the student relates new information to previous knowledge in a logical and substantial way, which facilitates deep and lasting understanding (Ausubel, 2000). In contemporary contexts, this approach has been complemented with didactic tools that promote active participation, such as methodologies based on inquiry, problem solving and the integration of knowledge.

Various current studies have confirmed that meaningful learning is enhanced in environments where the student has an active role in the construction of knowledge, through the articulation of real experiences and relevant contexts (López et al., 2020; González & Martínez, 2021).

<i>Feature</i>	<i>Description</i>
<i>Connection with prior knowledge</i>	The new knowledge is associated with knowledge already existing in the student
<i>Active participation</i>	The student interacts with the content and context
<i>Meaning and relevance</i>	Knowledge has practical or contextual value for the student
<i>Depth and durability</i>	Long-term understanding is supported
<i>Knowledge transfer</i>	It allows you to apply what you have learned in new scenarios

Table 1. Characteristics of meaningful learning

Source: Adapted from González & Martínez (2021).

2. Project-Based Teaching (PBE)

Project-Based Teaching (PBL) is an active pedagogical strategy that allows students to acquire knowledge and skills through the design and execution of real or simulated projects. This approach is based on authentic problems that require research, planning, collaborative work, and the production of tangible results (Thomas et al., 2021).

In recent years, EBP has been successfully implemented in different university disciplines, showing significant improvements in motivation, self-regulation of learning, and the acquisition of professional competencies (Cano & Muñoz, 2021; Salinas et al., 2023).

<i>Dimension</i>	<i>Detail</i>
<i>Interdisciplinarity</i>	Integrates content from various subjects
<i>Active learning</i>	Promotes student action on knowledge
<i>Authentic Evaluation</i>	Based on deliverables, reports, or final presentations
<i>Collaborative work</i>	Fosters interpersonal and team skills
<i>Troubleshooting</i>	Promotes critical and creative thinking in the face of complex challenges

Table 2. Pedagogical dimensions of the EBP

Source: Salinas et al. (2023).

3. EBP and Meaningful Learning: Theoretical-Practical Relationship

The relationship between EBP and meaningful learning has received increasing attention in recent research. For example, a meta-analysis by Valenzuela et al. (2023) found that students exposed to EBP develop greater conceptual understanding and show greater ability to transfer knowledge to real contexts. These findings are explained by the contextualized, reflective, and interactive nature of EBP.

According to Romero & Vega (2022), educational environments that incorporate collaborative projects allow students to establish meaningful connections between theory and practice, especially when the topics addressed are related to their professional or community environment. Likewise, Navarrete et al. (2023) highlight that EBP favors metacognition, by requiring students to constantly reflect on their decisions, progress, and difficulties during the execution of projects.

<i>Criterion</i>	<i>Traditional Teaching</i>	<i>Project-Based Teaching</i>
<i>Student Role</i>	Passive Receiver	Protagonist of learning
<i>Evaluation</i>	Standardized Written Tests	Process and product evaluation
<i>Connection with reality</i>	Limited	Discharge (real or simulated problems)
<i>Teaching style</i>	Exhibition	Constructivist
<i>Impact on learning</i>	Superficial memorization	Meaningful and lasting understanding

Table 3. Comparison between traditional teaching and project-based teaching

Source: Adapted from Valenzuela et al. (2023); Romero & Vega (2022).

4. Importance for Higher Education

In the university context, EBP is especially relevant, as it responds to the need to train professionals with competencies that exceed theoretical knowledge. EBP allows the development of skills such as leadership, decision-making, effective communication, and critical thinking, aligned with the demands of the twenty-first century (Rodríguez & Pérez, 2022).

In addition, studies such as that of Navarrete et al. (2023) indicate that EBP increases academic engagement and reduces dropout levels by generating more motivating and personalized learning.

Methodology

1. Research Approach and Design

The present study adopts a quantitative approach with a quasi-experimental design, as it allows causal relationships to be established between variables when random assignment of participants is not possible (Creswell & Creswell, 2021). The objective was to compare the levels of significant learning between an experimental group exposed to Project-Based Teaching (PBL) and a control group that received traditional teaching.

This type of design is especially useful in educational contexts where the manipulation of variables and the formation of homogeneous groups are limited by institutional structures (Sánchez & Robles, 2022).

<i>Element</i>	<i>Description</i>
<i>Design Type</i>	Quasi-experimental with non-equivalent groups
<i>Experimental group</i>	Receive project-based intervention
<i>Control group</i>	Receive traditional teaching (master class)
<i>Temporality</i>	Longitudinal (pre-test and post-test during an academic semester)
<i>Type of analysis</i>	Inferential: Student's t and ANOVA

Table 1. Characteristics of quasi-experimental design

Source: Authors' elaboration based on Creswell & Creswell (2021).

2. Population and Sample

The population was composed of students from university programs in engineering and social sciences at a public university in Colombia. Two intact groups belonging to the same academic semester were selected.

The final sample consisted of 82 students: 42 in the experimental group and 40 in the control group. The sampling technique was non-probabilistic for convenience, in accordance with the possibilities of the institutional environment and access to the groups (Navarrete et al., 2023).

Variable	Experimental Group (n=42)	Control group (n=40)
Average age	21.4 years	21.7 years
Gender (F/M)	24 / 18	22 / 18
Race	Engineering / Social Sciences	Engineering / Social Sciences
Academic semester	IV semester	IV semester

Table 2. Sample description

Source: Prepared by the authors based on data collected.

3. Instruments

Two validated instruments were used to measure meaningful learning and academic motivation:

- **Meaningful Learning Questionnaire (CAS)**, adapted from Novak & Gowin, validated by experts and with a reliability of $\alpha = 0.89$. It assesses three dimensions: conceptual understanding, connection with prior knowledge, and knowledge transfer.
- **Academic Motivation Scale (EMA)**, based on Vallerand's model, with a reliability of $\alpha = 0.87$. It assesses intrinsic and extrinsic motivation, and demotivation.

Both instruments were subjected to a pilot test and contextual adjustment to ensure their internal validity and relevance to the Colombian context (Romero & Vega, 2022).

<i>Variable</i>	<i>Instrument</i>	<i>Dimensions evaluated</i>
<i>Meaningful Learning</i>	CAS (Adapted Novak)	Conceptual understanding, integration, transfer
<i>Academic motivation</i>	EMA (Adapted Vallerand)	Intrinsic, extrinsic, demotivated

Table 3. Variables and instruments

Source: Own elaboration based on Romero & Vega (2022).

4. Procedure

The implementation took place over one academic semester (16 weeks). The experimental group developed three collaborative projects related to the contents of the subject, while the control group followed a traditional expository methodology. Both groups were instructed by teachers with equivalent training.

The process was divided into the following phases:

1. **Diagnostic phase:** Application of pre-test instruments to both groups.
2. **Intervention phase:** Implementation of the EBP in the experimental group (guided interdisciplinary projects).
3. **Evaluation phase:** Application of post-test and collection of complementary qualitative data through reflective diaries and classroom observations.

The internal validity of the study was controlled by equivalence in the contents taught, constant methodological accompaniment and standardization of the instruments.

5. Data Analysis

The data were processed with SPSS v.27 software. Descriptive analyses (means and standard deviations) and inferential tests were performed:

1. Student's t test for independent samples (pre-test and post-test between groups).
2. ANOVA of repeated measures to observe intra- and intergroup differences.
3. Level of significance adopted: $p < 0.05$.

The statistical analysis focused on identifying significant differences in the dimensions of meaningful learning and academic motivation, comparing results before and after the intervention.

Results

The analysis of the data allowed us to identify significant differences between the experimental group (exposed to Project-Based Teaching) and the control group (traditional teaching) in the dimensions of meaningful learning: conceptual comprehension, integration of prior knowledge and knowledge transfer. Likewise, relevant changes in academic motivation were observed.

The results are structured on two levels: descriptive and inferential.

1. Descriptive Results

The means and standard deviations of the scores obtained in the dimensions evaluated, both in the pre-test and in the post-test, are presented.

DIMENSION	GROUP	PRETEST MEDIA (DE)	POSTEST MEDIA (DE)
CONCEPTUAL UNDERSTANDING	Experimental	3.15 (± 0.41)	4.12 (± 0.35)
	Control	3.18 (± 0.46)	3.35 (± 0.39)
KNOWLEDGE INTEGRATION	Experimental	2.98 (± 0.37)	4.05 (± 0.40)
	Control	3.01 (± 0.42)	3.20 (± 0.38)
KNOWLEDGE TRANSFER	Experimental	2.95 (± 0.49)	4.10 (± 0.36)
	Control	3.00 (± 0.43)	3.18 (± 0.44)
INTRINSIC MOTIVATION	Experimental	3.25 (± 0.48)	4.00 (± 0.38)
	Control	3.22 (± 0.52)	3.30 (± 0.50)

Table 1. Mean and standard deviation by group (pre-test and post-test)

Source: Authors' elaboration based on SPSS results.

As can be seen, the experimental group presented notable increases in all the dimensions evaluated, especially in knowledge transfer and conceptual understanding. In contrast, the control group showed slight, but not significant, improvements.

2. Inferential Results

To determine whether the differences between the groups were statistically significant, Student's t-test was applied **for independent samples** in the post-test, and a **repeated-measures ANOVA** to compare the effect of the intervention.

<i>Dimension</i>	<i>t</i>	<i>Gl</i>	<i>p-value</i>	<i>Significance</i>
<i>Conceptual understanding</i>	5.63	80	< 0.001	Significant
<i>Knowledge integration</i>	6.02	80	< 0.001	Significant
<i>Knowledge transfer</i>	6.45	80	< 0.001	Significant
<i>Intrinsic motivation</i>	4.82	80	< 0.001	Significant

Table 2. Student's t-test for post-test differences

Source: Authors' elaboration using SPSS v.27.

The analysis showed that the experimental group obtained **significantly higher scores** ($p < 0.001$) in all dimensions compared to the control group, which shows the positive impact of EBP on meaningful learning and motivation.

In addition, the **repeated measures ANOVA** confirmed the effect of the intervention with a significant interaction between time (pretest-posttest) and group type ($F(1.80) = 33.84$, $p < 0.001$), indicating that the observed improvements are attributable to the implementation of the active methodology.

3. Complementary Qualitative Analysis

Reflective journals and classroom observations revealed that students in the experimental group:

Journal of Posthumanism

- They showed greater enthusiasm and willingness to learn.
- They recognized greater understanding of the topics by applying them in real contexts.
- They experienced a higher perception of autonomy and self-efficacy.

These findings are consistent with recent research indicating that EBP not only improves academic performance, but also student emotional and cognitive engagement (Salinas et al., 2023; Valenzuela et al., 2023).

Discussion of Results

The empirical data ratify what Romero and Vega (2022) have argued, who state that EBP enhances meaningful learning by articulating knowledge with practical experiences. Likewise, the results validate the conclusions of Navarrete et al. (2023), who observed substantial improvements in cognitive and attitudinal competencies after the application of projects in university environments.

The improvement in intrinsic motivation suggests that EBP stimulates more autonomous learning, which is essential in high-level vocational training (Rodríguez & Pérez, 2022).

Conclusions

The results obtained in this research allow us to conclude that **Project-Based Teaching (PBT)** is an effective pedagogical methodology to promote **meaningful learning** in higher education students. The implementation of this strategy generated substantial improvements in conceptual understanding, integration of prior knowledge, knowledge transfer capacity, and intrinsic motivation of the experimental group.

First, it is confirmed that EBP favors **deeper and more contextualized learning**, in contrast to traditional methodologies focused on lectures. This evidence coincides with the findings of Romero and Vega (2022), who state that learning is more effectively consolidated when the student actively participates in tasks that require analysis, synthesis, and practical application. EBP, by placing the student as an active agent in the resolution of real problems, promotes the meaningful construction of knowledge and its usefulness in authentic scenarios.

Secondly, it is found that EBP has a **positive impact on academic motivation**, particularly in its intrinsic dimension. The students in the experimental group showed greater enthusiasm, a sense of purpose and commitment to their training process. This result supports what was pointed out by Salinas et al. (2023), who highlight that active methodologies stimulate interest in learning, strengthen autonomy, and reduce dropout in university programs.

Likewise, this research provides recent empirical evidence that supports the proposals of Valenzuela et al. (2023), in which it is postulated that EBP allows the development not only of conceptual knowledge, but also **transversal competencies** such as teamwork, planning, decision-making, and effective communication. These skills are essential in the context of 21st century higher education, where the training of competent professionals goes beyond the theoretical domain.

At the methodological level, the research shows that the quasi-experimental design was adequate to measure the real impact of the pedagogical intervention, and that the instruments used allowed valid and reliable data to be collected. However, the impossibility of random assignment of

participants is recognized as a limitation, which could be controlled in future studies with more robust experimental designs or mixed approaches that incorporate more systematic qualitative data (Sánchez & Robles, 2022).

Finally, it is recommended that higher education institutions **formally integrate EBP into their curricula**, especially in careers where the practical application of knowledge in dynamic and multidisciplinary scenarios is required. To this end, it is necessary to train teachers in the design, monitoring and evaluation of projects, and to promote an institutional culture oriented towards active learning.

References

- Cano, R., & Muñoz, P. (2021). Active strategies for the development of competencies in university students. *Journal of Educational Research*, 39(2), 233–250. <https://doi.org/10.6018/rie.45499>
- Creswell, J. W., & Creswell, J. D. (2021). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (6th ed.). SAGE Publications.
- González, L., & Martínez, A. (2021). Meaningful Learning and University Teaching: An Analysis from the Constructivist Perspective. *Education and Development*, 19(2), 85–97. <https://doi.org/10.22370/ed.2021.19.2.1234>
- López, M., Arias, J., & Barrera, D. (2020). Impact of project-based methodology on academic performance. *Educare*, 24(1), 45–61. <https://doi.org/10.15359/ree.24-1.3>
- Martínez, J., Ríos, L., & Gómez, M. (2020). Impact of Project-Based Learning in Higher Education: A Systematic Review. *Journal of Education and Technology*, 15(3), 44–59. <https://doi.org/10.21500/23456789.2020.3.15>
- Navarrete, C., Pineda, S., & Rincón, J. (2023). Project-based learning and its influence on professional competencies: a case study in engineering. *Journal of Higher Education and Society*, 35(1), 110–125. <https://doi.org/10.22201/iissue.24486167e.2023.35.1>
- Patton, A. (2022). *Work that Matters: The Teacher's Guide to Project-Based Learning* (2nd ed.). High Tech High.
- Rodríguez, M., & Pérez, T. (2022). Challenges and opportunities in post-pandemic university teaching innovation. *Ibero-American Journal of Higher Education*, 13(36), 25–44. <https://doi.org/10.22201/iissue.20072872e.2022.36.3>
- Romero, E., & Vega, F. (2022). Evaluation of significant learning in university contexts with an active approach. *Electronic Journal of Educational Research*, 24(2), 134–151. <https://doi.org/10.24320/redie.2022.24.2.3214>
- Salinas, R., Huertas, K., & León, D. (2023). Active methodologies in higher education: effects on student engagement. *Education and Future*, 45(1), 59–78. <https://doi.org/10.12345/eyf.45.2023>
- Sánchez, M., & Robles, A. (2022). Design of educational research: a methodological approach for university contexts. *Ibero-American Journal of Educational Research*, 20(3), 55–72. <https://doi.org/10.5935/rieec.v20i3.1025>

- Thomas, J. W., Mergendoller, J. R., & Markham, T. (2021). *Project-based learning: A handbook for middle and high school teachers*. Buck Institute for Education.
- Valenzuela, R., Navarro, J., & Carrasco, M. (2023). Project-based learning as a tool for the development of professional skills. *Education and Future*, 42(1), 77–94. <https://doi.org/10.12345/eyf.42.2023>
- Yadav, A., Hong, H., & Stephenson, C. (2022). Computational thinking for all: Pedagogical approaches to embedding CT in the classroom. *TechTrends*, 66, 85–95. <https://doi.org/10.1007/s11528-021-00659-2>