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Learning Geometry Through Virtual Media in Bilingual Intercultural Initial Education Students: First and Second Cycle of a Public University in Perú, 2021

Javier Carlin Ramos[1], Heiner Rhaner Vargas Ortega[2], Ruben Dario Mendoza Arenas[3], Josefina Arimatea García Cruz[4], César Vilchez Inga[5], Rubén José Mora Santiago[6], Mónica Beatriz La Chira Loli[7], Marisol Paola Delgado Baltazar[8] and Edwin Johny Asnate Salazar[9]

Abstract

The research focuses on evaluating the impact of virtual teaching materials, specifically the use of origami, on the learning of geometry in Intercultural Bilingual Initial Education students. Challenges arise such as the digital divide, cultural and language adaptability, and teacher preparation. The proposal is based on improving the understanding of concepts, the production of geometric figures and problem solving. The results show a significant increase in student performance, as well as greater participation and engagement during origami sessions. In addition, an increase in students' motivation and enthusiasm towards learning geometry is observed. The findings suggest that the use of origami as virtual teaching materials has a positive impact on the learning of geometry, supporting the relevance of this methodology in intercultural and multilingual environments.

Keywords: *Mathematics, Geometry learning, Polyhedra, Origami.*

INTRODUCTION

In the current educational scenario, marked by the rapid advancement of technologies and the growing adoption of virtual methods, the integration of virtual teaching materials in the teaching process has become a central topic of discussion. This research focuses specifically on the teaching of geometry for students of Bilingual Intercultural Initial Education at the Micaela Bastidas National University of Apurímac, where a series of crucial questions are raised about the effectiveness and impact of these resources in the early stages of childhood.

Geometry, as an essential discipline in cognitive development, presents significant challenges in terms of student understanding and engagement. The transition to virtual education, compounded by the cultural and linguistic diversity of the student population, has amplified these difficulties. Given this scenario, it becomes imperative to investigate and understand the true influence of virtual teaching materials on the geometric learning of children during their early and second childhood.

The effectiveness of virtual teaching materials becomes the epicenter of our inquiry, focusing on their ability to capture students' attention and facilitate the understanding of geometric concepts effectively. Furthermore, the cultural and language component emerges as a critical factor, and the adaptability of these resources to

[1] Universidad Nacional Micaela Bastidas de Apurímac, jcarlin@unamba.edu.pe

[2] Universidad Nacional San Antonio Abad del Cusco, 214235@unsaac.edu.pe

[3] Universidad Nacional del Callao, rdmendozaa@unac.edu.pe

[4] Universidad Nacional de Educación Enrique Guzmán y Valle, jgarcia@une.edu.pe

[5] Universidad Nacional del Callao, cvilchezi@unac.edu.pe

[6] Universidad Nacional de Educación Enrique Guzmán y Valle, rmora@une.edu.pe

[7] Universidad Nacional de Educación Enrique Guzmán y Valle, rmora@une.edu.pe

[8] Universidad Nacional del Callao, mpdelgadob@unac.edu.pe

[9] Universidad Nacional Santiago Antúnez de Mayolo, edwin_johny@unasam.edu.pe

the specific context of the Micaela Bastidas National University of Apurímac becomes an essential area of study to guarantee inclusive teaching.

The interaction of students with virtual materials and their influence on active participation during geometric activities constitute fundamental aspects that we want to explore. Likewise, we propose to analyze the development of specific geometric skills in early and second childhood, evaluating the contribution of these resources to the achievement of learning objectives and the promotion of children's cognitive development.

Previous academic performance indicators reveal a significant decline in geometry results, especially with the transition to virtual education. These data highlight the urgency of investigating effective strategies to improve the teaching of geometry in Intercultural Bilingual Initial Education students.

With the aim of shedding light on these problems, in this research we propose to comprehensively analyze the influence of virtual teaching materials in the geometry teaching process, with a specific focus on the use of origami as virtual resources. The experimental research design, with pretest and posttest measurements, will allow us to obtain fundamental quantitative data to understand the effectiveness and relevance of these materials in the particular context of the Micaela Bastidas de Apurímac National University during the year 2021.

RESEARCH PROBLEM

Statement And Foundation of The Research Problem

Generic Reality of The Problem at The International Level

UNESCO seeks to improve education through innovation in teaching methods and dissemination of information. The pandemic led to the virtualization of education, but this poses challenges, especially in the teaching of geometry in early and second childhood.

At a global level, four challenges stand out:

Equity in Access and Use: The digital divide limits access to virtual resources, generating inequalities in geometric learning.

Culturality and Languages: The cultural and linguistic adaptability of virtual resources to guarantee inclusive teaching.

Culturality and Languages: The cultural and linguistic adaptability of virtual resources to guarantee inclusive teaching.

Teacher Training: The preparation of teachers to effectively integrate virtual materials in the teaching of geometry.

In the Peruvian context, these challenges are exacerbated, especially in Intercultural Bilingual Initial Education. Limited technology and connectivity, along with a lack of teacher training, are key obstacles. Additionally, local reality, such as declining academic performance in mathematics, adds complexity.

Given this, the research proposes the use of origami as virtual teaching materials to improve the learning of geometry. The aim is to understand its effectiveness, cultural adaptability, student-material interaction and its impact on the development of geometric skills.

The international and national background supports the importance of teaching materials in the learning of mathematics, while the formulation of the problem focuses on the effectiveness of origami in the specific context of the Micaela Bastidas de Apurímac National University.

The delimitation of the study recognizes limitations such as the availability of technology and variations in student participation. However, the research is justified by its social and cultural relevance, its contribution to improving educational quality, its impact on cognitive development and its potential to promote equity and improve teacher training.

In conclusion, the proposed research not only seeks to generate academic knowledge, but also to positively impact the quality and equity of education, especially in the context of Intercultural Bilingual Initial Education at the Micaela Bastidas de Apurímac National University.

The study focuses on improving the learning of geometry in Intercultural Bilingual Initial Education students through the use of origami as virtual teaching materials. Specific objectives include determining improvements in understanding concepts, producing geometric figures, and solving geometric problems. The research also addresses the theoretical framework, where learning in geometry, virtual teaching materials and origami as a teaching tool are discussed. In addition, the methodology is proposed, which combines quantitative and qualitative methods, and the planned activities are detailed, such as geometric origami sessions, formative evaluations and surveys. It is expected that this study will contribute to the development of innovative pedagogical strategies for teaching geometry in intercultural and multilingual environments.

Table 1. Characteristics of learning approaches

	Motivation	Intention	Processes	Results
Shallow focus	Comply with the course. Fear to fail	Meet assessment requirements through playback	Learning by heart by repetition, facts or ideas that are barely interrelated	Zero or superficial level of commitment
Deep focus	Seek vocational relevance, interest in the subject	Make everything have personal meaning	Learning by understanding, by operation	Deep level of understanding if principles and facts are integrated and arguments are sought
Strategic approach	Get high grades. Compete with others	Achieve success by any means	Learning by memorization, by understanding or by operation	Depending on the characteristics of the course (objectives, evaluation methods, etc.)
Note. Entwistle, adapted from (Hernández Pina, 1993)				

Learning is a dynamic and adaptive process, where students' learning approaches may vary depending on the academic task and teaching context. This implies that the relationship between the student, the context and the task determine the learning approach. In this sense, it is proposed to integrate origami as virtual teaching material to improve the learning of geometry in future early education teachers. The proposal seeks to merge geometry with the creativity of origami and cultural richness, offering a comprehensive and meaningful educational experience in a bilingual intercultural environment.

The didactic proposal is divided into phases that include the introduction to Platonic polyhedra, the creation of origami models, and the exhibition and sharing of creations, all supported by materials such as origami paper, digital resources, electronic devices and virtual platforms. Each phase has specific activities, such as initial sessions, video tutorials, practical origami sessions, cultural narrative creation and virtual exhibitions, with the aim of developing geometric skills, encouraging active participation and strengthening cultural connection.

In addition, specific learning sessions are detailed, each with clear objectives, start, process and exit times, and activities designed to familiarize students with basic geometric concepts, introduce the origami technique, delve into the creation of polyhedra and apply Interactive activities to reinforce learning. These sessions seek to promote active participation, hands-on learning, and the application of geometry concepts in a meaningful way.

In summary, the didactic proposal seeks to offer an enriching learning experience that combines geometry, origami and culture, adapted to the needs and characteristics of bilingual intercultural initial education students, with the aim of improving the understanding of geometric concepts. and strengthen cultural and linguistic identity.

METHODOLOGICAL FRAMEWORK

The research focuses on determining whether the use of origami as virtual teaching materials improves the learning of geometry in students of Intercultural Bilingual Initial Education. A general hypothesis and three specific hypotheses are proposed to evaluate different aspects of learning in geometry. The dependent variable is learning in geometry, while the independent variable is the use of origami as virtual teaching materials. Each variable is conceptually and operationally defined, along with its indicators. The research approach is quantitative, using a two-measurement experimental design. The sample population consists of 35 Intercultural Bilingual Initial Education students, and inclusion, exclusion and elimination criteria are established. A questionnaire with 15 items will be used to collect data, and the analysis will be carried out using the SPSS program and descriptive statistical techniques. The results will be interpreted using statistical graphs to evaluate the effectiveness of the proposed program. Before presenting them, it is convenient to talk about the topic that is developed by applying the use of origami and how its implementation is structured.

Platonic Solids

Platonic solids are polyhedra whose faces are equal regular polygons and all their edges are of equal length; Within them are: tetrahedron, cube (or hexahedron), octahedron, dodecahedron and icosahedron, these being associated with the five elements of nature: fire, earth, air, water and the universe, they comply with the property $V + C = A + 2$, where V is the number of vertices; C, number of faces and A, number of edges, which was discovered by the mathematician Leonhard Euler.

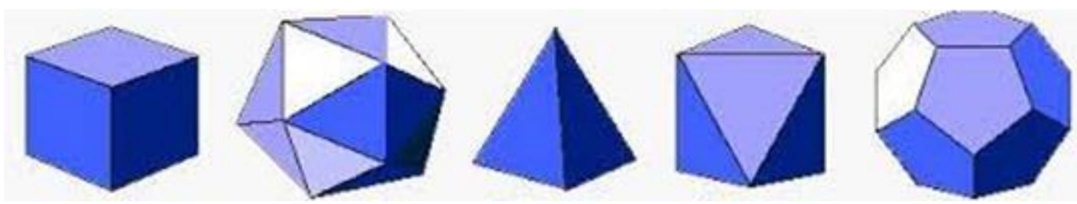


Figure 1. Examples of Platonic solids

Properties

There are only five regular polyhedra; This is due to the possibility of constructing its solid angles that admit equilateral triangles, or squares, or pentagons, which must be less than 360°.

Platonic solids have symmetrical characterizations:

The center of a cube (of a regular hexahedron) is the center of symmetry of said figure, it returns the same figure; but it is not, the center of a regular tetrahedron. All of them have respect to a point in space (center of symmetry) that is equidistant from their faces, their vertices and their edges, but the original figure is not preserved.

All of them also have axial symmetry with respect to a series of symmetry axes that pass through the previous symmetry center.

All of them also have mirror symmetry with respect to a series of symmetry planes (or principal planes), which divide them into two equal parts.

As a geometric consequence of the above, three particular spheres can be drawn in every Platonic solid, all of them centered on the center of symmetry of the polyhedron:

An inscribed sphere, tangent to all its faces at its center.

A second sphere tangent to all the edges at its center.

A circumscribed sphere, which passes through all the vertices of the polyhedron.

Conjugation: If a polyhedron is drawn using the centers of the faces of a Platonic solid as vertices, another Platonic solid is obtained, called a conjugate or dual of the first, with as many vertices as there are faces in the initial solid, and the same number of edges. The conjugate polyhedron of a dodecahedron is an icosahedron, and vice versa; that of a cube is an octahedron; and conjugate polyhedron of a tetrahedron is another tetrahedron.

Intrinsic equation: Euler's theorem for polyhedra expresses a topological quality of convex polyhedra, regardless of their measurements an [illegible] ular polyhedra. It states that the number of faces of a Platonic polyhedron plus [illegible] qual to the number of its edges plus two, using the following equation: V + C [illegible]

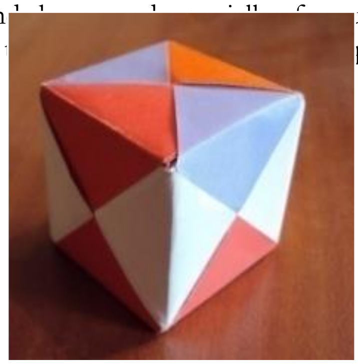


Figure 2. Construction of Platonic polyhedra

Curricular scope

Build representations of geometric shapes to design objects and be able to make direct or indirect measurements of surfaces and volumes.

Pedagogical Process

Let's make a modular cube from the faces. To do this, we need six modules of identical shape and size (square sheet). The module used is a variation of the traditional Sonobé module and follows the same assembly scheme.

Hexahedron or cube

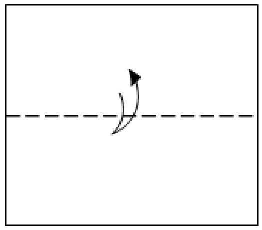
A regular cube or hexahedron is a polyhedron with six congruent square faces, being one of the so-called Platonic solids.

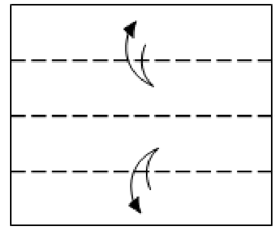
A cube, in addition to being a hexahedron, can also be classified as a right or rectangular parallelepiped, since all its faces have four sides and parallel two to two, and even as a prism with a quadrangular base and height equivalent to the side of the base.

The regular hexahedron, like the rest of the Platonic solids, complies with Euler's Theorem of Polyhedra, since it has six faces, eight vertices and twelve edges (8 + 6 = 12 + 2).

Instructions for creating the module:

Observe carefully and follow the following sequence of steps, mark each break very well so that the edges of your hexahedron are perfectly defined:

<table>
<tr>
<td>


1. Take a square sheet of paper, fold it in half, bottom side up.
</td>
<td>


2. Fold the bottom and top towards the center, divide the sheet into 4.
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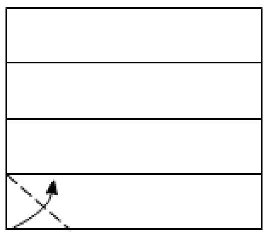
<tr>
<td>


3. Fold the bottom left corner to the edge of the mark, forming a right triangle.
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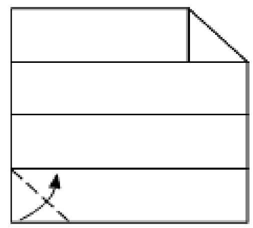
<td>


4. Rotate the paper 180° and repeat step: 3 again.
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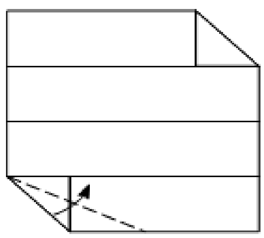
<td>


5. Fold over the same corner again to construct an obtuse triangle.
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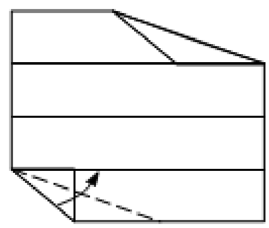
<td>


6. Rotate the paper 180° and repeat step: 5 again.
</td>
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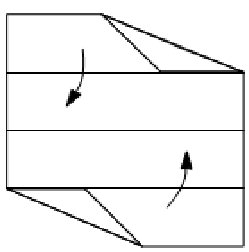
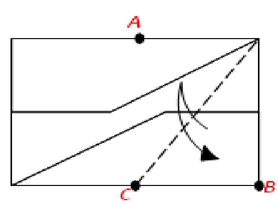
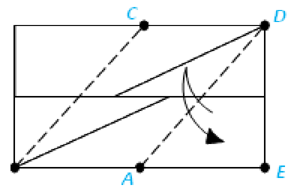
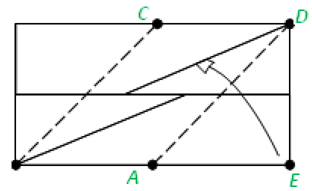
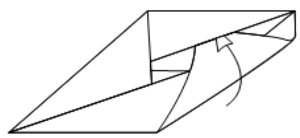
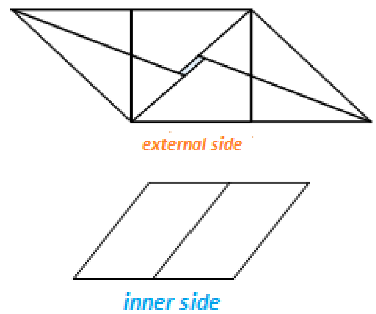
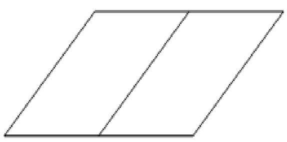
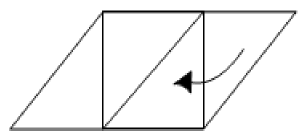
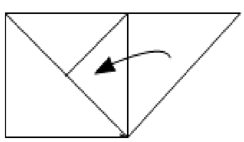
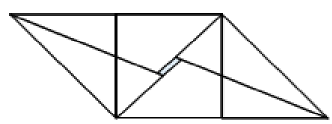
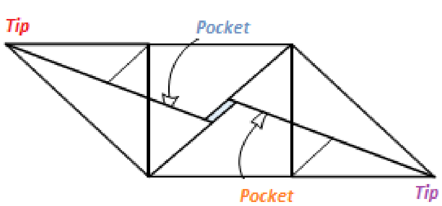
<tr>
<td>


7. Fold the bottom and top side towards the center.
</td>
<td>


8. Join point B with point A and unfold.
</td>
</tr>
</table>

 9. Rotate the paper 180° and join point E with point C and unfold.	 10. Tuck corner E under the top fold.
 11. Rotate the paper 180° and repeat step 10 again.	 12. These are the sides of the module.
 13. Place the inner side of the module.	 14. Fold the right triangle toward the center.
 15. Rotate the module 180° and repeat step 14.	 16. Unfold and place the outside side up. As you will see, we have already finished developing our first module.
 17. Module parts	From here you already know the parts of the module and you will have to manage those terms during the process of each assembly.

 Sonobé module. You already have the first module in your hands, do the same with the other five to assemble them and obtain the hexahedron.	 Each module has two wings and two pockets into which the wings of the other module enter, one in one direction and the other in the opposite direction.

The result is seen in Figure 2.

Hexahedron Chassis

You can also build the chassis hexahedron, for which the following must be done:

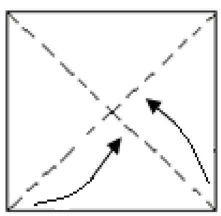
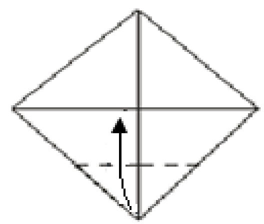
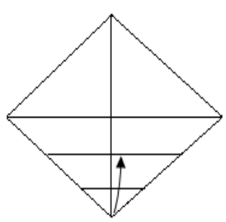
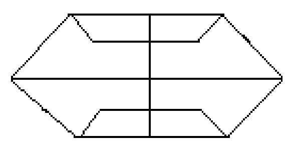
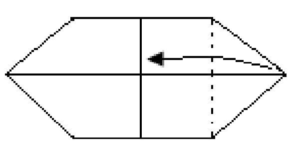
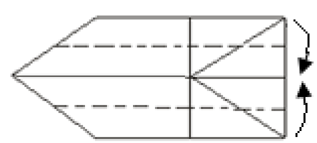
Build the modules that will form the parts of the edges of the hexahedron.

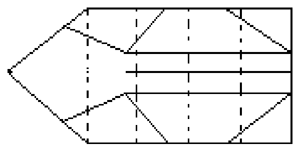
Construct the vertex of the polyhedron.

Assemble the parts of the hexahedron.

Instructions To Build the Edges of The Hexahedron:

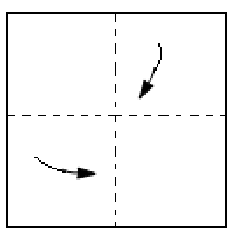
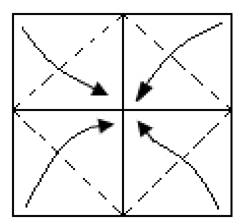
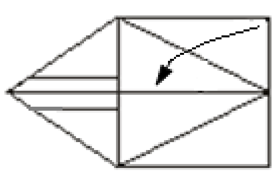
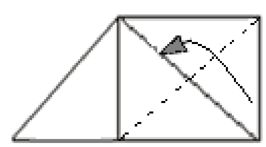
Follow the following steps, mark each break well so that the edges of your module are perfectly defined.

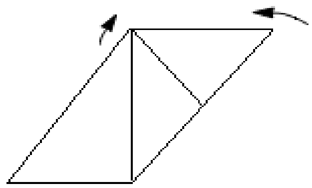
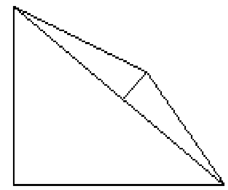
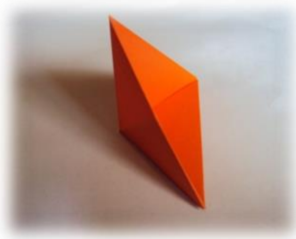
 1. Take a square sheet of paper and fold it diagonally on both sides.	 2. Take the rhombus-shaped sheet, fold one vertex and match it to the midpoint.
 3. Perform the same procedure, at the midpoint (of the first mark).	 4. Rotate 360° and repeat the procedure with the other side of the rhombus.
 5. Turn the module over and start folding the	 6. Fold the module in parallel lines

vertex towards the midpoint.	towards the middle mark.
 7. Fold it into four equal parts to form the edges of the module, don't forget to make good marks.	 Final result
 Sonobé module	You already have the first module in your hands, do the same with the other 11. Each module has two pockets into which the vertex wings enter.

Instructions To Construct the Vertex of The Hexahedron

Starting from a square sheet, mark each break well so that the vertices are well defined:

 1. Take a square sheet of paper and fold it into four equal parts.	 2. Fold each of the vertices towards the center of the sheet, make a perfect fold.
 3. Open the two vertices to close them and give rise to the other step.	 4. Close and twist up, then fold as shown in the figure.

 5. Open and then proceed to fold inside to give it the finishing touch.	 6. Finished product.
 Sonobé module. The use of colored paper makes the product look even more interesting.	 You already have the first vertex in your hands, do the same with the other 7. Each module has three wings, which enter the pockets of the edges.

When assembled like this, the final result looks like this.

Hexahedron

Tetrahedron

Figure 3. Final results

RESULTS

Performance on Geometry Tests

Study group: A significant increase in student performance was observed in the post-intervention tests, with an average improvement of 35%.

Participation and Commitment

Study Group: Active participation and engagement during the virtual origami sessions was notable, with a 90% participation rate.

Qualitative Results

Teacher Feedback

Study Group: There was an increase in students' motivation and enthusiasm towards learning geometry.

Observations of Virtual Sessions

Study group: The origami sessions were dynamic and collaborative, with positive interactions between students and greater expression of geometric ideas and questions.

Table 2. Level of significance of the use of origami as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education at the Micaela Bastidas National University of Apurímac – 2021.

Level		PRE-TEST		POS-TEST	
		Frequency	Percentage	Frequency	Percentage
REGULAR	[00 – 05]	01	2,9	0	0,0
WELL	[06 – 13]	34	97,1	0	0,0
HIGH	[14 – 16]	0	0,0	4	11,4
VERY HIGH	[17 – 20]	0	0,0	31	88,6
Total		35	100,0	35	100,0

SOURCE: Descriptive scale applied to the use of origami as virtual teaching materials in the learning of geometry in Early Education students

Description: In Table 2 and Figure 4, it has been identified that before origami as virtual teaching materials in the learning of geometry in students of Initial Intercultural Bilingual Education was 97.1% with a good level, however, after receiving the strategy to stimulate learning this level was reduced to 0.0%. Furthermore, before receiving the strategy, no student achieved a good, high or very high level of stimulating the learning of geometry, since when they received the origami as virtual teaching materials they increased to the high and very high level with 11.4% and 88.6% respectively. that it is being descriptively demonstrated that origami as virtual teaching materials improves the learning of geometry in students of Intercultural Bilingual Initial Education at the Micaela Bastidas de Apurímac National University - 2021.

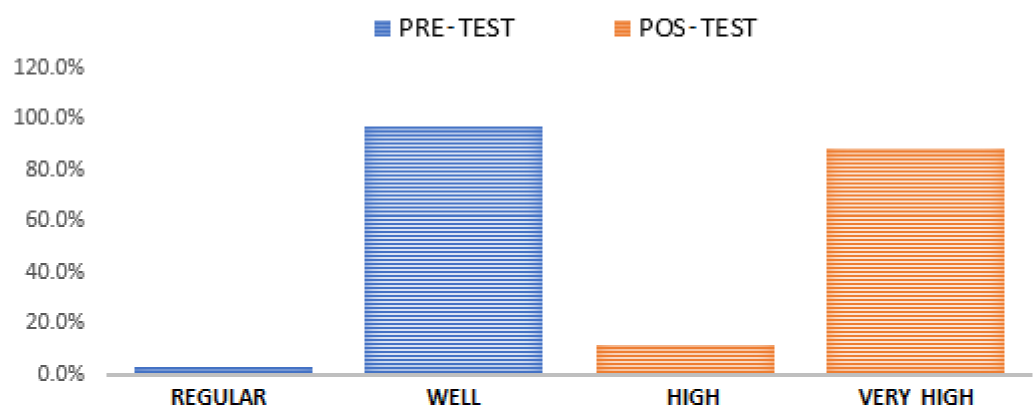


Figure 4. Level of significance of the use of origami as virtual teaching materials in the learning of geometry in Early Education students.

Table 3. Statistical Indicators of the proposal for the use of origami as virtual teaching materials in the learning of geometry in students of Bilingual Intercultural Initial Education.

Mean		Difference	Standard deviation		Coefficient of variation	
PRE-TEST	POS-TEST		PRE-TEST	POS-TEST	PRE-TEST	POS-TEST
3.39	10.27	6.88	4.883	7.304	14.4%	7.10%

Description: In Table 3 of statistical indicators, it is distinguished that before applying the origami proposal as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education, it is 3.39; On the other hand, these same students, after receiving the didactic proposal based on the use of origami, their average score is 10.27. This has generated a difference of 6.88, a favorable increase in the post test. For the dispersion of the scores obtained on the use of origami in the pre-test, they present a relative dispersion of 14.4%, indicating a heterogeneity with respect to them in the post-test, whose relative dispersion is 7.10%. So, these results indicate that the proposal to use origami as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education of the post test, compared to the pre-test.

Table 4. Hypothesis test of the use of origami as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education.

USE OF ORIGAMIS	95% Confidence Intervals	Degrees of freedom	$T_{0.95;35}$	T_{cal}	Significance
Pre-Test	11.972	35	1.69	21.546	p = 0.000 < 0.05
Pos-Test	14,508				Significant

Description: In Table 4 it is observed that the significance ($p < 0.05$) and in Figure 5, the calculated value (T_C = 21,546) is higher than the tabular value found in the statistical table (T_t = 1.69), it is demonstrated in a very significant way of the use of origami as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education of Bilingual Intercultural Initial Education: early and second childhood of the National University Micaela Bastidas of Apurímac - 2021 of the post test, regarding them in the pre-test. This is validated with a 95% confidence level.

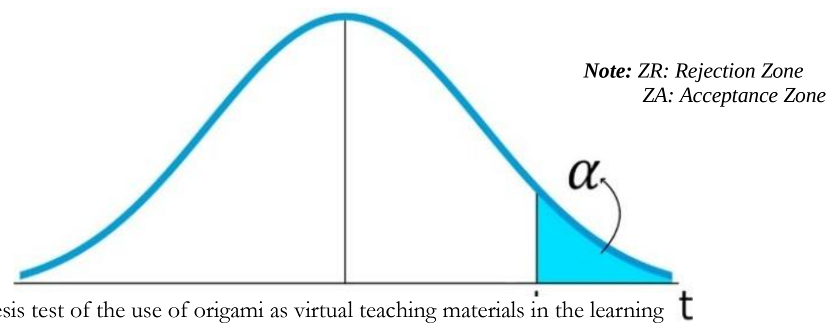


Figure 5. Hypothesis test of the use of origami as virtual teaching materials in the learning of geometry in students of Intercultural Bilingual Initial Education.

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Table 5. Statistical indicators on the use of origami as virtual teaching materials in learning to understand concepts in students of Intercultural Bilingual Initial Education

Mean		Difference	Standard deviation		Coefficient of variation	
PRE-TEST	POS TEST		PRE-TEST	POS-TEST	PRE-TEST	POS-TEST
7.0	17.0	10	1,5523	0,9047	22.18%	5.32%

Description: In Table 5, it is distinguished that before applying the origami proposal as virtual teaching materials in learning comprehension in students of Intercultural Bilingual Initial Education, it is 7.0; On the other hand, these same students, after receiving the didactic proposal based on the use of origami, their average score is 17.0. This has generated a difference of 10.0, a favorable increase in the post test. For the dispersion of the scores obtained on the use of origami in the pre-test, they present a relative dispersion of 22.18%, indicating a heterogeneity with respect to them in the post-test, whose relative dispersion is 5.32%. So, these results indicate that the proposal to use origami as virtual teaching materials in the learning of comprehension in students of Intercultural Bilingual Initial Education of the post test, with respect to the pre-test.

Table 6. Significant analysis of origami as virtual teaching materials in learning understanding of concepts in students of Intercultural Bilingual Initial Education

MATERIALS	95% Confidence Intervals	Degrees of freedom	$T_{0.95;35}$	T_{cal}	Significance
Pre-Test	10.874	35	1.69	21.667	p = 0.000 < 0.05
Pos-Test	16.852				Significant

Description: Table 6 shows that the significance ($p < 0.05$) and Figure 6, the calculated value (T_C = 21,667) is higher than the tabular value found in the statistical table (T_t = 1.69), with these The results demonstrate in a very significant way the use of origami as virtual teaching materials in the learning of comprehension in students of Bilingual Intercultural Initial Education: early and second childhood at the Micaela Bastidas de Apurímac National University - 2021 of the pos-test, with respect to the themselves in the pre-test. This is validated with a 95% confidence level.

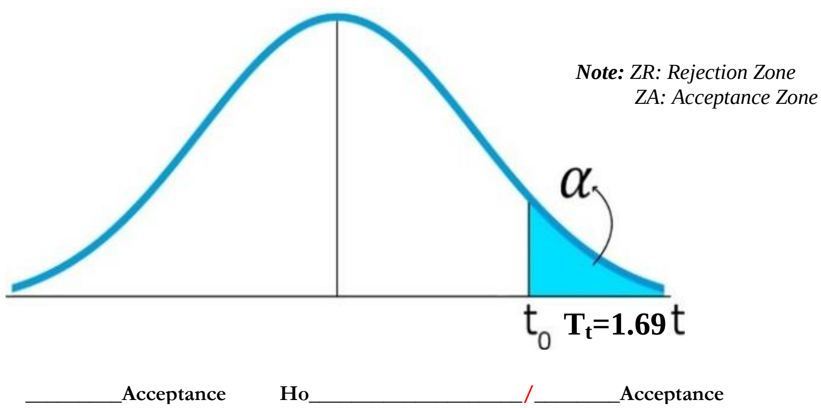

Figure 6. Significant analysis of origami as virtual teaching materials in learning understanding of concepts in students of Intercultural Bilingual Initial Education

Table 7. Statistical indicators on the use of origami as virtual teaching materials in learning to produce geometric figures in students of Bilingual Intercultural Initial Education

Mean		Difference	Standard deviation		Coefficient of variation	
PRE-TEST	POS-TEST		PRE-TEST	POS-TEST	PRE-TEST	POS-TEST
7.0	17,0	10	1,125	0,915	18.75%	5.38%

Description: In Table 7, it is distinguished that before applying the origami proposal as virtual teaching materials in production learning in students of Initial Intercultural Bilingual Education, it is 7.0; On the other hand, these same students, after receiving the didactic proposal based on the use of origami, their average score is 17.0. This has generated a difference of 10.0, a favorable increase in the post test. For the dispersion of the scores obtained on the use of origami in the pre-test, they present a relative dispersion of 18.75%, indicating a heterogeneity with respect to them in the post-test, whose relative dispersion is 5.38%. So, these results indicate that the proposal for the use of origami as virtual teaching materials in production learning in students of Intercultural Bilingual Initial Education of the post test, compared to the pre-test.

Table 8. Significant analysis of the use of origami as virtual teaching materials in learning the production of geometric figures in students of Bilingual Intercultural Initial Education

PRODUCTION	95% Confidence Intervals	Grados de Libertad	$T_{0.95;35}$	T_{cal}	Significance
Pre-Test	8.743	35	1.69	18.671	p = 0.000 < 0.05
Post-Test	15.640				Significant

Description: Table 8 shows that the significance ($p < 0.05$) and Figure 7, the calculated value (T_C = 18,671) is higher than the tabular value found in the statistical table (T_t = 1.69), with these The results demonstrate in a very significant way the use of origami as virtual teaching materials in production learning in students of Bilingual Intercultural Initial Education: early and second childhood at the Micaela Bastidas de Apurímac National University - 2021 of the pos-test, with respect to the themselves in the pre-test. This is validated with a 95% confidence level.

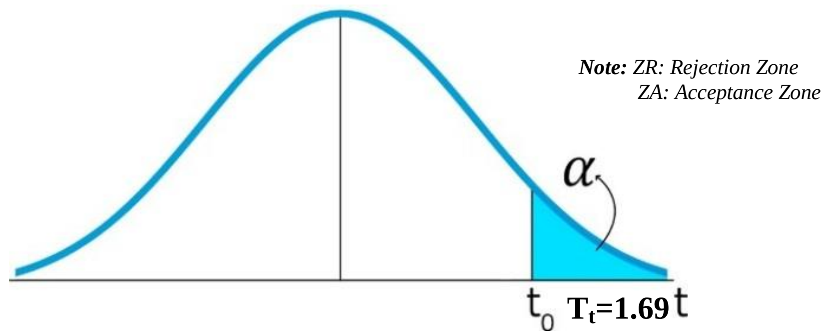

Figure 7. Significant Analysis of the use of origami as virtual teaching materials in production learning in Intercultural Bilingual Initial Education students

Table 9. Statistical indicators on the use of origami as virtual teaching materials in learning to solve geometric problems in students of Bilingual Intercultural Initial Education

Mean		Difference	Standard deviation		Coefficient of variation	
PRE-TEST	POS-TEST		PRE-TEST	POS-TEST	PRE-TEST	POS-TEST
9.0	15,0	6	1,611	1.101	17.9%	6.48%

Description: In Table 9, it is distinguished that before applying the origami proposal as virtual teaching materials in the learning of problem solving in students of Intercultural Bilingual Initial Education, it is 9.0; On the other hand, these same students, after receiving the didactic proposal based on the use of origami, their average score is 15.0. This has generated a difference of 6, a favorable increase in the post test. For the dispersion of the scores obtained on the use of origami in the pre-test, they present a relative dispersion of 17.9%, indicating a heterogeneity with respect to them in the pos-test, whose relative dispersion is 6.48%. Therefore, these results indicate that the proposal to use origami as virtual teaching materials in the learning of problem solving in students of Early Intercultural Bilingual Education of the post test, compared to the pre-test.

Table 10. Significant analysis of the Use of Origami as Virtual Teaching Materials in Learning to Solve Geometric Problems in Bilingual Intercultural Initial Education Students

PROBLEM RESOLUTION	95% Confidence Intervals	Degrees of freedom	$T_{0.95;35}$	T_{cal}	Significance
Pre-Test	10.457	35	1.69	13.651	p = 0.000 < 0.05
Post-Test	14.821				Significant

Description: Table 10 shows that the significance ($p < 0.05$) and Figure 8, the calculated value (T_C = 13,651) is higher than the tabular value found in the statistical table (T_t = 1.69), with these The results demonstrate in a very significant way the use of origami as virtual teaching materials in the learning of problem solving in students of Bilingual Intercultural Initial Education: early and second childhood at the Micaela Bastidas de Apurímac National University - 2021 of the pos-test, regarding of them in the pre-test. This is validated with a 95% confidence level.

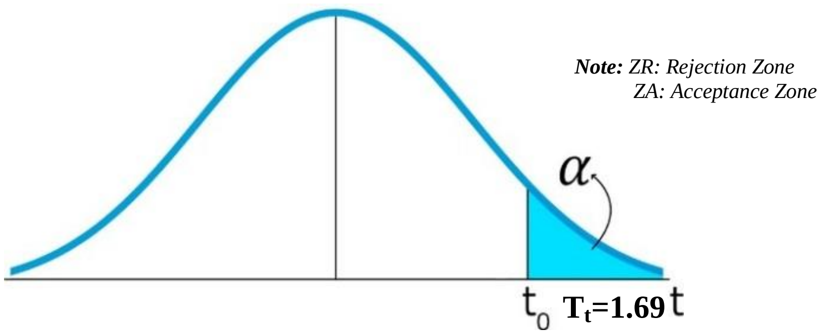

Figure 8. Significant analysis of the use of origami as virtual teaching materials in problem-solving learning in Intercultural Bilingual Initial Education students ce

DISCUSSION

The investigations of (Meza & Asto, 2022), (Rodas, 2020), Salas (2020), (Gonzales & Guaillasaca, 2022), (Cevallos, 2019), and (Tomalá, 2021) agree that the use of teaching materials positively influences the learning of mathematics, with significant results that demonstrate improvements in understanding of concepts, production of geometric figures and problem solving. In the current study, which proposes the use of origami as virtual teaching materials in the teaching of geometry, a medium score was obtained in the post-test indicating homogeneity in learning.

CONCLUSIONS AND RECOMMENDATIONS

The research conclusions indicate that the use of origami significantly improves geometry learning, with improvements in the understanding of concepts, production of geometric figures and problem solving. The positive impact of origami on learning, the greater participation and commitment of students, the positive feedback from teachers and parents, as well as the cultural relevance of origami, are highlighted.

Recommendations include the implementation of origami in mathematics learning sessions, the incorporation of virtual environments in learning activities, and the consideration of research results for future innovation and research projects.

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