

**Effectiveness of project-based learning at the secondary level in virtual classes by covid-19**

**Efectividad del Aprendizaje Basado en Proyectos en el nivel secundario en clases virtuales por covid-19.**

**Kelvison Reyes<sup>1</sup>; Greisy Morillo<sup>2</sup>**

<sup>1</sup> Universidad Abierta para Adultos de Rep. Dom. (UAPA) <sup>2</sup>Universidad Nacional Evangélica (UNEV).

<sup>1</sup> dr.kelvisonreyes@gmail.com; <sup>2</sup>gmorillo@unev.edu.do

Received 30 oct 2021; Approved 25 Nov 2021; P46-105



Esta publicación está bajo una  
licencia Creative Commons  
Reconocimiento-NoComercial 4.0

---

## Resumen

El objetivo de esta investigación es analizar la efectividad del aprendizaje basado en proyecto para expresiones algebraicas en el nivel secundario en clases virtuales por covid-19, determinando dentro de este análisis el nivel de satisfacción del docente y los estudiantes al emplear dicha metodología de forma virtual y el nivel de logro de las competencias en los contenidos de expresiones algebraicas presentada por los estudiantes al finalizar el proyecto durante las clases virtuales por Covid-19. La metodología empleada estuvo bajo el enfoque cuantitativo, donde se aplicó una lista de cotejo al docente y un cuestionario y lista de cotejo a los estudiantes. Dentro de los resultados se encuentran que tanto el docente como los estudiantes se sienten muy satisfecho de aplicar el aprendizaje basado en proyecto de forma virtual, los estudiantes en su mayoría lograron las competencias esperadas sobre el tema de expresiones algebraicas, ya que el proyecto desde la virtualidad le permitió el trabajo colaborativo, sentirse motivados y ser protagonista de su propio aprendizaje.

**Palabras clave:** Expresiones algebraicas, aprendizaje basado en proyectos, nivel secundario.

## Abstract

The objective of this research is to analyze the effectiveness of project-based learning for algebraic expressions at the secondary level in virtual classes due to covid-19, determining within this analysis the level of satisfaction of the teacher and students when using said methodology virtually and the level of achievement of competencies in the content of algebraic expressions presented by students at the end of the project during virtual classes by Covid-19. The methodology used was under the quantitative approach, where a checklist was applied to the teacher and a questionnaire and checklist to the students. Among the results, it is found that both the teacher and the students feel very satisfied with applying project-based learning in a virtual way, the students mostly achieved the expected competencies on the subject of algebraic expressions, since the project from the virtuality allowed him to work collaboratively, feel motivated and be the protagonist of his own learning.

**Keywords:** Algebraic expressions, project based learning, secondary level.

---

## Introduction

In the teaching-learning process from virtuality, one of the great challenges that has been assumed is to use appropriate strategies and methods that achieve the motivation and attention of the students, which will become the development of competencies. For this reason we will present attention to the subject of mathematics in the subjects of algebraic expressions which is one of the contents that presents more difficulties, since numbers and letters must be related, which secondary level students consider difficult to learn. It is worth highlighting the research carried out by Morillo G.P. (2020), where they take a group of students of mathematics and related areas to analyze their state tests of Colombia and found relevant results to raise the educational level in future students of mathematics.

In secondary level education centers in the Dominican Republic, both teachers and students have had to make great efforts to be able to adapt to virtual-distance education, since they were not prepared for this new modality, which was forced by the covid-19 pandemic and the teaching-learning processes have had to undergo transformations that include pedagogical strategies in the form of tests and trials in order to determine their effectiveness in the development of students' competencies.

For this reason, the teacher is called to use better strategies from virtuality and try to implement some of those that he used in face-to-face classes to see if it achieves the same effects of development of competence in students, leaving aside traditional strategies such as expository strategies, master class, among others and give way to innovative strategies such as Project-Based Learning (PBL).

In that same order, the student needs to know what he wants to teach him for, and that is why they question whether they can be useful throughout his life. If the teacher takes advantage of this concern by using virtual teaching strategies that allow the student to be a fundamental part of building their own knowledge through experience and taking said learning to real life, as proposed by the ABP, this will make it their own. and an important part of his life, for this reason the aim of this article is to analyze the effectiveness of project-based learning for algebraic expressions at the secondary level in virtual classes due to covid-19, also to identify the degree of satisfaction of both the teacher and the

student when implementing the PBL and determining the level of achievement of algebraic expression competencies by students when applying Project Based Learning.

It is a career in every sense that society, the institution and those who accompany the student participate in order to achieve the competences and the outlined learning, this is verified by a study carried out by Ruiz et al. (2020) that is used to measure the performance of students through the evaluation of competencies, they took the results of their state tests, and other variables such as socioeconomic, in the city of Sincelejo - Sucre, Colombia.

According to Cataldi et al. (2010), the teacher has a guiding role in the pedagogical process and students are responsible for developing their knowledge through research, solving situations, following their needs and motivation. This passing will lead him to make his own decisions, which makes it an autonomous entity with initiatives and responsibility for its growth.

To complement the theoretical part of this article, the interested reader can consult Reyes and Morillo (2021), where a review of the literature on this topic was carried out.

## **Materials and methods**

The methodology of this research is mixed which is multimethodic, which allows combining designs of the qualitative, quantitative and mixed types in turn or sequentially. Taking into account the above, this research reflects the quasi-experimental.

The quasi-experimental design is considered as "a work plan with which it is intended to study the impact of the treatments and / or the change processes in situations where the subjects or observation units have not been assigned according to a random criterion" (Arnau cited by Fernández, Vallejo, Livacic and Tuero, 2014, p.757).

As can be seen for the purposes of this research, the subjects were not chosen randomly, since they must be students of 3rd grade of secondary education in which the mathematics teacher of that grade participates, in addition to the fact that an instrument will be applied to them.

Through field work with the implementation of a pilot plan of a Didactic Unit (UD) for the teaching of mathematics, analysis of documents and theories regarding the teaching-learning processes and descriptive statistics methods, as it will be seen here chi square test was applied. As in the research by Ruiz et al. (2018), in this work, principal component analysis or a unifactorial design of experiments could be applied Morillo and Ruiz (2020), but that is the subject for another investigation.

The UD is developed under the ABP methodology, it consists of carrying out a project with a total of 22 3rd year high school students and a teacher, with the title of the project "Algebraic expressions, a language for life", it seeks to achieve in students mathematical competences related to the subject of algebraic expressions. This project consists of 3 phases divided into 12 sessions of 60 minutes each.

The proposal arises from a real problem where students show great difficulties to understand and apply the subject of algebraic expressions and a project is proposed that allows them to have an experience of the use of algebraic expressions to solve everyday situations

In the first phase, the topic is communicated, which consists of developing materials for an exhibition to be held at the Educational Center on the applications of algebraic expressions to real-life contexts and each group will present a poster on this topic, in addition to forming teams of 5 random students, where each one will have a specific role: the coordinator, who has the function of being the representative of the team, the ICT manager, who has the responsibility of managing everything related to technology and the collaborators, which will be in charge of being support and complements for the development of the project. These functions will be assigned by each team among its members.

The second phase is where the project is implemented and developed through teamwork and with specific responsibilities, information search through free internet search, organization of online repositories, where resources are selected and the final product is elaborated . In the third phase, each team presents the final product with its results to the entire educational community, evidencing the skills developed, to evaluate the effectiveness of the project, various instruments were applied to the students and the teacher.

About the application of the instruments, for this research, an anecdotal record and five instruments were prepared, instrument 1: Checklist to evaluate the work teams (C1) consisting of 8 questions with

a dichotomous answer option (yes and no), instrument 2: List of collation to evaluate the presentation of the project results (C2) consisting of 10 questions with a dichotomous answer option (yes and no), instrument 3: Individual test on the subject of algebraic expressions (C3) consisting of 10 questions of multiple options, instrument 4: Checklist to evaluate the degree of satisfaction of the project by the students (C4) with 8 dichotomous questions (yes and no) and instrument 5: Checklist to evaluate the degree of satisfaction of the project by the teacher (C5) with 8 dichotomous questions (yes and no). The sources of the tables are self-made and for better visibility initials such as P are used to indicate question, J to indicate jury.

## Results and discussion

The instruments went through the validation process by expert juries, where they evaluated each item of each instrument taking into account the three relevant aspects of relevance, coherence and clarity. The aforementioned is in order to certify each instrument to be applied.

The validation of the instruments is considered an important element when conducting research, as indicated by Alsina, Á., & Coronata, C. (2020).

It should be noted that the instruments are validated before application to ensure that they are ideal or within the standard to apply.

For this study, the instruments were sent to 6 expert juries who evaluated the relevance, coherence and clarity of each item.

Subsequently, with the results of each jury, a Binomial test was applied.

Pineda, D. A. (1988), the relevance, coherence and clarity included in each instrument.

Regarding the validity of the instruments, the categories are  $p$  (probability of successes) and  $q(1 - p)$  and it is assumed that  $p = q = 0.50$ . This test is taken because the data are dichotomous and there is only one group of subjects (Mayaute, L. M. E. (1988)), cited by Muchotrigo, M. G., & Merino-Soto, C. (2020). The executed calculation yields the probability of occurrence directly, so that if it is less than 0.05 or 0.01, it is accepted that the item includes content validity.

The formula to calculate the Binomial Test is:

$$P(x) = nCx p^x (1 - p)^{n-x} \text{ being } nCx = \frac{n!}{x!(n-x)!}$$

Where  $n$  is the sample size,  $x$  is the number of trials,  $p$  is the probability of success, and  $q = 1 - p$  is the probability of failure.

Taking the response of each jury, a Binomial test was applied. In tables 1, 2, 3, 4, 5 and 6 J.1 means jury 1 and so on until the last jury, Q.1 means question 1 and if successively up to the question number of each instrument, BT means Binomial Test and S means sum.

The results obtained are the following:

*Table 1. Validation of Relevance Anecdotal Record with Binomial Test*

Jury	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	S
J.1	1	1	1	1	1	1	1	7
J.2	1	1	1	1	1	1	1	7
J.3	1	1	1	1	1	1	1	7
J.4	1	1	1	1	1	1	1	7
J.5	1	1	1	1	1	1	1	7
J.6	1	1	1	1	1	1	1	7
$p$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
$q$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$pq$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$x$	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.0156	0.0156	0.0156	0.0156	0.0156	0.0156	0.0156	
BT	0.0156							

Source: Own elaboration

*Table 2. Validation of Coherence Anecdotal Record with Binomial Test*

<b>Jury</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>S</b>
J.1	1	1	1	1	1	1	1	7
J.2	1	1	1	1	1	1	1	7
J. 3	1	1	1	1	1	1	1	7
J.4	1	1	1	1	1	1	1	7
J.5	1	1	1	1	1	1	1	7
J.6	1	1	1	1	1	1	1	7
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
<b>B</b>	0.01 56	0.01 56	0.01 56	0.01 56	0.01 56	0.01 56	0.01 56	
<b>BT</b>	0.01 56							

Source: Own elaboration

*Table 3. Validation of Clarity Anecdotal Record with Binomial Test*

<b>Jury</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>S</b>
J.1	1	1	1	1	1	1	1	7
J.2	1	1	1	1	1	1	1	7
J. 3	1	1	1	1	0	1	1	6

J.4	1	1	1	1	1	1	1	7
J.5	1	1	1	1	1	1	1	7
J.6	1	1	1	1	1	1	1	7
<i>p</i>	1.00	1.00	1.00	1.00	0.83	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.17	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.14	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	5.00	6.00	6.00	
B	0.01 56	0.01 56	0.01 56	0.01 56	0.09 37	0.01 56	0.01 56	
BT	0.02 68							

Source: Own elaboration

Table 4. Validation of Relevance, Checklist to evaluate work teams, with Binomial Test

Ju ry	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	S
J. 1	1	1	1	1	1	1	1	1	8
J. 2	1	1	1	1	1	1	1	1	8
J. 3	1	1	1	1	1	1	1	1	8
J. 4	1	1	1	1	1	1	1	1	8
J. 5	1	1	1	1	1	1	1	1	8



J. 6	1	1	1	1	1	1	1	1	8
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.015 6	0.015 6	0.015 6	0.015 6	0.01 56	0.01 56	0.01 56	0.01 56	
B T	0.015 6								

Source: Own elaboration

*Table 5. Validation of Coherence Checklist for evaluating work teams, with Binomial Test*

<b>Ju ry</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>
J. 1	1	1	1	1	1	1	1	1	8
J. 2	1	1	1	1	1	1	1	1	8
J. 3	1	1	1	1	1	1	1	1	8
J. 4	1	1	1	1	1	1	1	1	8
J. 5	1	1	1	1	1	1	1	1	8

J. 6	1	1	1	1	1	1	1	1	8
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.015 6	0.015 6	0.015 6	0.015 6	0.015 6	0.015 6	0.015 6	0.015 6	
B T	0.015 6								

Source: Own elaboration

*Table 6. Clarity Validation Checklist for evaluating work teams, with Binomial Test*

<b>J ur y</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>
J. 1	1	1	1	1	1	1	1	1	8
J. 2	1	1	1	1	1	1	1	1	8
J. 3	1	1	1	1	1	1	1	1	8
J. 4	1	1	1	1	1	1	1	1	8
J. 5	1	0	1	1	1	1	1	1	7

J. 6	1	1	1	1	1	1	1	1	1	8
<i>p</i>	1.00	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	5.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.015 6	0.093 7	0.015 6	0.01 56	0.015 6	0.015 6	0.015 6	0.015 6	0.015 6	
B T	0.025 4									

Source: Own elaboration

*Table 7. Validation of Relevance, Checklist to evaluate the presentation of project results, with Binomial Test*

Ju ry	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	S
J.1	1	1	1	1	1	1	1	1	1	1	10
J.2	1	1	1	1	1	1	1	1	1	1	10
J.3	1	1	1	1	1	1	1	1	1	1	10
J.4	1	1	1	1	1	1	1	1	1	1	10
J.5	1	1	1	1	1	1	1	1	1	1	10

J.6	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.02	0.015 6	0.015 6	0.01 56	0.01 56	0.015 6	0.01 56	0.01 56	0.01 56	0.01 56	0.015 6	0.015 6	
BT	0.015 6												

Source: Own elaboration

In table 7, at 15 for better visibility in the row corresponding to item B, the value of 0.0156 was adjusted to 0.02.

Table 8. Validation of Coherence Checklist to evaluate the presentation of project results, with Binomial Test

<b>J</b>											<b>Q</b>	
<b>u</b>		<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>.1</b>	
<b>r</b>	<b>Q.1</b>	<b>.2</b>	<b>.3</b>	<b>.4</b>	<b>.5</b>	<b>.6</b>	<b>.7</b>	<b>.8</b>	<b>.9</b>	<b>0</b>	<b>S</b>	
<b>y</b>												
J.1	1	1	1	1	1	1	1	1	1	1	1	0
J.2	1	1	1	1	1	1	1	1	1	1	1	0
J.3	1	1	1	1	1	1	1	1	1	1	1	0

J. 4	1	1	1	1	1	1	1	1	1	1	1	0	1
J. 5	1	1	1	1	1	1	1	1	1	1	1	0	1
J. 6	1	1	1	1	1	1	1	1	1	1	1	0	1
$p$	1.00	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0	1. 0	0	0
$q$	0.00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0	0
$p$ $q$	0.00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0	0
$x$	6.00	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	0	0
B	0.02	0. 2	0. 2	0. 2	0. 2	0. 2	0. 2	0. 2	0. 2	0. 2	0. 2	0	0
B T	0.015 6												

Source: Own elaboration

Table 9. Clarity Validation Checklist to evaluate the presentation of project results, with Binomial Test

<b>J</b>		<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q</b>	<b>Q.</b>	<b>S</b>
<b>u</b>	<b>Q.1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>.5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>.9</b>	<b>10</b>	
<b>r</b>											
<b>y</b>											
J.								1.			1
1	1	1	1	1	1	1	1	0	1	1	0
J.											1
2	1	1	1	1	1	1	1	1	1	1	0
J.											1
3	1	1	1	1	1	1	1	1	1	1	0
J.											1
4	1	1	1	1	1	1	1	1	1	1	0
J.											1
5	1	1	1	1	0	1	0	1	0	0	6
J.											1
6	1	1	1	1	1	1	1	1	1	1	0
<i>p</i>	1.00	1.00	1.00	1.00	0.83	1.00	0.83	1.00	0.83	0.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.17	0.00	0.17	0.00	0.17	0.00	
<i>p</i>		0.00	0.00	0.00	0.14	0.00	0.14	0.00	0.14	0.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.04	0.00	0.14	0.00	0.04	0.14	

x	6.00	6.00	6.00	6.00	5.00	6.00	5.00	6.00	5.00	5.00	
B	0.02	0.02	0.02	0.02	0.09	0.02	0.09	0.02	0.09	0.09	
B T	0.04 69										

Source: Own elaboration

Table 10. Relevance Validation, Individual Test on the subject of algebraic expressions, with Binomial Test

<b>J</b>		<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>S</b>
<b>u</b>		<b>.2</b>	<b>.3</b>	<b>.4</b>	<b>.5</b>	<b>.6</b>	<b>.7</b>	<b>.8</b>	<b>.9</b>	<b>.1</b>		
<b>r</b>	<b>Q.1</b>											
<b>y</b>												
J.1	1	1	1	1	1	1	1	1	0	1	1	1
J.2	1	1	1	1	1	1	1	1	1	1	1	0
J.3	1	1	1	1	1	1	1	1	1	1	1	0
J.4	1	1	1	1	1	1	1	1	1	1	1	0
J.5	1	1	1	1	1	1	1	1	1	1	1	0

J.											1
6	1	1	1	1	1	1	1	1	1	1	0
		1.	1.	1.	1.	1.	1.	1.	1.	1.	
<i>p</i>	1.00	0	0	0	0	0	0	0	0	0	
		0.	0.	0.	0.	0.	0.	0.	0.	0.	
<i>q</i>	0.00	0	0	0	0	0	0	0	0	0	
		0.	0.	0.	0.	0.	0.	0.	0.	0.	
<i>p</i>		0	0	0	0	0	0	0	0	0	
<i>q</i>	0.00	0	0	0	0	0	0	0	0	0	
		6.	6.	6.	6.	6.	6.	6.	6.	6.	
<i>x</i>	6.00	0	0	0	0	0	0	0	0	0	
		0.	0.	0.	0.	0.	0.	0.	0.	0.	
<i>B</i>	0.02	0	0	0	0	0	0	0	0	0	
		2	2	2	2	2	2	2	2	2	
<i>B</i>	0.015										
<i>T</i>	6										

Source: Own elaboration

Table 11. Validation of Coherence Individual test on the subject of algebraic expressions, with Binomial Test

Jury	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	S	
J.1	1	1	1	1	1	1	1	1.	0	1	1	10
												.0



J.2	1	1	1	1	1	1	1	1	1	1	10 .0
J.3	1	1	1	1	1	1	1	1	1	1	10 .0
J.4	1	1	1	1	1	1	1	1	1	1	10 .0
J.5	1	1	1	1	1	1	1	1	1	1	10 .0
J.6	1	1	1	1	1	1	1	1	1	1	10 .0
$p$	1.00	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	1. 00	
$q$	0.00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	
$pq$	0.00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	0. 00	
$x$	6.00	6. 00	6. 00	6. 00	6. 00	6. 00	6. 00	6. 00	6. 00	6. 00	
B	0.02	0. 02	0. 02	0. 02	0. 02	0. 02	0. 02	0. 02	0. 02	0. 02	
BT	0.01 56										

Source: Own elaboration

*Table 12. Clarity Validation Individual test on the subject of algebraic expressions, with Binomial Test*

<b>J</b>		<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	
<b>u</b>	<b>Q.1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>S</b>	
<b>r</b>												
<b>y</b>												
J.								1.				10
1	1	1	1	1	1	1	1	0	1	1		.0
J.												10
2	1	1	1	1	1	1	1	1	1	1		.0
J.												10
3	1	1	1	1	1	1	1	1	1	1		.0
J.												10
4	1	1	1	1	1	1	1	1	1	1		.0
J.												4.
5	1	0	0	1	1	1	0	0	0	0		0
J.												10
6	1	1	1	1	1	1	1	1	1	1		.0
<i>p</i>	1.00	0.	0.	1.	1.	1.	0.	0.	0.	0.		
		83	83	00	00	00	83	83	83	83		
<i>q</i>	0.00	0.	0.	0.	0.	0.	0.	0.	0.	0.		
		17	17	00	00	00	17	17	17	17		
<i>p</i>		0.	0.	0.	0.	0.	0.	0.	0.	0.		
<i>q</i>	0.00	14	14	00	00	00	14	14	14	14		
<i>x</i>	6.00	5.	5.	6.	6.	6.	5.	5.	5.	5.		
		00	00	00	00	00	00	00	00	00		
<b>B</b>	0.02	0.	0.	0.	0.	0.	0.	0.	0.	0.		
		09	04	06	01	01	09	09	09	09		

B	0.06										
T	25										

Source: Own elaboration

*Table 13. Validation of Relevance, Checklist to evaluate the degree of satisfaction of the project by the students, with Binomial Test*

<b>J</b>		<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	
<b>u</b>									
<b>r</b>	<b>Q.1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>S</b>
<b>y</b>									
J.									8.
1	1	1	1	1	1	1	1	1	0
J.									8.
2	1	1	1	1	1	1	1	1	0
J.									8.
3	1	1	1	1	1	1	1	1	0
J.									8.
4	1	1	1	1	1	1	1	1	0
J.									8.
5	1	1	1	1	1	1	1	1	0
J.									8.
6	1	1	1	1	1	1	1	1	0
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

$p$		0.	0.	0.	0.	0.	0.	0.	
$q$	0.00	00	00	00	00	00	00	00	
$x$	6.00	6.	6.	6.	6.	6.	6.	6.	
$B$	0.02	02	02	02	02	02	02	02	
$B$	0.01								
$T$	56								

Source: Own elaboration

*Table 14. Validation of Coherence Checklist to evaluate the degree of satisfaction of the project by the students, with the Binomial Test*

<b>Ju</b>	<b>ry</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>
	J.1	1	1	1	1	1	1	1	1	8. 0
	J.2	1	1	1	1	1	1	1	1	8. 0
	J.3	1	1	1	1	1	1	1	1	8. 0
	J.4	1	1	1	1	1	1	1	1	8. 0
	J.5	1	1	1	1	1	1	1	1	8. 0
	J.6	1	1	1	1	1	1	1	1	8. 0

<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
B	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
B T	0.01 56								

Table 15. Clarity Validation Checklist to evaluate the degree of satisfaction of the project by the students, with the Binomial Test

<b>J</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>Q.</b>	<b>S</b>
<b>u</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	
<b>r</b>									
<b>y</b>									
J.									8.
1	1	1	1	1	1	1	1	1	0
J.									8.
2	1	1	1	1	1	1	1	1	0
J.									8.
3	1	1	1	1	1	1	1	1	0

J. 4	1	1	1	1	1	1	1	1	8. 0
J. 5	0	1	0	0	0	0	0	0	1. 0
J. 6	1	1	1	1	1	1	1	1	8. 0
<i>p</i>	0.8 3	1. 00	0. 83	0. 83	0. 83	0. 83	0. 83	0. 83	
<i>q</i>	0.1 7	0. 00	0. 17	0. 17	0. 17	0. 17	0. 17	0. 17	
<i>p</i> <i>q</i>	0.1 4	0. 00	0. 14	0. 14	0. 14	0. 14	0. 14	0. 14	
<i>x</i>	5.0 0	6. 00	5. 00	5. 00	5. 00	5. 00	5. 00	5. 00	
B	0.0 9	0. 02	0. 09	0. 09	0. 09	0. 09	0. 09	0. 09	
B T	0.0 84								

Source: Own elaboration

*Table 16. Validation of Relevance, Checklist to evaluate the degree of satisfaction of the project by the teacher, with Binomial Test*

<b>J</b>									
<b>u</b>									
<b>r</b>									
<b>y</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>

J.									8.
1	1	1	1	1	1	1	1	1	0
J.									7.
2	1	1	1	1	1	1	0	1	0
J.									8.
3	1	1	1	1	1	1	1	1	0
J.									8.
4	1	1	1	1	1	1	1	1	0
J.									8.
5	1	1	1	1	1	1	1	1	0
J.									8.
6	1	1	1	1	1	1	1	1	0
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	
<i>p</i>									
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	5.00	6.00	
B	0.015	0.015	0.015	0.015	0.015	0.015	0.093	0.01	
B	6	6	6	6	6	6	8	56	
B	0.025								
T	4								

Source: Own elaboration

*Table 17. Validación de Coherence Lista de cotejo para evaluar el grado de satisfacción del proyecto por el docente, con Prueba Binomial*

<b>J u r y</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>
J. 1	1	1	1	1	1	1	1	1	8 . 0
J. 2	1	1	1	1	1	1	0	1	7 . 0
J. 3	1	1	1	1	1	1	1	1	8 . 0
J. 4	1	1	1	1	1	1	1	1	8 . 0
J. 5	1	1	1	1	1	1	1	1	8 . 0
J. 6	1	1	1	1	1	1	1	1	8 . 0
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	
<i>p</i> <i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	



<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	5.00	6.00	
B	0.01	0.01	0.01	0.01	0.01	0.01	0.09	0.01	
B	56	56	56	56	56	56	38	56	
T	0.02								
T	54								

Source: Own elaboration

*Table 18. Clarity Validation Checklist to evaluate the degree of satisfaction of the project by the teacher, with Binomial Test*

<b>Ju</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>
J. 1	1	1	1	1	1	1	1	1	8 . 0
J. 2	1	1	1	1	1	1	0	1	7 . 0
J. 3	1	1	1	1	1	1	1	1	8 . 0
J. 4	1	1	1	1	1	1	1	1	8 . 0

J. 5	1	1	1	1	1	1	1	1	8 . 0
J. 6	1	1	1	1	1	1	1	1	8 . 0
<i>p</i>	1.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	
<i>q</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	
<i>pq</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	
<i>x</i>	6.00	6.00	6.00	6.00	6.00	6.00	5.00	6.00	
B	0.01 56	0.01 56	0.01 56	0.01 56	0.01 56	0.01 56	0.01 38	0.01 56	
B T	0.02 54								

Source: Own elaboration

The summary of the aforementioned can be seen in the following table.

Table 19. Summary Results of the Binomial Test for each instrument

Criteria	Anecdotal Record	C1	C2	C3	C4	C5
Relevanc e	0.0156	0.0156	0.0156	0.0156	0.0156	0.0254
Coherenc e	0.0156	0.0156	0.0156	0.0156	0.0156	0.0254
Clarity	0.0268	0.0254	0.0469	0.0625	0.0840	0.0254

Source: Own elaboration

Taking into account what is observed in the table, there is no value greater than 0.05, allowing all the instruments to be accepted for each of the criteria corresponding to relevance, coherence and clarity.

Just as the Validity of an instrument is important, so is the Reliability of the instrument.

It should be noted that the reliability of the instrument generates added value to the research, García (2020).

For this research, the Cronbach's Alpha test was selected to study the reliability of the instruments, as used by Núñez (2021).

Table 20. Cronbach's Alpha Criteria and KR-20

Interval	Conclusion
1 - 0.9	Excellent
0.89 - 0.8	Okey
0.79 - 0.7	Acceptable
0.69 - 0.6	Questionable
0.59 - 0.5	Poor
Menor a 0.5	Unacceptable

Source: Own elaboration

*Cronbach's Alpha Formula*

$$\alpha = \left[ \frac{k}{k-1} \right] \left[ 1 - \frac{\sum_{i=1}^k S_i^2}{S_t^2} \right]$$

Where,

$S_i^2$  is the variance of the item  $i$

$S_t^2$  is the variance of observed totals

$k$  is the number of questions or items

For this instrument, the Kuder-Richardson (Kr20) test was applied, the result and its formula are as follows:

$$r = \left[ \frac{k}{k-1} \right] \left[ 1 - \frac{\sum_{i=1}^k p_i q_i}{\sigma_X^2} \right]$$

where  $p_i$  is the proportion of correct responses to item  $i$ ,  $q_i$  is the proportion of incorrect responses to item  $i$  ( $p_i + q_i = 1$ )

Table 21. Checklist for evaluating work teams

G	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	S
1	1	1	1	1	1	1	1	1	8
2	1	1	1	1	1	1	1	1	8
3	0	1	1	1	1	1	1	1	6
4	1	1	1	1	1	1	1	1	8
5	1	1	1	1	1	1	1	1	7
6	1	1	0	1	1	1	1	1	7
$p$	0.833	1	0.833	1	1	1	1	1	7.666
$q$	0.166	0	0.166	0	0	0	0	0	0.333
$pq$	0.138	0	0.138	0	0	0	0	0	0.277
<i>Var t</i>	<b>0.667</b>								

$k$	<b>8.0</b>
$\sum pq$	<b>0.278</b>
$k/(k-1)$	<b>1.143</b>
$r_{11}$	0.667

Source: Own elaboration

Taking into account that the value 0.667 is not acceptable for this instrument, it is decided to work with the Cronbach's Alpha test from now on.

Table 22. Checklist for evaluating work teams.

<b>G</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>S</b>	<b>Var</b>
<b>1</b>	1	1	1	1	1	1	1	1	8	0
<b>2</b>	1	1	1	1	1	1	1	1	8	0
<b>3</b>	0	1	1	1	1	1	1	1	6	0.21 4
<b>4</b>	1	1	1	1	1	1	1	1	8	0
<b>5</b>	1	1	0	1	1	1	1	1	7	0.12 5
<b>6</b>	1	1	1	1	1	1	1	1	7	0.12 5
<i>Var t</i>	<b>0.667</b>									
$k$	<b>8</b>									
$\sum S^2$	<b>0.25</b>									

$k/(k-1)$	<b>1.143</b>
<b>Alpha</b>	0.714

Source: Own elaboration

Table 23. Checklist to evaluate the presentation of project results

<b>G</b>	<b>Q. 1</b>	<b>Q. 2</b>	<b>Q. 3</b>	<b>Q. 4</b>	<b>Q. 5</b>	<b>Q. 6</b>	<b>Q. 7</b>	<b>Q. 8</b>	<b>Q. 9</b>	<b>Q. 10</b>	<b>S</b>	<b>Var</b>
<b>1</b>	1	1	1	1	1	1	1	1	1	1	10	0
<b>2</b>	0	1	1	1	0	1	1	1	1	1	8	0.178
<b>3</b>	1	1	1	1	1	1	1	1	1	1	10	0
<b>4</b>	1	1	1	1	1	1	1	1	1	1	10	0
<b>5</b>	1	1	1	1	1	1	1	1	1	1	10	0
<b>6</b>	1	1	1	1	1	1	1	1	1	1	10	0
<i>Var t</i>	<b>0.667</b>											
<i>k</i>	<b>10</b>											
$\sum S^2$	<b>0.1778</b>											
$k/(k-1)$	<b>1.111</b>											
<i>Alpha</i>	0.815											

Source: Own elaboration

Table 24. Individual test on the subject of algebraic expressions.

Q. 1	Q. 2	Q. 3	Q. 4	Q. 5	Q. 6	Q. 7	Q. 8	Q. 9	Q. 10	S	Va r
1	0	1	1	1	1	0	0	0	1	6	0.2 7
1	1	1	1	1	1	1	1	1	0	9	0.1 0
1	1	1	1	1	1	0	1	1	1	9	0.1 0
1	1	1	1	1	1	1	0	0	1	8	0.1 8
1	1	0	0	1	1	0	1	1	1	7	0.2 3
1	1	1	1	1	0	0	0	0	1	6	0.2 7
1	1	0	0	1	1	1	1	0	1	7	0.2 3
1	1	1	1	1	1	1	1	1	0	9	0.1 0
1	1	1	1	1	1	1	1	0	1	9	0.1 0
1	0	0	1	0	0	0	1	0	0	3	0.2 3
0	1	1	1	1	1	1	1	0	1	8	0.1 8

1	1	1	1	1	1	1	1	1	1	10	0.0
1	1	0	1	1	1	1	1	0	0	7	0.2
1	1	1	1	1	1	1	1	1	1	10	0.0
1	1	1	1	1	1	1	1	0	0	8	0.1
1	1	1	1	1	1	1	1	1	0	9	0.1
1	1	1	1	1	1	1	1	1	0	9	0.1
1	1	0	1	1	1	0	0	0	0	5	0.2
1	1	1	1	1	1	1	1	1	0	9	0.1
1	1	1	1	1	1	1	1	1	1	10	0.0
1	1	0	1	1	1	1	1	1	1	9	0.1
1	1	1	1	1	1	1	1	1	1	10	0.0

<i>Var</i>	<b>3.28</b>
<i>t</i>	<b>4</b>
<i>k</i>	<b>10</b>



$\sum S^2$	<b>3.07</b> <b>78</b>
$k/(k-1)$	<b>1.11</b> <b>1</b>
<b>Alp ha</b>	0.07 0

Source: Own elaboration

The test was applied to this test, but it is understandable that it requires a more in-depth statistical analysis before concluding that it is not reliable. Since they are the students' responses according to the research topic.

Regarding the instrument: Checklist to evaluate the degree of satisfaction of the project by the teacher, the test is not applied because it was answered only by a teacher in charge of the course studied.

Table 25. Checklist to evaluate the degree of satisfaction of the project by the students.

**Cronbach's Alpha test reliability**

Q. 1	Q. 2	Q. 3	Q. 4	Q. 5	Q. 6	Q. 7	Q. 8	S	Var
1	1	1	1	0	1	0	1	6	0,21 43
1	1	1	1	0	1	0	1	6	0,21 43
1	1	1	1	1	1	1	0	7	0,12 50

1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	0	1	1	7	0,12 50
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	1	1	1	8	0,00 00
0	1	1	1	1	1	1	1	7	0,12 50
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	1	1	1	8	0,00 00
1	1	1	1	1	0	1	1	7	0,12 50
1	1	1	1	1	1	1	0	7	0,12 50
1	1	1	1	1	1	1	1	8	0,00 00

1	1	1	1	1	1	1	1	8	0,00
1	1	1	1	1	1	1	1	8	0,00
1	1	1	1	1	1	1	1	8	0,00
1	1	1	1	1	1	1	1	8	0,00
1	1	1	1	1	1	1	1	8	0,00
1	1	1	1	1	1	1	1	8	0,00
<i>Var t</i>					0,4437				
<i>k</i>					8				
$\sum S^2$					1,05				
<i>k/(k-1)</i>					1,1429				
<i>Alfa</i>					-1,57073				

Source: Own elaboration

Cronbach's alpha is a coefficient that takes values between 0 and 1. The closer it gets to the number 1, the greater the reliability of the latent instrument. Obtaining a negative result that appears in the table above shows a high degree of internal inconsistency of the instrument in such a way that the calculation of alpha is not justified.

*Table 26. Improvement of the results of table 25, the Kr-20 test is applied*

	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>
--	------------	------------	------------	------------	------------	------------	------------	------------

$p$	0,954 5	1,000 0	1,000 0	1,0000	0,90 91	0,90 91	0,9091	0,90 91
$q$	0,045 5	0,000 0	0,000 0	0,0000	0,09 09	0,09 09	0,0909	0,09 09
$pq$	0,043 4	0,000 0	0,000 0	0,0000	0,08 26	0,08 26	0,0826	0,08 26
$Var t$	0,443 7							
$k$	8							
$\sum s^2$	0.217							
$k/(k-1)$	1,142 9							
KR-20	0,584							

Source: Own elaboration

It can be seen that the Kr-20 test improves the test value with respect to reliability, but it is not enough. However, a more detailed statistical analysis of said instrument is carried out, remembering that this instrument contains the students' responses.

When applying an index of response options to the Checklist instrument to evaluate the degree of satisfaction of the project by the students, it is evident that being an online form by Covid 19 topics, it is presumed that the students respond quickly. Which can be seen in the following table.

In addition, it will be observed in the table that O.I means option index, N means No and Y means Yes/

Table 27. Degree of satisfaction of the project by students

O.I	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8
N	0.0455	0.000	0.000	0.000	0.0909	0.0909	0.0909	0.0909
% N	4.55%	0.00%	0.00%	0.00%	9.09%	9.09%	9.09%	9.09%
Y	0.9545	1.000	1.000	1.000	0.9091	0.9091	0.9091	0.9091
% Y	95.45%	100%	100%	100%	90.91%	90.91%	90.91%	90.91%

Source: Own elaboration

Chi-square test is applied to the checklist instrument to evaluate the degree of satisfaction of the project by the students, crossing the response option variable with the questions of the instrument. In table 27 and so on N means option no, O, Y. is option yes, # C is column number, df is degrees of freedom, Chi.T is Chi square table, Chi.C is Chi square calculated. The results are:

Table 28. Observed contingency

O.I	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Sum
N	1	0	0	0	2	2	2	2	9
Y	21	22	22	22	20	20	20	20	167
Sum	22	22	22	22	22	22	22	22	176

Source: Own elaboration

Table 29. Contingency of Expected Values

O.I	Q.1	Q.4	Q.5	Q.6	Q.7	Q.8	Sum

N		1.12	1.12	1.12	1.12	1.12	7.87
		5	5	5	5	5	5
Y	20.8	20.8	20.8	20.8	20.8	20.8	
	75	75	75	75	75	75	167
Sum	20.8						174.
	75	22	22	22	22	22	9

Source: Own elaboration

Tabla 30. Summary of previous results

Number of rows	2
Number of columns	8
df	7
Alpha	0,05
Chi Test	14.0671
Chi Calculated	6.44045
P-value	0.49091

Source: Own elaboration

H0: the answer options are independent with the questions of the Checklist instrument to evaluate the degree of satisfaction of the project by the students.

H1: The answer options are not independent with the questions of the Checklist instrument to evaluate the degree of satisfaction of the project by the students.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.49091 is greater than the significance level (0.05), it is concluded that the variable the response options with the questions on the Checklist to evaluate the degree of satisfaction of the project by the students, They are independent.

***Answer Options Against Question 1 AND 2***

*Table 31. Observed Contingency Table*

O.I	Q.1	Q.2	Sum
N	1	0	1
Y	21	22	43
Sum	22	22	44

Source: Own elaboration

*Table 32. Contingency Table of Expected Values*

O.I	Q.1	Q.2	Sum
N	0.5	0.5	1
Y	21.5	21.5	43
Sum	22	22	44

Source: Own elaboration

*Table 33. Summary of previous results*

# rows	2
# columns	2
df	1
Alpha	0,05

Chi.T	3.84
Chi.C	1.02
P-value	0.31

Source: Own elaboration

H0: the response options with questions 1 and 2 of the checklist instrument are independent to assess the degree of satisfaction of the project by the students.

H1: The response options with questions 1 and 2 of the instrument Check list to evaluate the degree of satisfaction of the project by the students are not independent

Given that the P-Value 0.31175 is greater than the level of significance (0.05), it is concluded that the variable response options with the questions on the Checklist to evaluate the degree of satisfaction of the project by the students, are independent.

When crossing the answer options with questions 1 and 3, 1 and 4, the results are the same.

When crossing the answer options with question 1 and 5, 1 and 6, 1 and 7, 1 and 8, the results are the same.

Table 34. Observed Contingency Table

O.I	Q.1	Q.2	Su m
N	1	2	3
Y	21	20	41
Su m	22	22	44

Source: Own elaboration

Table 35. Contingency Table of Expected Values



O.I	Q.1	Q.2	Su m
N	1.5	1.5	3
Y	20. 5	20. 5	41
Su m	22	22	44

Source: Own elaboration

*Tabla 36. Summary of previous results*

# rows	2
# columns	2
df	1
Alpha	0, 0 5
Chi.T	3. 8 4
Chi.C	0. 3 6
P-value	0. 5 5

Source: Own elaboration

H0: the response options with questions 1 and 5 of the Checklist instrument are independent to assess the degree of satisfaction of the project by the students.

H1: The response options with questions 1 and 5 of the instrument Check list to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.49091 is greater than the level of significance (0.05), it is concluded that the variable response options with the questions on the Checklist to evaluate the degree of satisfaction of the project by the students, are independent.

A passing rate is applied to the Individual Test instrument on the subject of algebraic expressions, where A means Approved and U means Unapproved. The following results are obtained:

Table 37. Approval Rate for the Individual Test Instrument on the Subject of Algebraic Expressions.

O.I	Q. 1	Q. 2	Q.3	Q. 4	Q. 5	Q. 6	Q.7	Q.8	Q.9	Q.10
A	0.95	0.91	0.73	0.91	0.95	0.91	0.73	0.82	0.55	0.59
% A	95%	91%	73%	91%	95%	91%	73%	82%	55%	59%
U	0.05	0.09	0.27	0.09	0.05	0.09	0.27	0.18	0.45	0.41
% U	4.6%	9.1%	27.3%	9.1%	4.6%	9.1%	27.3%	18.2%	45.5%	40.9%

Source: Own elaboration

It is evident that in this instrument, questions 9 and 10 are the ones with the highest percentage of difficulty, with 45.45% and 40.91% respectively.

Crossing the grade variable with question 1 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students.

Table 38. Observed Contingency Table.

	Approved	Unapproved	Total
Dissatisfied	1	0	1
Satisfied	17	4	21
Total	18	4	22

Source: Own elaboration

Table 39. Contingency Table of Expected Values

	Approved	Unapproved	Total
Dissatisfied	0.818181818	0.181818182	1
Satisfied	17.18181818	3.818181818	21
Total	18	4	22

Source: Own elaboration

H0: the marks with question 1 of the checklist instrument are independent to evaluate the degree of satisfaction of the project by the students.

H1: The marks with question 1 of the instrument Checklist to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.62945 is greater than the level of significance (0.05), it is concluded that the variable marks with question 1 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

When crossing notes with question 2, notes with question 3, notes with question 4, of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, it can be seen that the observed values contain 0, therefore chi square cannot be calculated.

When crossing the notes with question 5 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, the following is obtained:

*Table 40. Observed Contingency Table for Q5*

	Approved	Unapproved	Total
Dissatisfied	1	1	2
Satisfied	17	3	20
Total	18	4	22

Source: Own elaboration

*Table 41. Contingency Table of Expected Values for Q5*

	Approved	Unapproved	Total
Dissatisfied	1.636363636	0.363636364	2
Satisfied	16.36363636	3.636363636	20
Total	18	4	22

Source: Own elaboration

*Table 42. Summary of previous results.*

# rows	2
# columns	2
df	1

Alpha	0,05
Chi.T	3.841
Chi.C	1.49722
P-Value	0.22110

Source: Own elaboration

H0: the marks with question 5 of the checklist instrument are independent to evaluate the degree of satisfaction of the project by the students.

H1: The marks with question 5 of the instrument Checklist to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.22110 is greater than the level of significance (0.05), it is concluded that the variable marks with questions 5 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

When crossing the notes with question 6 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, we have:

*Table 43. Observed Contingency Table for Q6*

	Approved	Unapproved	Total
Dissatisfied	1	0	1
Satisfied	17	3	20
Total	18	3	21

Source: Own elaboration

*Table 44. Contingency Table of Expected Values for Q6*

	Approved	Unapproved	Total

Dissatisfied	0.857142857	0.142857143	1
Satisfied	17.14285714	2.857142857	20
Total	18	3	21

Source: Own elaboration

Table 45. Summary of previous results

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.17500
P-Value	0.67571

Source: Own elaboration

H0: the marks with question 6 of the checklist instrument are independent to evaluate the degree of satisfaction of the project by the students.

H1: The marks with question 6 of the instrument Checklist to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.67571 is greater than the level of significance (0.05), it is concluded that the variable marks with questions 6 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

Cross-grade with question 7 of the Checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

Table 46. Observed Contingency Table for Q7

	Approved	Unapproved	Total
Dissatisfied	1	0	1
Satisfied	17	3	20
Total	18	3	21

Source: Own elaboration

Table 47. Contingency Table of Expected Values for Q7

	Approved	Unapproved	Total
Dissatisfied	0.857142857	0.142857143	1
Satisfied	17.14285714	2.857142857	20
Total	18	3	21

Source: Own elaboration

Table 48. Summary of previous results.

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.17500
P-Value	0.67571

Source: Own elaboration

H0: the marks with question 7 of the checklist instrument are independent to evaluate the degree of satisfaction of the project by the students.

H1: The marks with question 7 of the instrument Checklist to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.67571 is greater than the level of significance (0.05), it is concluded that the variable marks with question 7 of the checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

Crossing the variable grade with question 8 of the checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

Table 49. Observed Contingency Table for Q8

	Approved	Unapproved	Total
Dissatisfied	2	0	2
Satisfied	16	4	20
Total	18	4	22

Source: Own elaboration

Tabla 50. Contingency Table of Expected Values for Q7

	Approved	Unapproved	Total
Dissatisfied P8	1.636363636	0.363636364	2
Satisfied	16.36363636	3.636363636	20
Total	18	4	22

Source: Own elaboration

Tabla 51. Summary of previous results.

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841



Chi calculated	0.48889
P-Value	0.48442

Source: Own elaboration

H0: the marks with question 8 of the checklist instrument are independent to evaluate the degree of satisfaction of the project by the students.

H1: The marks with question 8 of the instrument Checklist to evaluate the degree of satisfaction of the project by the students are not independent

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.48442 is greater than the level of significance (0.05), it is concluded that the variable marks with questions 8 of the checklist instrument to evaluate the degree of satisfaction of the project by the students, they are independent.

With regard to the checklist instrument to assess the degree of satisfaction of the project by the teacher, no statistical test is applied since it was only a teacher and answered positively to the questions.

Likewise, no statistical test is applied to the checklist instrument to evaluate the presentation of the project results, there is a positive response in each working group.

On the other hand, regarding the Checklist instrument to evaluate the work teams, the first question of the 6 groups, only one did not work autonomously throughout the project.

Regarding question 2, only one group does not show team and collaborative work.

And they coincide in being group 3.

Regarding question 6, only groups 5 and 6 have not distributed the roles equally so that everyone participates.

The rest of the answers are positive.

We proceed to cross notes with question 3 and 7 of the Individual Test instrument on the subject of algebraic expressions.

Table 52. Observed Contingency Table

	Approved	Unapproved	Total
Q3	16	6	22
Q7	16	6	22
Total	32	12	44

Source: Own elaboration

Table 53. Contingency Table of Expected Values

	Approved	Unapproved	Total
Q3	16	6	22
Q7	16	6	22
Total	32	12	44

Source: Own elaboration

Table 54. Summary of previous results

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.00000
P-Value	1.00000

Source: Own elaboration

H0: the marks with questions 3 and 7 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 3 and 7 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi-square is less than the chi-square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 1.0000 is greater than the significance level (0.05), it is concluded that the variable marks with questions 3 and 7 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Crossing of notes with questions 3 and 9 of the Individual Test instrument on the subject of algebraic expressions.

*Table 55. Observed Contingency Table*

	Approved	Unapproved	Total
Q3	16	6	22
Q9	12	10	22
Total	28	16	44

Source: Own elaboration

*Table 56. Contingency Table of Expected Values*

	Approved	Unapproved	Total
Q3	14	8	22
Q9	14	8	22
Total	28	16	44

Source: Own elaboration

*Table 57. Summary of previous results*

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	1.57143
P-Value	0.21000

Source: Own elaboration

H0: the marks with questions 3 and 9 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 3 and 9 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.21000 is greater than the level of significance (0.05), it is concluded that the variable marks with questions 3 and 9 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Note crossing with questions 3 and 10 of the Individual test instrument on the subject of algebraic expressions, they are independent.

Table 58. Contingency Table Observed

	Approved	Unapproved	Total
Q3	16	6	22
Q10	13	9	22
Total	29	15	44

Source: Own elaboration

Table 59. Contingency Table of Expected Values

	Approved	Unapproved	Total
P3	14.5	7.5	22
P10	14.5	7.5	22
Total	29	15	44

Source: Own elaboration

Table 60. Summary of previous results

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.91034
P-Value	0.34002

Source: Own elaboration

H0: the marks with questions 3 and 10 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 3 and 10 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.34002 is greater than the significance level (0.05), it is concluded that the variable marks with questions 3 and 10 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Note crossing with questions 7 and 9 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Table 61. Observed Contingency Table.

	Approved	Unapproved	Total
P7	16	6	22
P9	12	10	22
Total	28	16	44

Source: Own elaboration

Table 62. Table of Expected Values.

	Approved	Unapproved	Total
P7	14	8	22
P9	14	8	22
Total	28	16	44

Source: Own elaboration

Table 63. Summary of previous results.

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05

Chi table	3.841
Chi calculated	1.57143
P-Value	0.21000

Source: Own elaboration

H0: the marks with questions 7 and 9 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 7 and 9 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.21000 is greater than the significance level (0.05), it is concluded that the variable marks with questions 7 and 9 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Note crossing with questions 7 and 10 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Table 64. Observed Contingency Table

	Approved	Unapproved	Total
P7	16	6	22
P10	13	9	22
Total	29	15	44

Source: Own elaboration

Table 65. Contingency Table of Expected Values

	Approved	Unapproved	Total

P7	14.5	7.5	22
P10	14.5	7.5	22
Total	29	15	44

Source: Own elaboration

Table 66. Summary of previous results.

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.91034
P-Value	0.34002

Source: Own elaboration

H0: the marks with questions 7 and 10 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 7 and 10 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.34002 is greater than the level of significance (0.05), it is concluded that the variable scores with questions 7 and 10 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Note crossing with questions 9 and 10 of the Individual Test instrument on the subject of algebraic expressions, they are independent.

Table 67. Observed Contingency Table



	Approved	Unapproved	Total
P9	12	10	22
P10	13	9	22
Total	25	19	44

Source: Own elaboration

*Table 68. Contingency of Expected Values*

	Approved	Unapproved	Total
P9	12.5	9.5	22
P10	12.5	9.5	22
Total	25	19	44

Source: Own elaboration

*Table 69. Summary of previous results*

# rows	2
# columns	2
df	1
Alpha(N sig)	0,05
Chi table	3.841
Chi calculated	0.09263
P-Value	0.76086

Source: Own elaboration

H0: the marks with questions 9 and 10 of the Individual Test instrument on the subject of algebraic expressions are independent.

H1: The marks with questions 9 and 10 of the Individual Test instrument on the subject of algebraic expressions are not independent.

Since the calculated chi square is less than the chi square of the table, the null hypothesis that they are independent is accepted.

Given that the P-Value 0.76086 is greater than the significance level (0.05), it is concluded that the variable marks with questions 9 and 10 of the Individual Test instrument on the subject of algebraic expressions, are independent.

## Conclusions

By applying various instruments to evaluate the effectiveness of the PBL for teaching algebraic expressions and evaluating the results, it is concluded.

That the students felt very motivated, they worked independently as a team, they were able to follow each of the 3 phases required by the PBL.

Both the teacher and the students expressed their satisfaction at the time of developing the project, since they found it very fun and that it was developed in a reasonable time allowing the students to develop the expected competencies.

It can be noted that with the correct implementation of the PBL, significant learning is developed in terms of mathematics content, more specifically in algebraic expressions.

For the students and the teacher, this strategy is innovative, since it is not implemented continuously, in addition to allowing the easy integration of technological resources and interdisciplinary integration, because it can be related to other subjects, allowing the student to develop comprehensively..

## References

- [1]. Alsina, Á., & Coronata, C. (2020). “Los procesos matemáticos en las prácticas docentes: diseño, construcción y validación de un instrumento de evaluación”. *Edma 0-6: Educación Matemática en la Infancia*, 3(2), 23-36.
- [2]. Cataldi, Z., Lage, F., y Cabero, J. (2010). La promoción de competencias en el trabajo grupal con base en tecnologías informáticas y sus implicancias didácticas. *Píxel-Bit. Revista de Medios y Educación*, (37), 209-224. <https://r.issu.edu.do/?l=11373uju>
- [3]. Fernández-García, P., Vallejo-Seco, G., Livacic-Rojas, P. E., & Tuero-Herrero, E. (2014). “Validez Estructurada para una investigación cuasi-experimental de calidad: se cumplen 50

- años de la presentación en sociedad de los diseños cuasi-experimentales”. *Anales de psicología*, 30(2), 756-771.
- [4]. García, F. D. A. C., & Barrios, Z. M. S. (2020). “Diseño y validación de un instrumento para medir los conocimientos en matemáticas básica que poseen los estudiantes de ciencias”. *Ciencia Digital*, 4(1), 253-269.
- [5]. Morillo, G. P. (2020). A Factorial Design Applied to Saber Pro Test of Math Students. *Revista Matua*, 7, No. 1, 1–13
- [6]. Muchotrigo, M. G., & Merino-Soto, C. (2020). “Efectos de un Programa de Intervención sobre las habilidades emocionales en niños preescolares”. *REOP-Revista Española de Orientación y Psicopedagogía*, 31(1), 62-80.
- [7]. Núñez, R. P., Suárez, C. A. H., & Fernández-César, R. (2021). “Determinantes afectivos, procedimentales y pedagógicos del rendimiento académico en matemáticas. Aproximación a una escala de valoración”. *Revista Boletín Redipe*, 10(3), 202-224.
- [8]. Pineda, D. A. (1988). Índices de los diez primeros números de *Universitas Philosophica*. *Universitas Philosophica*, 6(10).
- [9]. Reyes Alcequiez, K., y Morillo, G. P. (2022), Una metodología para el aprendizaje basado en proyectos de expresiones algebraicas en el nivel secundario. Aceptado en *Revista Transformación*.
- [10]. Ruíz Escorcía, R. R., y Morillo, G. P. (2020). A Design Of Experiments With A Single Factor Applied To The Test Icfes Saber 11 District Of Barranquilla Made In 2017. *Revista Matua*, 7, No. 1, 1–11
- [11]. Ruíz Escorcía, R. R., Rivas Méndez M., y Morillo, G. P. (2020). Factors associated with the results of the evaluation of Saber-Pro Competencies in the municipality of Sincelejo, Sucre in the period 2017. *Revista Matua*, 7, No. 1, 1–10
- [12]. Ruíz Escorcía, R. R., Arévalo Medrano, J. B., Morillo, G. P., Acosta-Humánez, P. B. (2018). Análisis de componentes principales aplicado a la prueba estatal Colombiana Saber 11. *Revista Espacios*, 39, No. 10, 1–12.

<sup>1</sup> Profesor de Postgrado de la Universidad Abierta para Adultos de Rep. Dom. (UAPA). Profesor de la escuela de matemáticas de la Universidad Nacional Evangélica de Rep. Dom. (UNEV), Profesor de postgrado de la Universidad Católica Santo Domingo de Rep. Dom. (UCSD). Doctor en didáctica de las matemáticas. Línea de investigación: aprendizaje y educación. Factores y estrategias asociados. CE: dr.kelvisonreyes@gmail.com

<sup>2</sup> Directora de Investigaciones de la Universidad Nacional Evangélica (UNEV), Recinto Santiago (República Dominicana). Directora Ejecutiva de Sembrando Pensamiento Científico, Santiago (República Dominicana). Magister en Estadística Aplicada. Doctorante en Estadística. Línea de investigación: Estadística Aplicada; Administración Financiera; Efecto Escuela; Cienciometría; Educación. Publicaciones recientes: (2020, en coautoría con R. Ruíz Escorcía y M. Rivas Méndez), “Factors associated with the results of the evaluation of Saber-Pro Competencies in the municipality of Sincelejo, Sucre in the period 2017.”. (2020), “A Factorial Design Applied to Saber Pro Test of Math Students”. (2020, en coautoría con R. Ruíz Escorcía) “A Design Of Experiments With A Single Factor Applied To The Test Icfes Saber 11 District Of Barranquilla Made In 2017”. CE: gmorillo@unev.edu.do