

# Project-Based Learning (PBL) With Virtual Mediations And Computer Tools In An Animal Genetics Course In An Animal Science Program

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## ABSTRACT

The project-based learning (PBL) strategy, supported by virtual mediations and computer tools, is an effective method of learning complex subjects based on the use of problems as a starting point for the acquisition or reinforcement of knowledge. In this study, it is proposed to adapt the methodology and approach of PBL to use it as a method of approaching all the curricular contents of the subject Animal Genetics, of the Animal Science programme of the University of Sucre-Colombia. The strategy was developed in the time allotted for the course and was applied to 32 students. The degree of familiarization, academic productivity, asynchronous mediation through e-mail, spreadsheet mastery and appreciation of the methodology implemented were determined. The results showed that 100% of the students were unaware of the application of the strategy, initially showing fears at the beginning of the activity. On analyzing the reports submitted throughout the semester, it was found that 50.0% of the students achieved an average mark of  $4.2 \pm 0.14$ , 40.6% achieved an average mark of  $3.70 \pm 0.09$  and only 9.4% obtained a failing mark. 55.2% of the students who achieved a passing grade had an average of more than 4.0 and 45.8% of the students were in the range 3.0- 3.9. The products delivered and the degree of completion were influenced by the degree of mastery of the spreadsheet and the level of email participation recorded. It was found that the learning strategy generated motivation in the students, reflected in the fulfilment of the goals and objectives set at the beginning of the course, and increased student-teacher interaction.

**Keywords:** Project-based learning, virtual mediations, informatics, Genetics, teaching.

## I. INTRODUCTION

Higher education programmers in the area of Agricultural Sciences in Colombia, have in common the theoretical-practical training that fosters the development of transversal competences in students, through the permanent application of knowledge in their own areas of knowledge in activities related to their professional work, constantly generating suitable environments to develop significant learning outcomes. Therefore, project-based learning (PBL) is an ideal strategy for the fulfilment of the learning outcomes of the subject Animal Genetics, which make up the curriculum of Animal Science of the University of Sucre Animal Science programme of the University of Sucre.

The PBL strategy promotes educational innovation, since the formulation of a project is used to solve a real problem in a community. Each project contains a problem or challenging question that guides students in the research process and the development of the project. In this search, they must generate questions and look for different sources to find solutions. Throughout this process, the school community reflects on what, how and why they are learning (Valencia & Suárez, 2023).

PBLs have been successfully applied in different subjects in different academic programmers (Lerzo et al., 2022; Alca & Vidal, 2023). Comparing PBL with behavioral methodologies has shown a higher degree of learning, since it allows the active participation of students, improving

their results, knowledge and habits, developing skills such as teamwork, autonomous learning, responsibility and time management (Maldonado, 2008; Balanza et al., 2022).

Traverso et al. (2016), state that "In project-based learning experiences, detailed monitoring of the activities of the members of each team can be useful for the evaluation of their work. By means of assessment procedures, counsellors can evaluate teamwork skills with a formative purpose.

In the application of PBL, several assessments (self-assessment, peer-assessment, co-assessment) can be carried out to make the formative assessment sustainable. Following an evaluation strategy is not always easy for team members, as they need a reasonable knowledge of the evaluation process and criteria", that is why the rubric allows establishing the evaluation criteria for the project-based learning process, since through the defined assessment levels, judgements are made on the performance of the project developed by the students and the level achieved (Martínez, 2008). In this framework, PBL mediated by Information and Communications Technologies (ICT), promotes the construction of knowledge, life skills, meaningful learning, the development of skills to face challenges and the exploration of various alternatives that provide solutions to environmental problems (Badia & Garcia, 2006; Valencia & Suarez, 2023). In the subject of animal genetics, the teacher must design problems that are

challenges to be solved by the students, inducing them to commit to their resolution, through enquiry, analysis and evaluation of the information. Because of this, PBL is a didactic methodology that allows to respond to the formative needs of the student. In this context, PBL allows the teacher to motivate students and to achieve a deep understanding of the purpose of the principles that govern general genetics and that can be applied in the development of animal breeding programmers. In this way, and through group work, the students will incorporate the new knowledge into their previous cognitive structure, constructing their own knowledge and collaborating with each other to solve the problems (challenges) proposed by the teacher. For this reason, the objective of this study was to apply the PBL methodology in the design and evaluation in the development of the subject of general genetics in the Zootechnics programme of the Faculty of Agricultural Sciences of the University of Sucre, as a strategy to favors the acquisition of knowledge.

## **2. METHOD**

**2.1 Study participants.** The case study was conducted at the El Perico farm located at Kilometer 7 via Sincelejo-Sampués-Colombia (09°15' north latitude and 71°22'54" west longitude), where the campus of Agricultural Sciences of the University of Sucre is located. In relation to the study population, the sample is non-probabilistic (Hernández, et al., 2014). The methodological strategy of project-based learning, supported by virtual mediations and computer tools was applied to 32 students of the subject animal genetics (68.0% men and 32% women) of the fourth

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semester of the Animal Science programme of the academic period 01-2022, the subject, contemplates 3 academic credits, with a weekly hourly intensity of 3 theoretical hours and 2 practical hours, during 16 weeks, the ages of the students ranged between 19 and 27 years.

The course contemplates the development of learning outcomes that frame the understanding of genetic variability and its expression in animal production systems, analysis and application of the laws of inheritance and modification patterns of Mendelian inheritance within animal production systems, supported by basic statistical concepts, as well as the recognition and estimation of the sources of genetic variation from mathematical procedures as a fundamental basis of hereditary processes.

**2.2 Instruments for collecting information.** Questionnaires were used as an instrument to collect information. Initially, a survey was prepared to identify the degree of familiarity and fear of facing the strategy, which consisted of 2 questions; the first one to identify if they knew and/or had carried out academic activities with this type of methodological strategy in other subjects of their curriculum, with a positive and a negative option; if the answer was affirmative, they had to indicate which areas. The second was aimed at establishing the degree of uncertainty generated with the proposal, asking if they would change the learning strategy. Participant observation (researcher's field diary) and the application of knowledge enquiry instruments (previous ideas and final ideas), followed by the fulfilment of the aforementioned phases, the respective objectives, the products to be

generated and the evaluation rubric were socialized (Table 1).

**Table 1.** Assessment rubric agreed with learners.

Assessment ítems	Low rating	Average rating	High rating	Maximum score
Team Formation	He was not part of any team.	The team was set up, but no responsibilities were assigned.	The team was formed and responsibilities were distributed.	30
	0 points	To 10 points	To 20 points	
Mendelian inheritance	They did not carry out inspection of documents, nor did they participate in solving problems of classical genetics as applied to animal science.	Carried out the inspection of documents or participated in solving problems in classical genetics as applied to animal science.	Carried out the inspection of documents and participated in solving problems in classical genetics as applied to animal science.	80
	0 points	To 40 points	To 80 points.	
Probability and chi-square test, applied to genetics	I do not carry out any of the planned activities	Performed, or applied, the basic mathematical concepts of the chi-square significance test.	Performed, and applied the basic mathematical concepts of chi-square testing. -square test.	80
	0 points	To 40 points	To 80 points	

Pedigree analysis	It did not evaluate the submitted presented pedigree -	Evaluated or submitted pedigree Pedigree -	Evaluated and presented the schemes Pedigree -	80
	0 points	To 40 points	To 80 points	
Genetic interaction	No Applied techniques explaining the principles and application of genetic interactions in animal production systems .-	Applied techniques or explained the principles and application of genetic interactions in animal production systems .-	They applied techniques, explained and simulated the principles and application of genetic interactions in animal production systems. -	80
	0 point	To 40 points	To 80 points	
Linkage and recombination	Does not apply the theoretical foundations, does not know the consequences of gene linkage and recombination. -	Apply the theoretical underpinnings or know the consequences of gene linkage and recombination. -	Apply the theoretical foundations and understand the consequences of gene linkage and recombination .-	50
	0 point	To 20 points	To 50 points	

Mutations	They do not define mutation and its types, nor did they determine the levels of gene, chromosomal and genomic damage in the hereditary material of any species.	Define the concept of mutation and its types, or determined the levels of gene, chromosomal and genomic damage in the hereditary material of any species.	They define the concept of mutation and its types. They also determine the levels of gene, chromosome and genome damage in the hereditary material of any species.	50
	-	-	-	
	0 points	To 20 points	To 50 points	
Co-evaluation	He did not take responsibility and was not co-evaluated.	Assumed some responsibilities or performed them poorly	He assumed his responsibilities and co-assessed his colleague.	50
	-	.	-	
	0 points	To 10 points	To 30 points	
<b>Total</b>				<b>500</b>

The products generated were sent in a zipped folder, in PDF format, to the

The activities carried out by the students corresponded to the report of 50% of the final grade in the subject of genetics.

The activities carried out by the students corresponded to the report of 50% of the final grade of the genetics subject (500 maximum possible points were equivalent to an evaluation of 5).

The impact of the methodological strategy on the students was related to the percentage of compliance with the rubric, the products delivered and the grade obtained. Another © 2021 JPPW. All rights reserved

relevant indicator was the independent work activities carried out by the students to develop the competences.

At the end of the course, a survey was conducted to establish the impact of the proposal on the learning process, asking them whether or not they had been favored by the strategy implemented and what recommendations or adjustments they would make.

### 3. RESULTS

The results of the questionnaire showed that 21.4% of the students considered the project-based strategy to be a strategy that oriented

to the application of concepts in different areas, especially in livestock production systems, while 83.34% stated that they did not know the methodology. In the second

question, 100% of the students indicated that they wished to change the strategy for another one known and applied by the teachers (Table 2).

**Table 2.** Responses to a preliminary survey on the application of project-based learning (PBL) to students of the animal genetics course of the animal science programme at the University of Sucre.

Answers	Frequency	Questions 1(%)	Frequency	Questions a 2 (%)
YES	8	21.4	32	100
NO	24	78.6	0	0

Based on the fact that a large percentage of the students were unaware of the didactic strategy related to PBL, 8 groups of 4 participants were formed.

On analyzing the reports submitted throughout the semester, it was found that 50.0% of the students achieved an average mark of  $4.2 \pm 0.14$ , 40.6% achieved an

average mark of  $3.70 \pm 0.09$  and only 9.4% obtained a fail mark. 55.2% of the students who achieved a passing grade had an average of above 4.0 and 45.8% of the students were in the range 3.0- 3.9. Table 3 shows the number of students by range of marks obtained, the products delivered and the degree of compliance, taking the evaluation rubric as a reference.

**Table3.** Range of grades per student, products delivered and percentage of compliance applying.

Range of final grades	Number of students	Delivered products	Compliance (%)
0- 0.9	0	N.A	N.A
1.0–1.9	0	N.A	N.A
2.0-2.9	3	4	50.5
3.0-3.9	13	7	100
4.0-5.0	16	7	100

21 students completed 100% of the products, with grades  $\geq 3.7$ , attended extra sessions of guided accompaniment during the production cycle, reflecting a high degree of motivation and commitment to achieving the project objectives and the goals set out in the

rubric. The group of students (9.4%) who did not obtain a passing grade ( $\geq 3.0$ ) were the ones who showed the greatest disinterest, the least compliance and low or scarce mastery of the spreadsheet to analyses data, few consultations of digital information and

programmers on the internet, less use of crossover simulators to obtain F1 and F2 descendants and application of computer programmers to determine significance between the observed and the expected.

8 of the 32 students demonstrated mastery of the spreadsheet and 21 a basic to elementary level, an aspect that influenced the products delivered and the grade obtained.

The virtual mediations facilitated the delivery of the products and increased student-teacher interaction, since all the activities were sent through this medium and there was a feedback that allowed the students' interest to be maintained and enriched the experience with their comments and contributions. 100% of the students considered that the implementation of the strategy favored their learning.

#### 4. DISCUSSION

The initial survey showed that in general, the group of students was not familiar with the project-based learning strategy and recorded implementation of this strategy in other subjects throughout their curriculum, evidencing fears related to the non-fulfilment of the proposed objectives, similar to what has been found in the literature by several authors in different disciplines in the application of PBL (Sánchez et al., 2023; Zambrano et al., 2022; Maldonado, 2008).

The free formation of the groups allowed for the strengthening of interpersonal relationships and trust, allowing them to develop freely among peers and to join forces to achieve the objectives (Pino et al., 2023; Batista et al., 2023), except for those

students who showed the lowest percentage of compliance, which is consistent with the findings of Guerra (2008), where the students of the subject Mathematical Analysis II established social and friendship bonds that favored significant learning, due to the mutual support that allowed them to clarify ideas and strengthen their knowledge.

A high level of student interest in achieving the objectives and goals set out in the rubric was evident, since a large number of students (21) who participated in this learning strategy obtained high final evaluations ( $\geq 3.7$ ), sent the products in the required terms of reference, participated actively via email, socializing and asking for advice on their progress, and used the spreadsheet for the required activities, which influenced the percentage of compliance and the grade obtained. The opposite occurred with those students who obtained low and failed grades ( $\leq 3.0$ ), which reinforces what Badia & Garcia (2006) and Amari & Cárdenas (2022), who state that "novice students do not usually have prior knowledge of the subject, the procedures and their needs, and undertake complex tasks superficially. They use unsophisticated strategies, do not set ambitious goals and are very conformist with the result".

The use of the rubric allowed the student to establish the purpose, the methodology, encourage teamwork, meet the goals, interact permanently with the teacher, generate products and socialize them, complying with the elements for the design and development of a collaborative project described by Garcia and Badia (2006) and Altuna et al. (2021), but differing from other types of



projects according to Maldonado (2008) and in contrast to what is reported by Muñoz & Maldonado (2011) and Batista et al. (2023), who applied the project-based learning strategy to develop problem-solving skills in higher education, which allowed them to identify a health problem in the students' communities, its causes and the context of prevalence, focusing on the search for information, writing and submission of reports, bibliographic citation and copyright, encountering difficulties at the beginning of the course due to poor information management.

When evaluating the impact on the perception of the applied strategy on learning, we found that all participants (100%) considered it favorable, as the course allowed the application of the knowledge acquired theoretically and obtained results from it. Other cases have been reported, such as the one by Sánchez et al. (2023), on the perception of university students regarding project-based learning with technology, where through the execution of a project, participants showed their satisfaction with the proposed tasks. All of them were mediated by educational technology applications that were known to the sample. The good results were confirmed in the systematic observation, and in the research questionnaires applied, the students expressed that they learned adequately to plan, search for bibliography, apply the acquired knowledge, analyses, interpret and communicate results and work in groups.

Several authors have focused on the design and selection of teaching resources, considering them to be a key factor for

methodological success in the teaching of a thematic axis (Gómez, 2019; Smirnova et al., 2020). However, other studies assign a secondary role to didactic resources, placing them behind aspects such as the teaching role (Haerazi et al., 2019) or school organization (Sánchez et al., 2022).

## **5. CONCLUSION**

The present studies have explained the satisfaction of students in didactic experiences of methodological innovation by alluding to the potential for motivation that it provides.

Virtual mediations and computer tools and the involvement in learning attributed to project-based learning, it is considerable that both circumstances have influenced the good results obtained. However, we understand that there is another element that may be even more decisive, such as: the degree of affinity of perception of university students regarding project-based learning, the proposed reading, given that on some occasions they did not point to the need to consider the interests of students as a criterion for selection of teaching material.

## **6. AUTHOR'S CONTRIBUTION.**

Alexander Pérez Cordero: inquiry and research process, specifically conducting experiments and collecting data/evidence. Donicer E. Montes Vergara: Application of statistical, mathematical, computational and other formal techniques to analyze or synthesize the data of the study. William Niebles Núñez: Creation and/or presentation of the published work, specifically writing the initial draft.

**7. CONFLICT OF INTEREST.** The information contained in this manuscript is original, reviewed and prepared by the individuals involved. We declare that there is no conflict of interest that could compromise the validity of the results.

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