Full Length Research Paper

Articulation of ethnomathematical knowledge in the intercultural bilingual education of the Guna people

Luisa Morales Maure[1,3*], Diomedes Fábrega[2], Marcos Campo Nava[4] and Orlando García Marimón [1,3]

[1]Department of Mathematics, University of Panama, Panama.
[2]Ministry of Education of Panama, Panama.
[3]Faculty of Biosciences and Public Health, University Specialized of Americas, USA.
[4]Academic Area of Mathematics and Physics, Autonomous University of the State of Hidalgo, Mexico.

The aim of this research is to study the fundamental elements used to broaden mathematical knowledge and to establish guidelines for its development using Intercultural Bilingual Education (IBE) framework. This study is an experimental quantitative research. Problem solving pretest and posttest were given to the students of Carti Tupile School (control group) in Spanish and students of Sayla Olonibiginya School (experimental group) in their mother tongue. A didactic guide was used as the learning method in IBE for the fourth grade students of Sayla Olonibiginya School. It was used to motivate them to discover the principles and concepts of mathematics in arithmetic and geometry. The results showed that traditional methodologies are not better than the didactic guide used for contextualized development under the IBE.

Key words: Intercultural Bilingual Education, mother tongue, ethno-mathematics, problem-solving, didactic guide.

INTRODUCTION

This research was conducted at Sayla Olonibiginya School and Carti Tupile School. The participants were primary students (4th grade) from Guna-Yala Region. Pre-test and posttest were applied in Spanish and mother tongue of the participants. Basic mathematical education is required for developing their mathematical reasoning. It is an unlimited mathematical education for obtaining terminology knowledge and performing mathematical operations. Basic mathematical education also helps one to identify and understand the role that mathematics

plays; it enables one to make sound judgments. The objective of this work is to use a didactic guide (problem solving strategy) for arithmetic and geometry problems under Intercultural Bilingual Education (IBE) for the fourth-grade students at Sayla Olonibiginya School.

It is required that the students based on the Intercultural Bilingual Education have at least two cultures and two languages. Using Spanish to teach students who do not understand the language mathematics is ineffective. This is evident in the Ministry of Education of Panama, in particular, the census evaluations done with grades III and VI of Basic Education. The children who use more than two languages and those who belong to indigenous communities had the lowest achievement.

There is, therefore, a need to clarify and expand mathematical knowledge based on the IBE framework. The implementation and development of these guidelines will help the learning needs of Panamanian students efficiently and effectively. This will enable them to improve learning conditions, since mathematics and communication makes one to be competent in other curricular areas. Therefore, the didactic guides that are presented in the proposal consist of:

1. Entering sums and identifying the place value of the digits of a natural number: Students write their answers in the guide, then discuss, and check answers and use arithmetic writing as a conclusion.
2. Adding decimal numbers: There are three different techniques used to find the sum of decimal numbers. Students in Activity No. 1 can present the techniques of addition in column. In Activity No. 3, students can build their hypotheses on the calculation, compare them with reality, reject errors and look for a mathematical explanation.
3. Using different materials to represent ½: The students are to use the representation of flat figures, while in reality, there exists many forms that represent ½.
4. Recognizing the concept of perimeter (activity 4): It is necessary that the learning of this concept is done using real-world models and objects and in a way that allows the students to acquire perimeter concepts that are generally very abstract.

All the activities of the didactic guide involve Gunas' practices. In Activity 4, the students are asked to make a mola (textile sewn with complex designs by the Gunas with realistic and abstract representations of flowers, animals and sea); the students are asked to recognize the perimeters of the said representations involved as other geometric elements. The notion of geometric figures developed by Guna women in the making of molas, connecting ethno-mathematics with school mathematics was contextualized.

Through the didactic guides, this proposal motivates students to discover the principles and concepts of mathematics in arithmetic and geometry. It gives one the ability to wonder, to understand how and why things happen, and be involved in the systematic search for answers. It is expected that the application of the didactic guides proposed in this work, under the problem-solving approach, will significantly affect students' learning.

Theoretical framework

Panama, rich in diversity and with an intercultural education, recognizes ethno-mathematics as part of their math education; it makes mathematical knowledge valid in its cultural context. In IBE, mathematics syllabi include ethno-mathematics expressed in students' original language and the mathematics of the national curriculum. The goal of IBE is to develop the languages, cultures and knowledge of each indigenous nationality without giving up on understanding Spanish (Fabara, 2017).

From a perspective of facilitating the development of an intercultural mathematical education and considering the contributions of researchers (D'Ambrosio, 1985; Bishop, 1988; Ascher & Ascher, 1981; Urton, 2003), who have studied the relationship between mathematics and culture, and based on the studies that we have been doing since the 80s, this paper aims to show the knowledge of the identified socio-cultural group based on the following activities: counting, measuring, locating, designing, playing and explaining. This implies that both the knowledge of mathematics and the ethno-mathematics of one's own culture constitute curricular content. It is achieved by students together with the development of their skills and attitudes. In this sense, ethno-mathematics is oriented towards helping students to live in harmony with Mother Earth, identify with their culture and solve problems in their own context. Learning mathematics helps them to solve other real problems and facilitates their link with other cultures.

From an intercultural perspective, indigenous mathematics or ethno-mathematics and the national mathematics curriculum have the same values. Teachers take into consideration the linguistic background of the students they teach. During the learning process, they use the language they understand and propose activities that enable the proper articulation of their own ethno-mathematics knowledge using national curriculum mathematics knowledge.

In recent years, many countries have incorporated problem-solving strategy into their curriculum either as a transversal axis or as a content. Some people consider it as applying previously acquired knowledge in new and

unknown situations or to solve practical problems related to everyday' s life situations. In other countries, the development of problem-solving strategies is emphasized and it is suggested that they should be used as basic heuristics for problems resolution, according to Pólya (1965). Singapore designed its mathematics curriculum for problem resolution; it established the use of heuristics for it, through the so-called "model". Currently, Costa Rica has adopted the Educational Mathematical Reform Project that began in 2012. Therefore, there are countries that have spoken on this subject for thirty years, but others are quite new. This depends on the context and the country, but the important thing is to know that it is an old issue in the curriculum (Gaulin, 2001).

In addition, different entities such as the Association of Teachers of Mathematics (ATM), the National Council of Teachers of Mathematics (NCTM) and the Organization for Economic Co-operation and Development (OECD) have promoted the inclusion of problem solving strategy in teaching mathematics. These institutions have been able to influence curriculum development in many countries, since they show an effort to identify problem-solving as the main axis of mathematics education (Santos-Trigo, 2008; Schoenfeld, 2007).

Taking this current trend into account, problem-solving strategy can help to implement educational environments in which the students participate with peers in solving mathematical problems. Schoenfeld (1992) proposes that problems be solved in small groups, in order to promote the development of skills related to a subject, so that each one can learn how others control their work.
Besides, NCTM states that when students think, argue and communicate their ideas to others, either in writing or speaking, they are often clear and convincing. Learning to expose and solve problems is adopted as a central strategy to generate those skills. The intellectual challenge is consubstantial for an intelligent and motivating classroom work.

Therefore, the didactic guide has many functions, including suggesting curriculum approaches, promoting self-learning and encouraging students to study by themselves (Aguilar, 2004). The strategic plan of the Ministry of Education (2009-2014) proposed that the increase of didactic materials in 2014 offers a Methodological seminars Guide to all teachers in the country; it proposes learning activities that represent an intellectual challenge for students and generate interest in finding at least one way to solve them.

A problem-solving strategy in learning mathematics allows the use of non-routine mathematical situations and conceptual constructions by students. For that reason, it is necessary to use real situations; it is not just to do a routine algorithmic solution exercises that make students to believe that mathematical problems have a single correct answer; there are few problems or activities that involve several reasoning or multiple solution strategies for mathematical problems. Only then, will it be possible

to engage students in an active way. This leads to the following research questions:

Does didactic guide under the Intercultural Bilingual Education lead to better performance than traditional method?

METHODOLOGY

Mathematics education concept is broader than "teaching Mathematics". In this sense, mathematics education comprises the formal and non-formal educational processes that lead to cognitive-type learning achievement and skills and values development.

In this context, we agree with Bishop (1988) when he says that educating people mathematically is much more than just teaching them some math. It is much more difficult. The problems and pertinent issues constitute a much broader challenge. Solving them requires a fundamental awareness of the underlying values in mathematics and acknowledging the complexity of teaching these values to children. It is not simply enough to teach them mathematics; we must also educate them on mathematics, through mathematics and with mathematics.

The research seeks to help Grade III students of Sayla Olonibiginya School in building their learning, developing concepts with meaning and not only to memorize rules, definitions and algorithms.

Nowadays, socio-constructivist perspective is being adopted. When learning things, cognitive activity does not only help, but also interaction with other people; it is a support factor and it accelerates knowledge (Gaulin, 2001). Guzmán (1993) points out that in relation to the cognitive aspect and development of capacities, that it is mainly interesting to emphasize the thought processes of mathematics, problem-solving, reasoning and communication more than transferring content. Since mathematics is, above all, practical, it is a science whose method clearly predominates over its content. For this reason, high importance is attached to the study, largely bordering the cognitive psychology, which refers to the mental processes of problem-solving.

In fact, in constant change in which we find ourselves, it is evident that many times you have to prioritize some content and leave others aside. Instead, truly effective thought process does not become obsolete so quickly.

This research aims to use the problem-solving strategy as a didactic guide to teach Grade III mathematics class. In this work, the didactic guide was first proposed to the students and then taught how to use it in such a way that it will help their cognitive skills to address modern societal challenges, where information, knowledge and the demand for a greater mental abilities are needed.

Also, it is necessary to clarify that the Guna Yala region schools are located in difficult access areas and the distance between them forced the authors to work with a reduced sample for the study. This means that from 45 schools, 6514 primary school students participated in the study (Meduca, 2013). Therefore, only two schools are taken as sample in this research. The two samples are homogeneous in comparison with the study population, since all the students belong to the same indigenous region, where the curriculum is the same for all the schools using their native language and Spanish. For this reason, the research results are expected to occur in other schools in the region.

Through this study, it is proposed to implement didactic guides as a methodological resource for the benefit of indigenous students and to have better performance. Also, it is suggested that the Intercultural Bilingual Education should be the main focus of problem-solving curriculum, be useful to other researchers for them

to be able to complete the study in other parts of the region.

In this way, the didactic guide as an active strategy contributes to the achievement of educational purposes and serves as a means to promote students' participation, and to obtain a better learning; it also proposes a favorable classroom climate that generates interest in finding different solutions and suggests alternatives for a good way to study mathematics at the primary level.

Type of investigations

The research is an explanatory model since it supports the description, analysis and interpretation of the knowledge level of arithmetic and geometry of Grade III students of Sayla Olonibiginya School and Carti Tupile School. It is a basic research, according to the classification made by Del Rincón et al. (1992), oriented towards the search for new knowledge on the phenomenon of study; it uses a path of inductive analysis in field study.

Research design

Nowadays, studies mark a descriptive character, as they aim to describe the methodological aspects of the field research. This is because they are carried out where the problem is presented, thus establishing an interaction between the studies' objectives and reality. However, it is considered that there are quasi-experimental methodology elements because two groups are used (control and experimental): both groups are subjected to previous tests (Shadish et al., 2001). The tests were done in Spanish and mother tongue of both groups. This allows one to estimate population values from smaller size samples. The teachers are in the same groups, and given equal content during the course development.

Variables

The dependent variable is "Mathematical Learning" and the independent variable is "Didactic guide for solving problems of arithmetic and geometry using the IBE".

Conceptual definition

Mathematical learning

Mathematical learning: NCTM (2000) stated that it is important for the students to learn beyond the rules and be able to express relationships in mathematical language. Schoenfeld (1985) mentioned that the main goal in learning mathematics is to identify connections and to understand the meaning of mathematical structures. Furthermore, he mentions that finding the solution to a mathematical problem is not the end of the mathematical enterprise, but the starting point for finding other problem solutions and extensions. In order to achieve these goals, students need to discuss their ideas, negotiate their points of view, speculate possible outcomes, and use various examples to help confirm or adjust their ideas.

Didactic guide for solving arithmetic and geometry problems in IBE[2]: It is conceived as a structure that fosters students' creative

---

[2] The curricular proposal of IBE (IBE Guna, formalized by Executive Decree No. 687 of December 23, 2008), seeks to correct, correct and consolidate the educational reality in Guna Yala, for that it should create concrete spaces and times where students not only Learn, but also train and use their knowledge as

capacity; it provides them with skills and strategies development tools that allow them to work, research, discover and build their own knowledge with teachers' guidance.

Operational definition

Mathematical learning

Students share the strategies they use in resolving the pre-test problems. In subsequent sessions, the four steps suggested by Pólya (1965) are used. The general idea is that the students, during the learning period, build a frame of reference that will help to understand and solve mathematical problems. However, the students are not expected to strictly use them. The posttest results provide evidence that students show clear qualitative improvement.

Didactic guide presented in the proposal consists of:

1. Identifying the position of the digits of natural numbers
2. Addition of decimal numbers.
3. Representing 1/2 number.
4. Recognizing the concept of perimeter.

When we work with the experimental group, the didactic guide is used and at the end a posttest is applied to both groups. It uses a weighting qualification of requirement from 810 Decree (October 11, 2010) established in chapter 11-12 in elementary, middle and high school stages. The grading scale is one (1) to five (5). The equation below serves as a basis for its generation and can be used to match the grade with any score:

$$C = 4 \times \frac{Score\ obtained}{Total\ score} + 1$$

In the control group, the teachers use a methodology where their class presents mathematical problems (in Spanish) that are little contextualized. This methodology is what is usually used throughout the Guna Region, which is always displayed in Spanish language.

Population and purposive sampling

There are 45 students in grade and multi-grade schools in primary education level at Guna Yala Region; fourth grade students consist of 1123 population (Meduca, 2013). Meanwhile, with the fourth grade students, only 36 students from Sayla Olonibiginya and Carti Tupile Schools were worked with. In 2015, the sample consisted of students of the two schools.

Data collection techniques and tools

The followings are the instruments used for data collection

Mathematical knowledge pretest

This was given to the two groups of students (fourth grade) with objective to measure the mastery of the mathematical concepts; the same was written in Spanish and Gunagaya, which is their mother tongue.

---

decision-making and problem-solving tool for their daily life (General Gunas Congresses, 2011). IBE Guna Curriculum Proposal, p.130.

Mathematical knowledge posttest

This was given to the same population of students which allowed the authors to know the results obtained in the investigation.

Procedures

Before applying the pretest to the students, they received an induction process as follows:

1. Familiarizing with the experimental situation.
2. Objectives and structure of the test (indications supplied in the test).
3. Developing the ability to perform logical problem-solving processes, using the logical sequence of steps in the Polya's method.

The pretest and posttest problems with significant questions and a close and comprehensible context for children seek to evaluate mathematical problem-solving skills. There is the elaboration, comparison and exercise of procedures, using the Polya's method. All the questions used in the application are multiple-choice ones with only one answer; they have statement and four response options, called A, B, C, D. Only one of them is correct and valid in relation to the situation.

With the didactic guide activities, it is recommended to solve the same problem in several ways. Addressing a problem in different ways, developing arguments for solutions and analyzing which one is better are necessary for mathematics development. In that way, students expand their steps using the Polya's method and then apply posttest to allow a comparison before and after the implementation of the methodological proposal. The data obtained are presented in graphics with explanation and comments which give us a clear result of the research.

Data analysis

As the study is described, the data instrument responses are presented and analyzed in frequency and proportions terms through statistical charts. The results basis and alternatives proposed the use of arithmetic and geometry problem-solving didactic guide, as a learning method in Intercultural Bilingual Education for third grade students of Sayla Olonibiginya School.

RESULTS AND DISCUSSION

Accordingly, with the current trends in mathematics education, students are expected to beachieve competent. Tcieshis helps them to, which build knowledge, develop skills and attitudes that allow them to have perform with confidence in themselves in many situations for personal, social and work life.

In the Panamanian curriculum Mathematics, competencies must be achieved through the activities carried out by the own students themselves, specially, problem solving, reasoning and mathematical communication processes. Mathematical knowledge requires a construction process and a determined intention to learn. It is necessary to select and organize sequentially, the activities that will be proposed to the

students. In this sense, the activities to be proposed will be selected and organized in levels; they, so that can start from situations that generate processes at a concrete level, then through representations at the graphic and symbolic level. S, students canwill be supported in the formation of their abstract thinking. It is important to keep in mind that abstraction is occurs when students have the opportunity to have done an adequate job in the previous levels.

In the research development, two groups of fourth-grade students from the carti tupile schools (control group) and Saila Olonibiginya School (experimental group) participated in the study. The first group has 15 students and the second group has 21 students. this research lasted for one week, from 5th to 9th October and from 26th to 30th October, which corresponds to the second month of the third quarter in 2015.

It was considered that the best way to collect information is through the pretest application. The posttest was applied to both groups on the first day. The difference is that for the experimental group, the tests were written in their mother tongue.

The posttest was applied to the two groups, after solving different problems. The exercises applied in pretest were mentioned, using the problem-solving strategy obtained by observations and measurements that are very important for the study. Next, some figures and tables that are necessary were added in the pretest and posttest.

Figure 1 shows the result obtained by the control group students during the pretest of the Table 1; 4 students could not solve any problems, 4 students solved a problem, 4 students solved two problems and 3 students solved three problems; 1.0 to 5.0 scale was used for qualification, according to 810 Decree from October 11, 2010.

Figure 2 shows the result obtained by the control group in posttest of the Table 2. These results are shown in percentage. One student could not solve any problems, 3 students solved a problem, 10 students solved two problems and 1 student could solve three problems. A study reveals that many of the teachers have problems on the expected learning outcomes in other languages (Canbulat and Dilekci, 2015).

Figure 3 shows the results obtained by the experimental group in the pretest of the Table 3; 2 students could not solve any problems, 2 students solved a problem, 3 students solved two problems, 6 students solved three problems, 7 students solved four problems and 1 student solved all the problems.

Figure 4 shows the results obtained by the experimental group in post-test of the Table 4, where 5 students solved a problem, 6 students solved two problems, 1 student solved 1 problem, 4 students solved 4 problems and 5 students solved all the problems. The use of didactic guides translated into the mother tongue
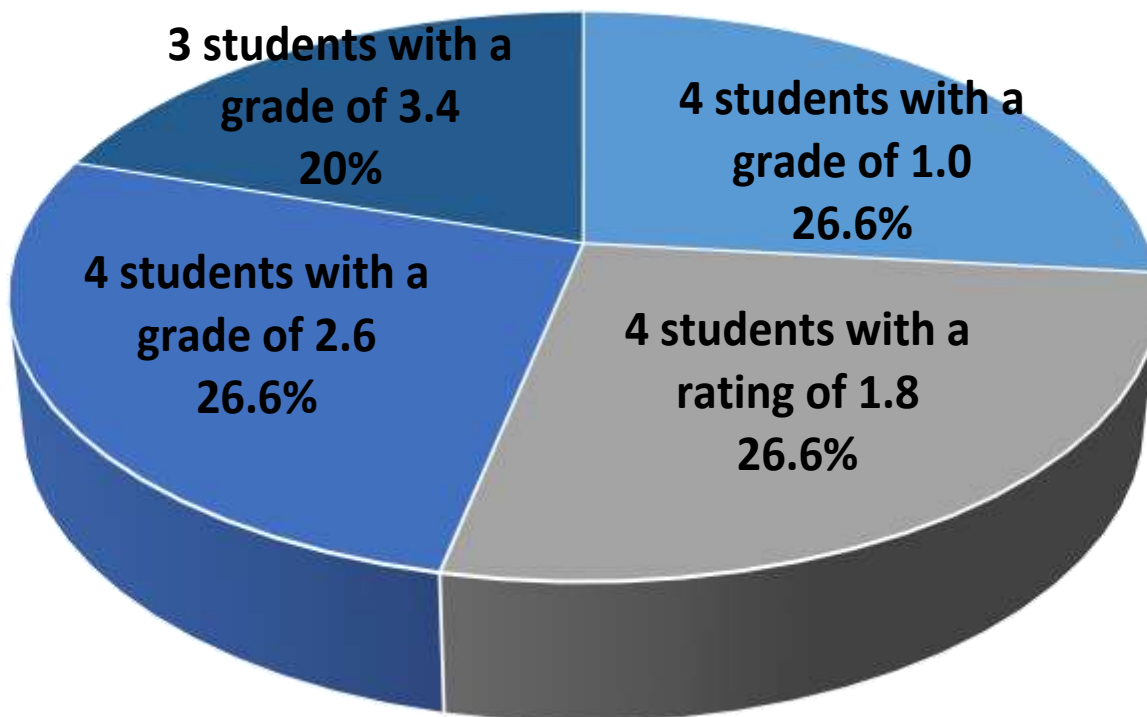
Figure 1. Items solved by students in the pretest test of the control group.

Table 1. Results of the pretest of the control group.

Qualification	Number of students
1.0	4
1.8	4
2.6	4
3.4	3
Total students	15

Source: Pretest applied to the fourth-grade students of the Carti Tupile School.

reflects a substantial improvement in problem solving in the experimental group since it is supported by IBE. In this sense, Naštická (2016) stated that if students are able to understand the problem, then they can solve it.

Choice of statistical test

There is a descriptive model with two independent samples, for which the "T "test is used for unrelated data (independent samples).

There is a descriptive model with two independent samples, for which the "t "test is used for unrelated data (independent samples).

Approach of the hypothesis

1. Alternate hypothesis (Ha): There are differences in the mean of the control group and experimental group that properly applied the pretest and posttest using the problem-solving strategy.
2. Null hypothesis (Ho): There is no significant difference in the mean of the control group and experimental group that correctly apply the pretest and posttest using the problem-solving strategy.
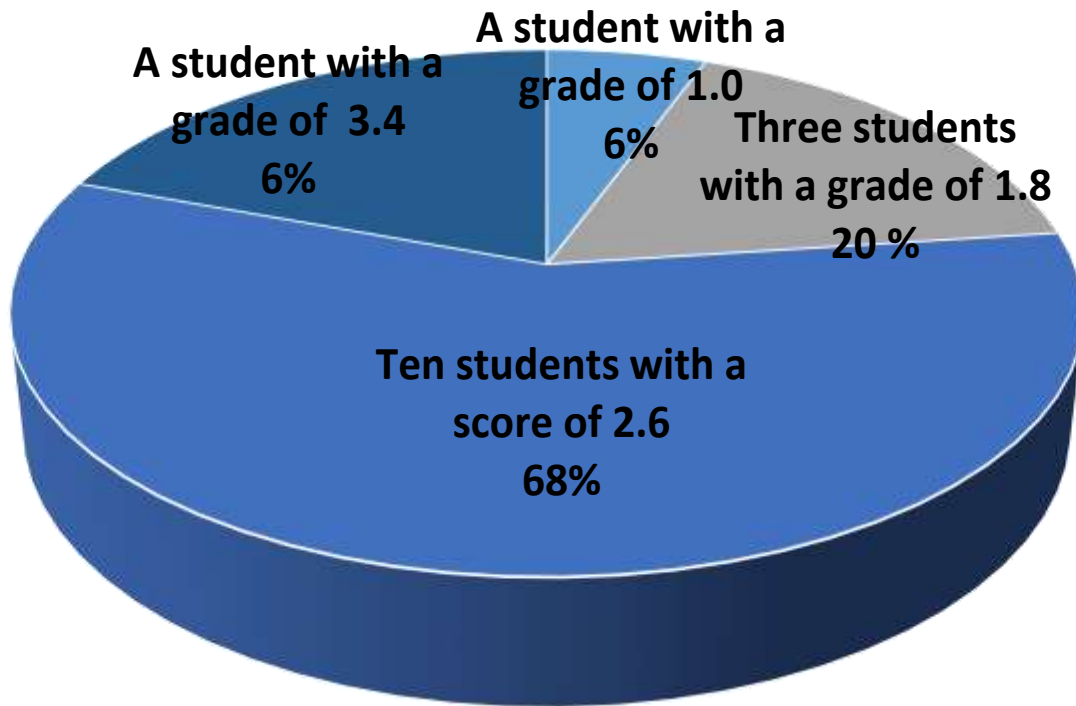
Figure 2. Items solved by students in the control group posttest.

Table 2. Results of the control group posttest.

Qualification	Number of students
1	1
1.8	3
2.6	10
3.4	1
Total students	15

Source: Post-test applied to the fourth-grade students of the Carti Tupile School.

Level of significance

For all probability values equal to or less than 0.05, Ha is accepted and Ho is rejected.

Rejection zone

For any probability value greater than 0.05, Ho is accepted and Ha is rejected.

$SC_1 = \sum(x_1 - \bar{x}_1)^2 = 4.4373$

$SC_2 = \sum(x_1 - \bar{x}_2)^2 = 31.8781$

$$\sigma_p = \sqrt{\frac{SC1+SC2}{N1+N2-2}} = \sqrt{\frac{4,4373+31,8781}{15+21-2}} = \sqrt{\frac{36,3154}{34}} = 1.0335$$

$$t = \frac{\bar{x}1 - \bar{x}2}{\sigma p\sqrt{\frac{1}{N1}+\frac{1}{N2}}} = \frac{2,3867-3,3238}{1,0335\sqrt{\frac{1}{15}+\frac{1}{21}}} = \frac{-0.9371}{0.3494} = -2.6820$$

$gl = N_1 + N_2 - 2 = 15 + 21 - 2 = 34$

$P(t_{34} < 2.7) = 0.994$

$P(t_{34} < -2.7) = 1-0.994 = 0.006$
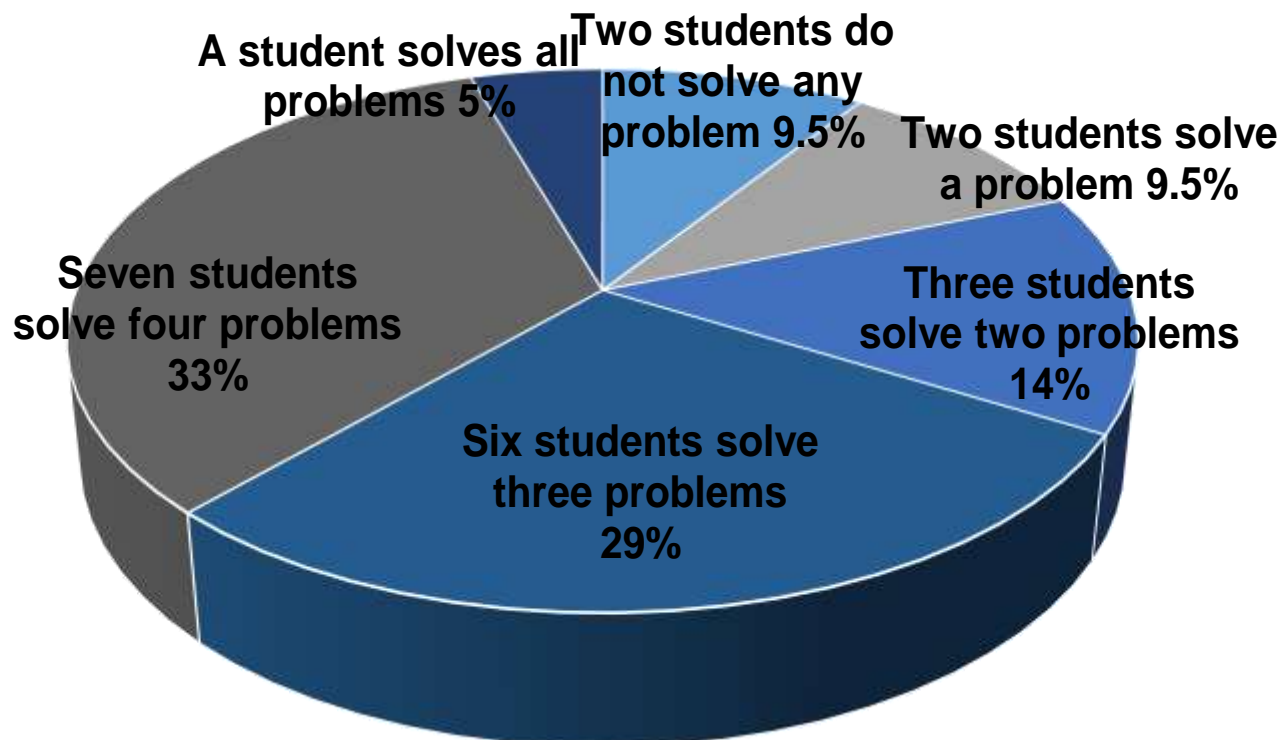
Considering an alpha error of 0.05 (5%), the acceptance

Figure 3. Items solved by students of the experimental group of the pretest test.

Table 3. Results of the pretest test of the experimental group.

Qualification	Number of students
1.0	2
1.8	2
2.6	3
3.4	6
4.2	7
Total	21

Source: Pretest test applied to 4th grade students at Saila Olonibiginya School.

region of null hypothesis and the critical region (or rejection of null hypothesis) in a t-distribution of student had an alpha of 0.05 and 34 degrees of freedom in between the critical values of -2.03 and 2.03. These critical values were calculated using the Excel INV function, t (alpha, degrees of freedom), with the probability of 0.975 (1- (0.05 / 2)) and 34 degrees of freedom. Thus, the acceptance region (according to the t-student table) would be between t values greater than –

2.03 and lesser than 2.03 (results obtained using Table 5).

Decision

Since the value of t (-2.6820) has a probability of less than 0.006, it is also less than 0.05, where H_a is accepted and H_o is rejected. Moreover, since t = -2.6820, which is
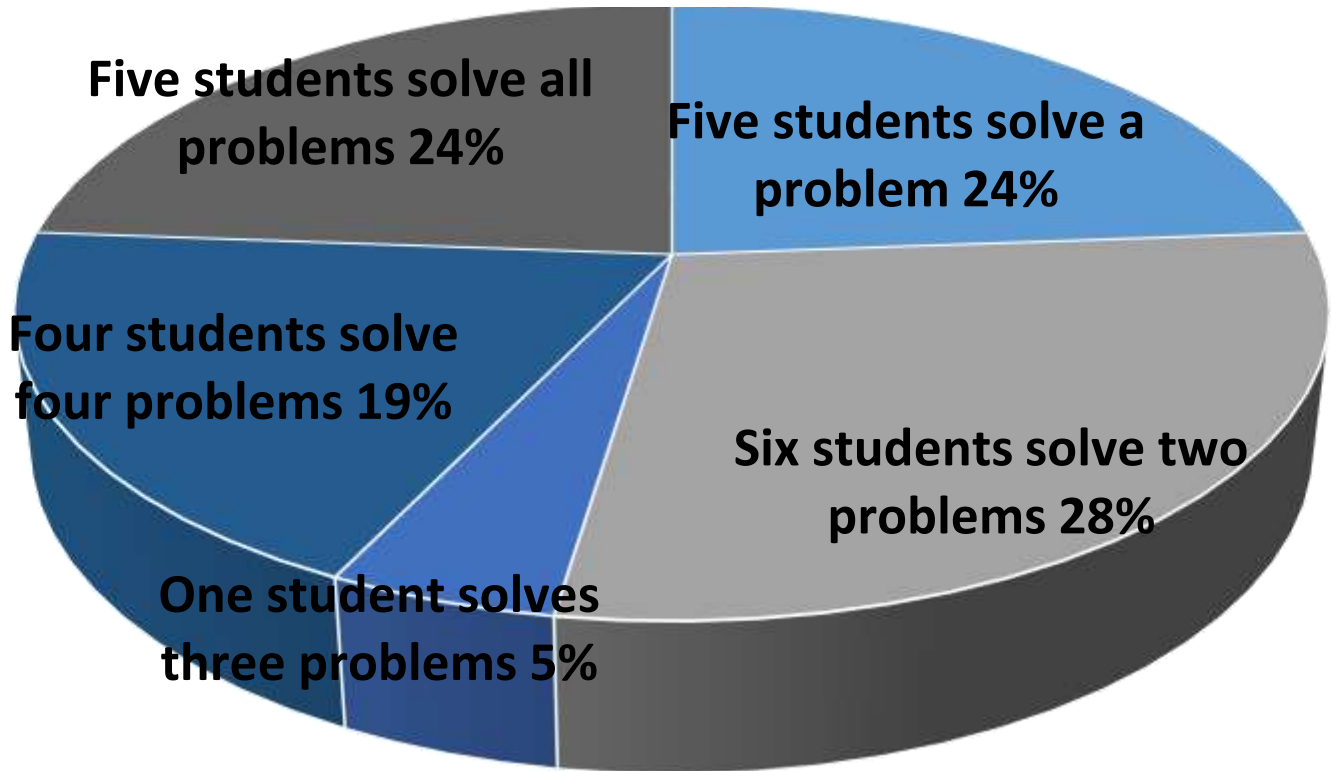
Figure 4. Items solved by students of the experimental group of the posttest.

Table 4. Posttest result of the experimental group.

Qualification	Number of students
1.8	5
2.6	6
3.4	1
4.2	4
5.0	5
Total	21

Source: Posttest test applied to 4th grade students at Saila Olonibiginya School.

less than -2.03 and is outside the acceptance region of the null hypothesis, we accept the alternative hypothesis.

From the research with the two groups (experimental and control groups), there are an initial and a final evaluation; only the experimental group receives the treatment. In order to conclude that the experience is effective, it is shown in Figure 5 that the students of the experimental group (lower box) obtain higher scores than the control group (top box).

The result of the research makes us to change the teaching method and to make appropriate pedagogical use of sequences in which the ethno-mathematics resources are offered by the culture that stimulates students' mathematical thinking development and contributes to their learning achievement. Several formulas could be used to calculate the effect size. According to Cohen:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{(S_1{}^2 + S_2{}^2)/2}}$$

$$d = \bar{X}_1 - \bar{X}_2/\sigma \text{ where } \sigma = \sqrt{\Sigma(X - M)/N}$$

Table 5. Qualifications of the control and experimental students in the posttest.

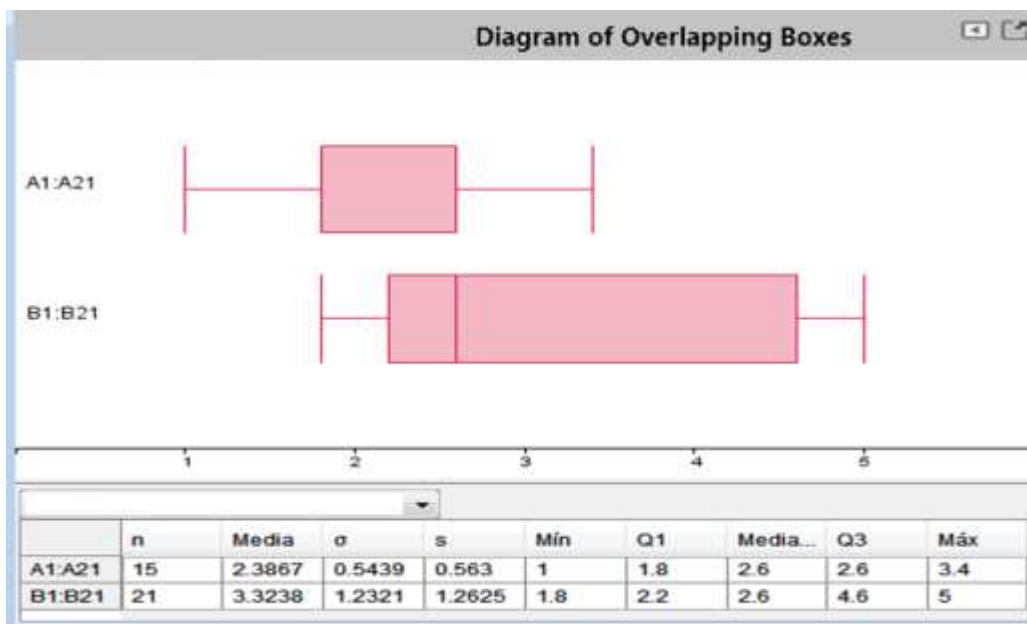| Rating of the control group in the post	Group qualification experimental in the post	$(x_1 - \bar{x}_1)$	$(x_1 - \bar{x}_1)^2$	$(x_2 - \bar{x}_2)$	$(x_1 - \bar{x}_2)^2$
1.0	1.8	-1.3867	1.9228	-1.5238	2.3220
1.8	1.8	-0.5867	0.3442	-1.5238	2.3220
1.8	1.8	-0.5867	0.3442	-1.5238	2.3220
1.8	1.8	-0.5867	0.3442	-1.5238	2.3220
2.6	1.8	0.2133	0.0455	-1.5238	2.3220
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	2.6	0.2133	0.0455	-0.7238	0.5239
2.6	3.4	0.2133	0.0455	0.0762	0.0058
2.6	4.2	0.2133	0.0455	0.8762	0.7677
2.6	4.2	0.2133	0.0455	0.8762	0.7677
3.4	4.2	1.0133	1.0268	0.8762	0.7677
	4.2			0.8762	0.7677
	5.0			1.6762	2.8096
	5.0			1.6762	2.8096
	5.0			1.6762	2.8096
	5.0			1.6762	2.8096
	5.0			1.6762	2.8096
$\bar{x}_1 = 2.3867$	$\bar{x}_2 = 3.3238$		$\sum(x_1 - \bar{x}_1)^2 = 4.4373$		$\sum(x_1 - \bar{x}_2)^2 = 31.878$

Source: Data from field (2016).

Diagram of Overlapping Boxes

	n	Media	σ	s	Mín	Q1	Media...	Q3	Máx
A1:A21	15	2.3867	0.5439	0.563	1	1.8	2.6	2.6	3.4
B1:B21	21	3.3238	1.2321	1.2625	1.8	2.2	2.6	4.6	5

Figure 5. Final comparison of sample groups.

Table 6. Cohen's d

	$\overline{X}$	S	n* *Optional – for Hedges g only
Group 1	3.323	0.543	21
Group 2	2.386	1.232	15

Results: d-based, Cohen's d = 0.9839, Glass's Δ = 0.7605, Hedges' g = 1.0249.

In this case X is the raw score, M is the mean, and N is the number of cases.

Since the value of Cohen is greater than 0.8 (Table 6), it indicates a high magnitude effect. Therefore, the intervention in the experimental group is viable. The children whose mother tongue is Spanish and understand the original language in the community are taught by the teachers. This would make them not to have difficulties in their Mathematics learning process. In either cases, it is evident that the students will not learn Mathematics if they use a language they do not understand. The only thing that is achieved when the student does not understand a language is that he or she repeats mechanically names of numbers or tables of operations without any meaning to his life; this method of work generates in the students, a negative attitude towards Mathematics (Romero-Bojórquez et al., 2014).

Figure 5 presents the final comparison of the two research groups in which the experimental group scored 0.94 higher than the control group. This shows that problem-solving strategy helps the students to solve problems. In addition, the degree of concentration of 50% of the observations indicates that the students in the experimental group manage and obtain higher grades. Gamboa (2007) argued that a contextualized guide increases the reflection and exploration of the students who use it, which promotes the articulation of their learning processes.

The idea that many of our students have about math is that they are done and the last thing they have to do is to learn the rules, formulas, algorithms and repeat it over and over again because, as we all know, math is an exact science and is already well established. Also, many people think that with mathematics, any problem can be solved. In fact, mathematics is not an exact science and the sense of always giving a perfect result does not exist; on the other hand, good problems must produce new questions. Villalobos (2008) argued that with problem-solving skill, students can develop intellectual skills such as relating, drawing conclusions, organizing and linking mathematical arguments, compare, interrogate, inquire, among others.

Thus, didactic guide under the problem-solving strategy motivates students to discover the principles of mathematics and concepts of some arithmetic and geometry topics; in this way, the capacity of wondering is fostered and the attitude of asking why things happen is maintained, as well as the systematic research for answers.

The elements that constitute the didactic guide contextualized are the theme, objective, content, didactic resources and development activities. It is considered an activity in such a way that it falls into the students' cognition and identifies information that can be a relationship between data and unknowns patterns.

Conclusion

It is evident that a lot of the Panamanian heritage can be found in mathematics, and therefore the indigenous people's culture can be found in ethnomathematics. Indeed, architectural monuments, ceramic works, typical textiles of a typical town, among others, are regional resources to be taken into consideration for a design and an activity proposal related to patterns, numeric system, space distribution, geometric shapes, measurement system, plane and space transformation, etc.

The proposal gives special attention to heritage because in many of our towns and cities, there is a great historical and natural wealth that we must know, value and care for. It is important that children investigate their origins, meanings and the archaeological natural monuments that exist in the places where they live. The current work has the following conclusions:

1. Using the IBE learning in grade IV students from Sayla Olonibiginya School from 2015, will improve with the use of arithmetic and geometry didactic guides to solve problems.
2. The posttest proves that students are able to develop different Polya's method stages significantly and improve in their analysis in solving arithmetic and geometric problems.
3. This methodological alternative promotes the interaction between teachers and the students, as well as among the students.
4. The use of traditional methodologies leads to poor algorithmic mathematical knowledge; that is why when students are faced with mathematical challenges, they

tend to have lower academic performance.

RECOMMENDATIONS

1. Problem-solving strategy should be the main focus of the IBE project.
2. Elementary teachers should propose learning activities that represent an intellectual challenge to the students and generate interest in finding a way to solve them.
3. Students' activities as well as strategies and procedures used to solve problems should be evaluated.
4. The students' previous knowledge should be used as a basis for a new didactic guide development.
5. It is important to present contextualized problems, in which language regularities are visualized in the resolution of arithmetic and geometric problems, supported by specific materials and graphic representation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Aguilar R M (2004). La guía didáctica y las estrategias de aprendizaje, un enfoque centrado en la comprensión. Ecuador: UNED

Ascher M and Ascher R (1981). Code of the Quipu: a study in media, mathematics, and culture. Chicago: University of Michigan Press.

Bishop AJ (1988). Mathematical enculturation: A cultural perspective on mathematics education. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Canbulat M, Dilekci A (2015). Difficulties encountered by both teachers and students in teaching and learning Turkish as a second language. Educ. Res. Rev. 10(9):1335-1346.

Del Rincón D, Arnal J, Latorre A, Sans A (1992). Técnicas de Investigación en Ciencias Sociales. [Techniques of Social Science Research] Madrid: Morata.

D'Ambrosio U (1985). "Ethnomathematics and its place in the history and pedagogy of mathematics", For the Learning of Mathematics 5(1):44-48.

Fabara M (2017). Intercultural bilingual education: A multidisciplinary analysis. Master thesis. Oslo: University of Oslo. https://www.duo.uio.no/handle/10852/57301

Gamboa ME (2007). El diseño de unidades didácticas contextualizadas para la enseñanza de la Matemática en la Educación Secundaria Básica. [The Design Of Contextualized Didactic Units For The Teaching Of Mathematics In Basic Secondary Education] Thesis in option to the Scientific Degree of Doctor in Pedagogical Sciences. Las Tunas. Recovered: http://roa.ult.edu.cu/jspui/handle/123456789/3560

Gaulin C (2001). "Tendencias actuales de la resolución de problemas". [Current trends in problem-solving] Conference delivered on 12/15/2000. Recovered: https://sferrerobravo.files.wordpress.com/2007/10/7_tendencias_actuales.pdf

General Gunas Congresses (2011). Propuesta Curricular de la EBI Guna. Panamá: Editora Sibauste, S.A. Primera Edición.

Guzmán M de (1993). Enseñanza de las Ciencias y las Matemáticas. OEI Para la Educación, la Ciencia y la Cultura. Recovered from http://www.oei.es/historico/oeivirt/edumat.htm

Meduca (2013) Estadísticas Educativas. Recovered: https://www.educapanama.edu.pa/?q=estadisticas-educativas

Naštická, Z (2016) Intercultural Features and the Theme of Traveling in Bilingual Mathematics Lessons. In: Problems of Education in the 21st Century. 72:76-88. ISSN 1822-7864.

NCTM (2000). Principles and standards for school mathematics. Reston, VA: NCTM https://www.nctm.org/Standards-and-Positions/Principles-and-Standards/

Pólya G (1965). Mathematical Discovery: On understanding, learning and teaching problem. Nueva York: John Wiley & Sons Inc. 2:160-175.

Romero-Bojórquez L, Ultrilla-Quiroz A and Ultrilla-Quiroz VM (2014). Las actitudes positivas y negativas de los estudiantes en el aprendizaje de las matemáticas, su impacto en la reprobación y en la eficiencia terminal. Rev. Ximhai 10(5):291-319 Recovered: http://www.redalyc.org/pdf/461/46132134020.pdf

Santos-Trigo LM (2008). La resolución de problemas matemáticos: avances y perspectivas en la construcción de una agenda de investigación y práctica. En R. Luengo, B. Gómez, M. Camacho, L. Blanco (eds.), Investigación en educación matemática XII. Badajoz: Sociedad Española de Investigación en Educación Matemática, SEIEM. Recovered: https://dialnet.unirioja.es/servlet/articulo?codigo=2748785

Schoenfeld A (1985). Mathematical problem solving. (1ª. Edición). Orlando, Florida: Academic Press.

Schoenfeld A (1992). Learning to think mathematically: problem solving, metacognition and sense making in mathematics. In Handbook for Research on Mathematics Teaching and Learning. New York: Macmillan. Recovered: http://mrbartonmaths.com/resourcesnew/8.%20Research/Problem%20Solving/Learning%20to%20think%20mathematically.pdf

Schoenfeld A (2007). Problem solving in the United States, 1970-2008: research and theory practice and politics. ZDM. Int. J. Mathematics Educ. 39:537-551.

Shadish WR, Cook TD, Campbell DT (2001). Experimental and Quasi-Experimental Designs for Generalized Causal Inference (2nd Edition). Wadsworth: Cengage Learning. https://pdfs.semanticscholar.org/9453/f229a8f51f6a95232e42acfae9b3ae5345df.pdf

Urton G (2003). Signs of the Inka Khipu: Binary Coding in the Andean Knotted-String Records. Austin: University of Texas Press.

Villalobos X (2008). Resolución de problemas matemáticos: un cambio epistemológico con resultados metodológicos. [Mathematical problem-solving: an epistemological change with methodological results] Revista Electrónica Iberoamericana sobre Calidad, Eficiencia y Cambio en la Educación, 6(3):36-58. Recovered: http://redalyc.uaemex.mx/pdf/551/55160303.pdf.