Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Método de Pólya aplicado al lenguaje algebraico en primer año de licenciatura

Pólya Method Applied to the Algebraic Language in First Year of Degree

Método de Pólya aplicado à linguagem algébrica no primeiro ano de graduação

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Resumen

El bajo rendimiento presente en los estudiantes de diversos niveles en el ámbito matemático es un tema preocupante en la actualidad para los docentes. Mediante este estudio se efectuó un análisis documental a través del cual se pudo evidenciar que el método de Pólya, como estrategia didáctica aplicada a las matemáticas, incrementa las habilidades en los alumnos como resolutores. El estudio de alcance correlacional se trabajó con dos grupos, control y experimental, formados a partir de la población de 68 estudiantes de primer año de la Universidad Autónoma del Carmen. El desarrollo de la investigación consistió en una evaluación previa para verificar la homogeneidad de los grupos; posteriormente se

implementó la estrategia didáctica al grupo experimental, y finalmente se evaluaron los conocimientos adquiridos. Dentro de los resultados arrojados por las pruebas estadísticas se pudo encontrar evidencia significativa, y se concluyó que el método de Pólya incrementó el rendimiento de los estudiantes con los que se trabajó la estrategia en comparación con aquellos a los que no se les aplicó.

Palabras clave: álgebra, competencia, método de Pólya, rendimiento.

Abstract

The low performance present in students of various levels in the mathematical field is a matter of concern for teachers. Through this study a documentary analysis was carried out through which it was possible to demonstrate that the Pólya method, as a didactic strategy applied to mathematics, increases the abilities of students as solvers. The study of correlational scope was worked with two groups, control and experimental, formed from the population of 68 students entering the first year of the Universidad Autónoma del Carmen. The development of the research consisted of a previous evaluation to verify homogeneity of groups; after this the didactic strategy was implemented to the experimental group, and finally the acquired knowledge was evaluated. Within the results of the statistical tests, significant evidence could be found. It was concluded that the Pólya method increased the performance of the students with whom the strategy was worked on compared to those who did not.

Keywords: algebra, competition, Pólya method, performance.

Resumo

O baixo desempenho presente em estudantes de vários níveis no campo da matemática é motivo de preocupação para os professores de hoje. Através deste estudo, foi realizada uma análise documental através da qual foi possível demonstrar que o método Pólya, como estratégia didática aplicada à matemática, aumenta as habilidades dos alunos como solucionadores. O estudo do escopo correlacional foi trabalhado com dois grupos, controle e experimental, formados a partir da população de 68 alunos do primeiro ano da Universidad

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Autónoma del Carmen. O desenvolvimento da investigação consistiu em uma avaliação prévia para verificar a homogeneidade dos grupos; Posteriormente, a estratégia didática foi implementada para o grupo experimental e, finalmente, o conhecimento adquirido foi avaliado. Dentro dos resultados dos testes estatísticos, evidências significativas puderam ser encontradas, e concluiu-se que o método Pólya aumentou o desempenho dos alunos com quem a estratégia foi trabalhada em comparação àqueles a quem não foi aplicada.

Palavras-chave: álgebra, competência, método de Pólya, desempenho.

Fecha Recepción: Agosto 2018 **Fecha Aceptación:** Noviembre 2018

Introduction

In the Autonomous University of Carmen (Unacar), the competency model called Acalan, valid since 2010, is used with a pedagogical framework oriented towards sociocultural constructivism (Unacar, 2010). This model allows to develop certain competences, or rather, a set of skills and abilities that, together with the accumulation of knowledge, allows the student to be prepared to carry out the necessary knowledge management and apply them according to the context.

However, before taking a step further, and knowing that problems are the order of the day both on a personal and professional level, one must bear in mind that a problem is everything that presents itself as an obstacle. or an impediment to access a certain purpose, and in turn, the solution is the search for the end or, where appropriate, the search and proposal of alternatives that pave the way to the goal. The mechanism to find solutions is not a simple process, it is necessary to stimulate the development of reflective mental processes that favor decision making (Herrera, 2013).

The method of problem solving has been applied as a didactic strategy with good expectations in various research works, such as the one carried out by Matute, Pérez and Di 'Bacco (2009), in which it was applied to topics related to electrochemistry , and three groups with different authors each were validated. The result of this investigation showed that there is no significant difference in the type of author chosen for each group; there is, however, a

clear advantage in using the method compared to the failure to do so. Benítez and Benítez (2014), on the other hand, specifically worked on the Pólya method as a strategy to solve problems. The research of these authors focused on students with non-passing grades for college entrance. And they concluded that the strategy, enriched with its own techniques and mathematical foundations, such as reasoning, intuition and symbology, allowed the students to acquire confidence and confidence in their learning.

It should be noted that the interest of this research arose because the young people assigned to the course of Logical Reasoning, which is taught at Unacar, have shown low performance. This was evidenced in works such as those of Díaz, Lagunes, López and Recio (2012), who implemented videos as technological support in the learning of polynomials due to the difficulty of their learning. Herrera (2013), meanwhile, based his proposal on the solution of problems by the case method. It was an investigation that had the objective of attending to the low interest of the students in the aforementioned course, and as a result it was possible to improve the academic performance. In addition, Saucedo, Herrera, Díaz, Bautista and Salinas (2014) undertook an investigation to detect the indicators of failure specifically in the Faculty of Educational Sciences of Unacar. As a result, they obtained that subjects related to mathematics and technology were those that presented the highest failure rate. Finally, summit of the teaching concern in the difficulties that the course represents, the research work of Díaz, Herrera, Saucedo and Recio (2015), entitled "The course of logical reasoning and the mathematical attitude of students", showed evidence significant between school performance and attitude toward mathematics.

However, it was found that the Pólya method as a didactic strategy presents, in addition to what has already been mentioned above, a favorable background in the academic performance of the students. Roque (2009), for example, did a paper whose objective was to determine if there are significant differences in the students' academic performance, and found enough statistically significant evidence to allow him to affirm such an approach. Likewise, Acuña (2010) evaluated the method in 183 students and concluded that there was no correlation between problem solving and academic performance, although there was a level of analysis and understanding of the problems. Escalante (2015), meanwhile, found that with this method the students worked more analytically, shared ideas, criteria and interests

fostering unity and teamwork. Similarly, Cardona (2007) observed that teamwork contributed to a better performance when translating verbal expressions into algebraic language, as well as when expressing numerical relationships through the use of this language; the students recognized, described and generalized numerical patterns; proposed and managed adequate techniques to simplify similar terms and multiply monomials, and constructed numerical sequences from a given rule. In short, the strategy was adequate to initiate in the students the development of each of the skills that were intended with the work guide. Rodríguez and Yangali (2016) and Aguilar (2014) used the method to improve academic performance in mathematics starting from homogeneous groups. The results obtained in the study by Rodríguez and Yangali (2016) were very satisfactory with regard to the increase in performance: an increase of 67.46% was evidenced, with which the level of achievement expected by the students was reached. Aguilar (2014) found that the control group and the experimental group were in different conditions after treatment. In the same sense were the results of the works of Cedeño (2015) y Casimiro (2017). Both showed an increase in the means of the groups with clear advantage of the experimental group: the members of this group managed to demonstrate a better development, with greater efficiency and autonomy, in the resolution of problems. In the work Cedeño (2015) in particular, a substantial improvement was evidenced by the population under study in the learning of the algebraic language.

Teaching the Pólya method and its pedagogical effect

The didactic proposal to solve problems through the Pólya method is developed through the reflexive process, with which the connectivity of the information is stimulated. From the point of view of constructivism, the student throughout his student development is acquiring information, knowledge, theoretical bases and practices that are forming cognitive structures. And, this time in sync with Jean Piaget, in Arancibia, Herrera, and Strasser, 2008, in the determination of information the student interacts with his environment, his physical and social environment, and it is through this interaction that the assignment of images to a theoretical context, which later becomes part of the procedural memory.

If the information was acquired with sufficient reinforcement, it passes from the procedural or execution memory to be part of the consciousness. On the categorical level of constructivism it is emphasized that the apprentice must be able to seek and develop his own knowledge. However, the theoretical-practical bases deficient or not well fixed are confused in the call of their memories. At this point, the teacher's mission is to regulate: to bring the student enough to identify the stage of intrapersonal development, according to Vygotsky's theory, in Arancibia et al., 2008, which allows the teacher to discover the individual abilities that own each student. According to this, the methodology of Pólya allows to execute the reflective impulses stimulating the memories, the relation of the language with the learned cognitive structures that allow to relate the information that the student has with the recently acquired one.

One of the advantages of the Pólya method is that it offers the possibility for the teacher to approach the student without invading their individual development. The student, therefore, remains independent and autonomous. Likewise, this method fosters social learning, since it generates group or subgroup cooperation within the classroom, which provides that someone with greater mastery of the subject can act as a facilitator among those with less ability and even before the same teacher.

Due to all of the above, in this work the problem solving strategy was used in order to contribute to the development of competences during the progress of the Didactic Sequence three, with the topic of algebraic language, corresponding to the Reasoning course Logical that is taught during the first year at Unacar. In order to seek the increase of academic performance and decrease the rate of failure, we worked with the new student population of the Bachelor of International Business (LNI) of the Faculty of Economic and Administrative Sciences (FCEA).

Materials and methods

Study Type

The present investigation had a quantitative approach with a correlational scope. We chose a quasi-experimental design derived from the manipulation of at least one variable, the problem-solving strategy. Also, the subjects were not assigned randomly, we worked with preformed groups called intact, according to the definition of Hernández, Fernández and Baptista (2010).

Population

The research was carried out in the August-December 2017 cycle with a population of 68 students of first-year LNI belonging to the Unaca FCEA. The population was divided into two groups: 37 for the control group and 31 for the experimental group.

Instrument

To pilot the instrument, as a first phase, an instrument consisting of 12 items was designed, which was previously validated by three experts in the field. To evaluate its reliability, this was applied to a group of students with the same academic characteristics to the population with which the research was developed. The reliability analysis of this was carried out by Cronbach's alpha method, from which the value of 0.812 was obtained in the statistical program SPSS version 22. Subsequently, the item discrimination analysis was carried out and the relevant adjustments were made.

Methodology

With the instrument designed and ready to be applied, the students of both groups were evaluated before and after the treatment. After the pretest, the problem-solving strategy was developed through the Pólya methodology and the tools were elaborated with which the student was guided in the process of developing the solution. We worked on a structured anthology mainly under the theme of Sequence three of the course of Logical Reasoning, elaborated with the theoretical elements of content, algebraic thinking, algebraic operations

and problem solving. The previous thing was complemented with a notebook of work, which consisted of exercises that reinforced the learning of each subject seen in class. In this last section, a menu of problems formed by the own statement of the problem was incorporated and a guide table prepared in four sections according to the Pólya methodology -but addressed to what the student was expected to develop according to the topic of algebraic thinking. . The table that accompanied each problem required the filling of the fields: data, procedure, algebraic expression and result.

The procedure of the Pólya method as such was shown in each session dedicated to the solution of problems, through the projection of slides, in which the statements-problems to be solved accompanied by the phases of development of said method were shown. This is:

•Step 1: Understand What do you mean? What are the data? Do you know where you want to go?

• Step 2: Configure the plan. The student is expected to analyze the information contained in the statements. That discriminates the known values of the unknowns and assigns variables.

• Step 3: Execute the plan. In this phase, the operations concerning the type of expressions obtained were developed, be it an algebraic expression of an unknown or variable, or a linear system of two unknowns or variables.

• Step 4: Look back. In this last step, the student was asked to analyze the values obtained for the variable (s), if they were in accordance with what was requested, if it was a value according to the expected and if it was congruent. Finally, it was checked operationally whether or not it met the algebraic expression found.

As a complementary part of the competency-based learning system, the situation was designed according to the real context, called the problem situation. In this, the student had to collect the theoretical elements acquired in the classroom. Developed in teams of four people, the apprentice put to the test his capacity to solve problems: the procedure had to be developed through the methodological structure of Pólya, since it is the guide of ordering the analysis of the problem in the process of solving it.

The strategy was developed during six weeks, four hours per week, in the August-December 2017 school year, as previously specified. The activities through which the

strategy was developed are shown in table 1. There, the structured work plan is also detailed in accordance with the times foreseen for the development of the topic and the teaching objectives of the teaching strategy and also considering the model educational Acalán, based on the development of competences, which were fostered through the development of PowerPoint presentations (PPT), reinforcement activities through which knowledge was consolidated and student learning was evidenced.

Tabla 1. Cronograma de actividades de la propuesta didáctica.

Actividad	**Periodo: octubre-noviembre de 2017**	**Objetivo de aprendizaje**	**Estudiante**	**Docente**
Evaluación diagnóstica (pretest)	24 de octubre	Conocer los conocimientos previos presentes en el estudiante	Ejecución	Evalúa
PPT: principales conceptos y definiciones	26 de octubre	Homogeneizar los conceptos básicos del álgebra	Investiga previamente los conceptos	Efectúa lluvia de ideas, conoce la perspectiva del estudiante y los alienta en la construcción del concepto
Elaboración de mapa mental	31 de octubre	Demostrar el dominio de los conceptos y reconocer su aplicación	Elaboración metódica del mapa mental	Valora el desarrollo asertivo del estudiante y supervisa las áreas de oportunidad
PPT: procesos de generalización	31 de octubre	Conocer el procedimiento deductivo en la generalización matemática	Observa y cuestiona	Guía y supervisor del análisis efectuado por el estudiante
Ejercicio lúdico: “secuencia de tablas” “calculando áreas y perímetros”	31 de octubre	Conocer las capacidades desarrolladas por el estudiante	Ejecuta y refuerza lo aprendido en clase. Pone a prueba sus cuestionamientos	Guía superficialmente al estudiante sin invadir a zona de desarrollo próximo
PPT: proceso de traducción del lenguaje común al lenguaje algebraico	31 de octubre	Demostrar el procedimiento de traducción al lenguaje algebraico	Analiza y comprende conceptos reflexivamente acorde con el planteamiento de Pólya	Demuestra el procedimiento de traducción de enunciados sencillos del lenguaje común al lenguaje algebraico
Ejercicio lúdico: “lenguaje	7 de noviembre	Reforzar el aprendizaje del procedimiento de	Analiza y ejecuta la traducción al	Guía pasivamente al estudiante, monitorea los niveles de

algebraico uno y dos"		traducción al lenguaje algebraico	lenguaje algebraico	comprensión del estudiante
Evaluación previa de las operaciones algebraicas	9 de noviembre	Conocer la existencia de posibles deficiencias sobre el tema	Ejecuta las operaciones que reconoce	Evalúa e identifica las áreas de oportunidad
Entrega del Objeto de Aprendizaje	9 de noviembre	Desarrollar las competencias digitales	Conoce, analiza y manipula un Objeto de Aprendizaje. Demuestra su capacidad de autoaprendizaje	Monitorea y asesora el uso de un Objeto de Aprendizaje
PPT: presentación de los conceptos básicos, así como la parte procedimental	9-28 de noviembre	Homogeneizar las bases operacionales de las expresiones algebraicas	Conoce y efectúa los procedimientos operacionales del álgebra	Muestra el desarrollo de las operaciones algebraicas
Ejercicios lúdicos: "balanza", "trazar al pato", "color al pez"	9-28 de noviembre	Desarrollar las capacidades de ejecución en los estudiantes	Demuestra activamente el desarrollo de las operaciones algebraicas	Guía pasivamente al estudiante, foementando el análisis reflexivo acorde con el método de Pólya
Solución de problemas de aplicación en contexto	14 de noviembre- 5 de diciembre	Desarrollar la habilidad para solucionar problemas (método Pólya)	Demuestra el manejo, dominio y aplicación de los conceptos	Monitorea y evalúa las áreas de oportunidad del estudiante
Situación problema: problemática planteada en contexto real	24 de octubre- 5 de diciembre	Desarrollar las capacidades de comprensión, análisis y aplicación de los conocimientos	Aplica el conocimiento	Monitorea y da seguimiento a la ejecución de la metodología empleada por el estudiante
Evaluación objetiva (post-test)	7 de diciembre	Conocer el grado de dominio de los conocimientos básicos, así como la comprensión, planteamiento y desarrollo algebraico por parte del estudiante acerca del tema de pensamiento algebraico	Ejecuta activamente el conocimiento adquirido	Evalúa el grado de conocimientos que posee el estudiante posterior al desarrollo del tema de pensamiento algebraico (secuencia tres), así como el proceso metodológico empleado

Fuente: Elaboración propia

The proposal or didactic strategy, problem solving, was carried out once the thematic content of the Sequence was made known and worked with the students, with the corresponding realization of the activities that allowed strengthening each segment. At that

point it was considered that the student was prepared with the minimum necessary knowledge as mathematical tools for the intervention and solution of the problems.

To apply the Pólya method, we started with simple cut problems, that is, when we had to identify a single variable involved. It is important to point out that the key point for the student when solving a problem is always to know where he wants to go; and it is equally important that you understand and be clear about when you found the answer you were looking for. As a complementary part, you should be motivated to structure the semifórmulas. By ordering the ideas and structuring the complete formula by segments, the purpose is for the student to formulate each segment of the statement. In this way, you can visualize the semifórmula that corresponds to each statement and thus have the necessary elements to formulate the complete expression. Once this has been done, the formulation or mathematical model can be combined, and with this the learner can observe which procedure, within the algebraic operations, corresponds to him.

The next step is the mathematical development based on algebra, so it is necessary to have worked on this topic in class and reinforce it enough so that it does not generate complications in the problem solving procedure. Finally, the student is asked to reflect on the result, therefore, phase four of the Pólya method is worked on, in which it is necessary to analyze if the obtained value is in accordance with what can be expected in the problem, subsequently, performs mathematical verification. Through the same procedure, he may be able to state the algebraic expressions necessary to solve a problem, which in turn may increase the level of complexity of the algebraic models.

Results

The application of the previous evaluation had the purpose of knowing the academic conditions of the students in terms of the prior knowledge they possess. The t-Student statistical study was performed for independent samples in SPSS. The data shown are shown in Table 2. It is noteworthy that both groups are very similar means and non-creditable value, according to the scale of 0-12% established by the Academy of Mathematics of Unacar.

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Tabla 2. Resultados de las pruebas de estadística descriptiva

Estadísticas de grupo					
		N	**Media**	**Desviación estándar**	**Media de error estándar**
Rendimiento académico	Grupo control	37	3.2369	2.07179	0.33175
	Grupo experimental	31	3.2043	1.97927	0.32539

Fuente: Elaboración propia

Following with the statistical-descriptive analysis, table 3 was elaborated. In this, the conditions of the students are compared according to the indicators designed to evaluate them, according to the cognitive level of Bloom's taxonomy for the pre-treatment of the didactic strategy.

Tabla 3. Porcentaje de estudiantes correspondientes a cada indicador y su respectivo nivel de rendimiento académico

Dimensión	**Indicador**	**Pretratamiento**							
		Grupo control				Grupo experimental			
		Nulo	Bajo	Regular	Alto	Nulo	Bajo	Regular	Alto
Comprensión	Comprende textos	37.83	0	0	62.16	41.93	0	0	58.06
	Traduce algebraicamente	37.83	0	0	62.16	3.2	0	0	96.8
Aplicación	Comprende textos y obtiene la información	10.81	40.54	27.03	0	29.03	45.16	19.35	3.23
	Plantea metodológicamente	100	0	0	0	100	0	0	0
Análisis	Aplicación de procedimientos y solución algebraica	24.32	27.03	0	48.65	9.68	38.71	0	51.61
Síntesis	Aplicación de conceptos algebraicos	100	0	0	0	100	0	0	0

Fuente: Elaboración propia

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Table 4 shows the comparison between the control group and the experimental group after the treatment with the didactic strategy and after being evaluated according to the established indicators. This shows the progress of the students in their academic performance, assessed according to the scale assigned to the course and according to each level of cognitive maturity reached in the learning process.

Tabla 4. Porcentaje de estudiantes correspondientes a cada indicador y su respectivo nivel de rendimiento académico

Dimensión	**Indicador**	**Post-tratamiento**							
		Grupo control				Grupo experimental			
		Nulo	Bajo	Regular	Alto	Nulo	Bajo	Regular	Alto
Comprensión	Comprende textos	27.03	0	0	72.97	19.35	0	0	80.65
	Traduce algebraicamente	18.92	0	0	81.08	16.13	0	0	83.87
Aplicación	Comprende textos y obtiene la información	18.91	35.14	37.84	8.11	3.23	54.84	35.48	6.45
	Plantea metodológicamente	37.84	48.65	13.51	0	25.81	51.61	16.13	6.45
Análisis	Aplicación de procedimientos y solución algebraica	10.82	24.32	0	64.86	6.45	22.58	0	70.97
Síntesis	Aplicación de conceptos algebraicos	45.95	51.35	2.7	0	29.03	45	9.68	16.13

Fuente: Elaboración propia

The scores resulting from the post-test evaluation were analyzed in SPSS. The results were poured into table 5. This time it is evident that the average of the experimental group's ratings exceeds that of the control group.

Tabla 5. Resultados de la estadística descriptiva en el post-test.

Estadísticas de grupo					
	Grupo	N	Media	Desviación estándar	Media de error estándar
Rendimiento académico	Control	37	5.36	2.617	0.419
	Experimental	31	6.65	1.992	0.358

Fuente: Elaboración propia

Subsequently the hypothesis was contrasted, namely, is there a difference in academic performance between the experimental group in terms of the knowledge they possess after the development of the didactic proposal and the control group, that is, the group over which no proposal was applied? any?

Considering the level of significance (□) of 5%, the t-Student test was performed for corresponding independent samples. Thus, the comparison was made between the value of significance of 0.05 and the value p = 0.027 obtained in the test and it can be seen that the level of significance is greater than the value of the p-test, so the hypothesis is not rejected null (Ho) and that of the investigation is taken.

In accordance with the approach of the present problem in the academic performance of the students, the investigation was carried out in order to satisfy the following question: Is there an increase in the academic performance of the students of the first semester of the FCEA of Unacar with the application of the didactic strategy of problem solving in the interpretation of the algebraic language in comparison with those that do not apply to them? To answer this question, the comparison of means was made. Figure 1 shows that there is an advantage on the part of the experimental group.

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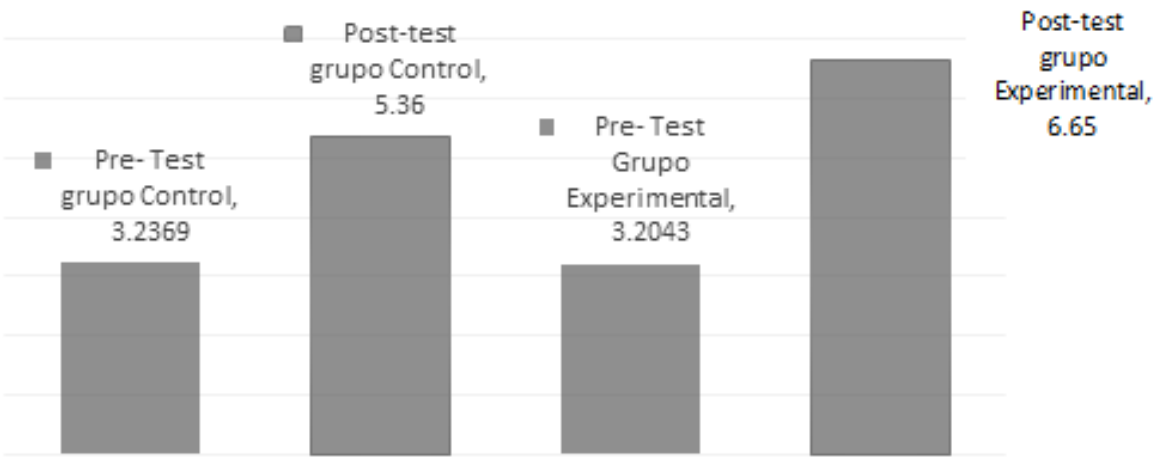
Figura 1. Comparación de las medias obtenidas en el pretest y post-test para ambos grupos.



Fuente: Elaboración propia

To verify if Pólya's problem-solving method is significantly related to the academic performance obtained in the students' grades, Pearson's correlation statistical analysis was performed in SPSS, taking into consideration the activities that supported the learning of the method. and the results obtained in the post-test. As a result, what was shown in Table 6 was obtained.

Tabla 6. Análisis estadístico de la correlación entre el método de Pólya y el rendimiento académico

Correlaciones			
		Rendimiento del método de Pólya	Rendimiento académico
Método de Pólya	Correlación de Pearson	1	0.836**
	Sig. (bilateral)		0.000
	N	37	37
Rendimiento académico	Correlación de Pearson	0.836**	1
	Sig. (bilateral)	0.000	
	N	37	37
**La correlación es significativa en el nivel 0.01 (2 colas).			

Fuente: Elaboración propia

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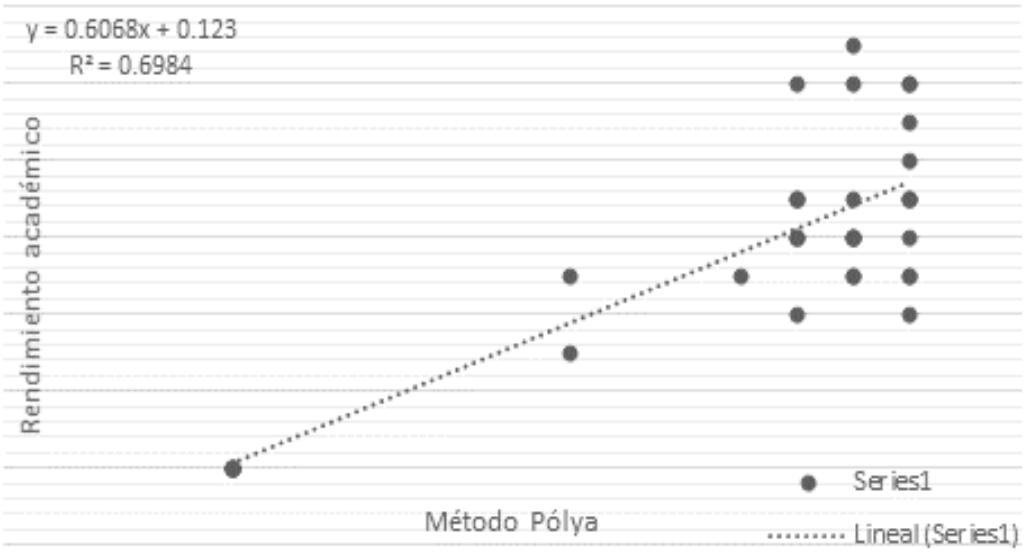
It can be observed that the value of p (sig.) Is less than the value of significance, 0.000 □ 0.05, with which the Ho is rejected, and the research hypothesis is validated or alternates with a correlation of 0.836.

Likewise, we proceeded to evaluate the linearity of the data with the linear regression procedure in which the correlation of positive slope is appreciated, which indicates that a greater development of activities that the students did with the problem solving method of Pólya higher performance. Then, the data dispersion graph was made, from which the statistical analysis was carried out, represented in figure 2, where the linearity equation (y) and the coefficient of determination (R2) are obtained, thus verifying the positive correlation.

Figura 2. Distribución de datos para la regresión lineal, ecuación de ajuste y coeficiente



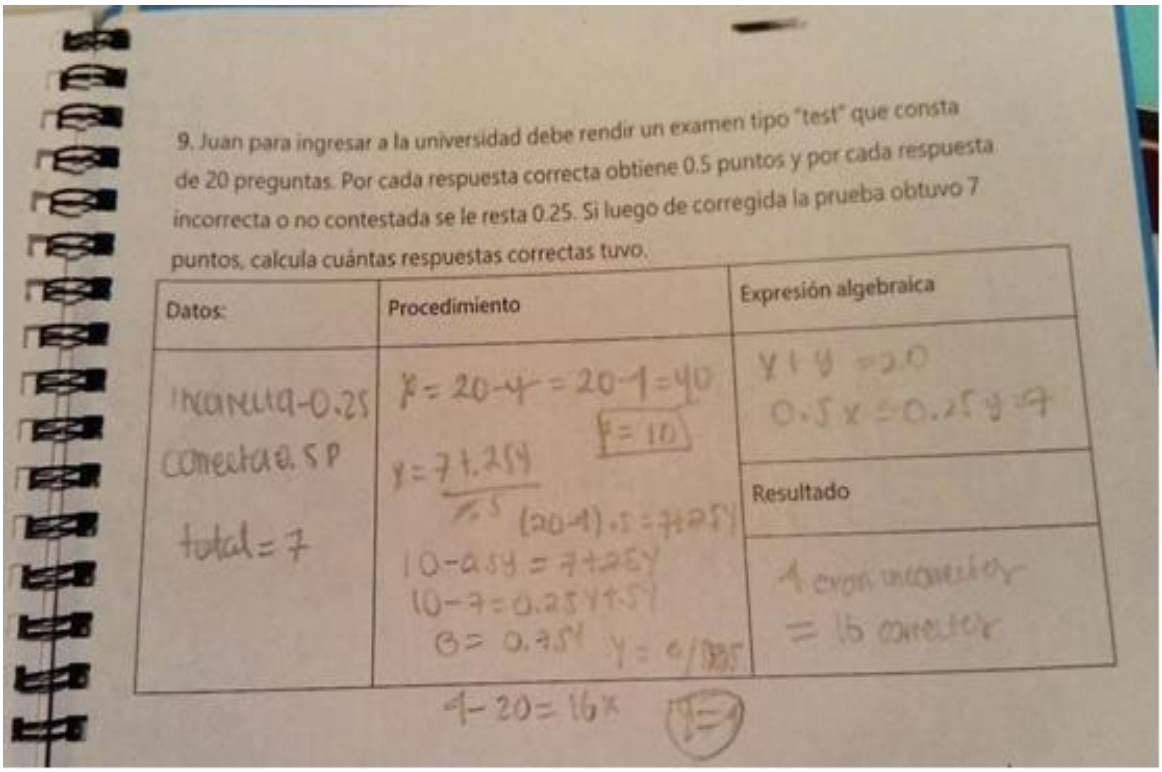
Fuente: Elaboración propia

The development of the strategy by the experimental group could be evidenced through the work manual, which was developed inside and outside the classroom. Also, through the problem situation, which is constituted by a statement of a problem as close as possible to everyday situations that can be faced professionally, of which the students

propose the solution. This is developed through the previous training of teams formed by four students each.

It was possible to observe progress in the development of the student to solve the problems of the manual in comparison with the group that did not take the didactic strategy. The experimental group could develop approaches, discern and obtain the data of a text, propose the concrete solution according to the algebra. This can be verified in Figure 3.

Figura 3. Planteamiento de un estudiante perteneciente al grupo experimental



Fuente: Elaboración propia

On the contrary, the control group tried to use its own strategy ignoring the principles of algebraic language seen in class. In most cases, he worked trial and error without identifying the variable element. This can be analyzed in figure 4.

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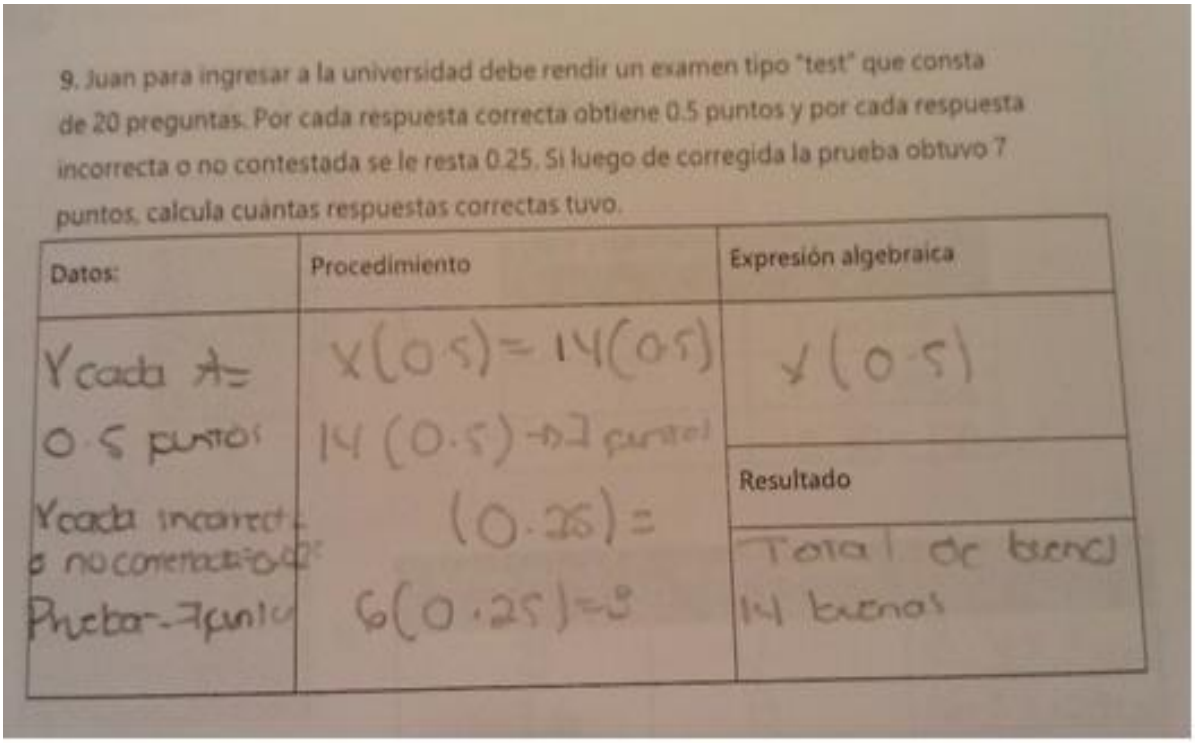
ISSN 2007 - 7467

Figura 4. Solución del problema por parte de un estudiante del grupo control



9. Juan para ingresar a la universidad debe rendir un examen tipo "test" que consta de 20 preguntas. Por cada respuesta correcta obtiene 0.5 puntos y por cada respuesta incorrecta o no contestada se le resta 0.25. Si luego de corregida la prueba obtuvo 7 puntos, calcula cuántas respuestas correctas tuvo.

Datos:	Procedimiento	Expresión algebraica
Y cada A= 0.5 puntos Y cada incorrecta o no contestada se le resta 0.25 Prueba-7puntos	x(0.5)=14(0.5) 14(0.5)=7 puntos (0.25)= 6(0.25)=3	y(0.5) Resultado Total de buenas 14 buenas

Fuente: Elaboración propia

While it finds the result, it takes more time and exhaustion. In most cases, however, it does not reach the correct result.

The strategy of the Pólya method allows the student to move to the analysis in an autonomous way, that is, that gradually emerges from the guidance and tutelage of the teacher, and makes its own decisions, analyzes and raises the case on its own, due that this is developed extra classroom. The experimental group carries a methodological procedure, although generalized, later delimits and concludes assertively. It also shows that the difficulty in identifying variables decreased, keeping in mind at the same time where you want or have to go.

However, for the control group it did not result in the same way, it put to trial and error the algebraic formula that was requested as part of the solution to the problem. The team, after the numerical deduction of the table, used to take the value and test it in the formula that it found as possible. Seeing that equality was checked, he took one of the values

and worked now on algebraic bases to find the value, which he deducted previously from the numerical sequence, not through the algebra. Although the analytical capacity of the team in its search for the solution is taken as valid, it is evident that it is not capable of performing it with the algebraic tools seen in class, that is to say, carrying out the translation of the statements.

As a conclusive part of its procedure, the team makes the last deductions based on the values used and thus arrives at the solution of the problem, although not to the correct answer.

Discussion

The main objective of the present investigation was to evaluate whether there is an increase in the academic performance of first-year students of the Unacan LNI with the application of the problem-solving method, specifically the Pólya method as a teaching strategy for interpretation and translation from the common language to the algebraic language. The development of the research had favorable results in the collaborative development of the students and in their social integration to develop the solution to the problems that were posed to them.

As part of the process of evaluating the results obtained in the pre-test, it was evidenced that the groups did not have enough knowledge to develop the translation to the algebraic language starting from non-creditable means in the 1-12% scale established as a parameter . When comparing the means of both groups, it was found that they were in equal academic conditions, which coincides with the works of Matute, Pérez and Di 'Baco (2009) and Aguilar (2014).

The activities carried out in accordance with the didactic proposal of the Pólya method led to favorable results, and the highest average of the grades in the experimental group was obtained, initial expectation before the development of the antecedents. The obtained result agrees with the works of Cardona (2007), Cedeño (2015) and Casimiro (2017), in which they analyzed and observed the development of the activities based on the method and concluded that this significantly influences the academic performance.

Given the heuristic nature of the Pólya method, it allowed the student not to mechanise procedures, but rather to explore the possible solutions, to make the

comprehension of the information and to be creative in search of an alternative, as it was presented in the research work of Benítez and Benítez (2014), who highlighted that the methodology supported by the Pólya method provides greater reasoning and intuition, which allows the student to acquire greater security and confidence.

Conclusions

In relation to the results obtained, it can be said that the problem solving methodology is effective in the cognitive development of the student, in particular the Pólya method, at the same time concrete and reflexive, which provides the basic structure of the analysis to raise and develop the solution to the problems.

The hypothesis test allows us to conclude that the problem solving method represents the relevant didactic strategy to increase the academic performance of the first-year students of the Unacar NIB.

Through the application of the didactic strategy, the students were able to develop analytical skills, such as the understanding of information, the translation of the algebraic language, the comprehension to obtain information, the methodological approach and the application of the procedures for the solution of problems. And it was found that this favored in a greater percentage the application of algebraic concepts in the synthesis dimension according to Bloom's taxonomy: the experimental group obtained a 23.11% advantage, in students with a performance from regular to high in this field, the which represents the maximum cognitive development within the selected domains according to the handling of the algebraic language. While the control group only managed to achieve a regular performance of 2.7% of students.

The ability to understand texts and extract information continues to demand greater attention because, although the experimental group improved its ability considerably, it does not outperform the control group; he only managed to level his knowledge and reduce the difference between them. Even with all this, the strategy allowed to reduce the percentage of the students that presented a null or low performance: from 22.84% in favor of the experimental group before the strategy to only 4% afterwards. When comparing the tables of the indicators to be evaluated in each test, only the experimental group managed to advance

to the synthesis phase of knowledge according to Bloom's taxonomy. This indicates that the student is more analytical, can make metacognitive or conscious use of the information relating the previous knowledge with the new one.

The relationship between the application of the method and academic performance was verified positively by determining the Pearson coefficient. This was found as the value of the coefficient of 0.836, which is very close to the unit, which indicates that there is a strong relationship between them and that it is a positive relationship: the greater the number of activities the student performs by applying the method, the greater the the performance obtained in the evaluation of the student. This was favorable to decrease the failure rate and at the same time develop the problem-solving competence.

The effectiveness of the Pólya method for solving problems can be seen in the individual and team development shown in the figures of this work. The student of the group to which the method was applied is safer, participatory and, what is expected, has a clear, concise, safe and accurate approach to reach the correct result.

Recommendations

The recommendations that are described are the product of the reflection of the results obtained in the research, which have been favorable to the objectives, hypothesis and research question posed, which confirms the expected research expectations. However, it is worthwhile to consider that the strategy can be strengthened from its design by proposing the methodology not only in the solution of problems, but from the structure of the exercises that reinforce each topic. This would give more time for the familiarization of Pólya's methodological approach. With this, when tackling the problems that put into practice the knowledge acquired in the learning sequence, the student may have established himself with the method previously, and when the time comes, only worry about the development of the problem itself.

The development of the didactic strategy could have alternative factors such as the time in which it was applied, because the course in which this research was applied was 9:00 a. m. at 11:00 a. m., with the disadvantage that the students entered the campus from 7 a. m.,

with class continuous without interruption to get food. It may be considered to test the treatment under other conditions.

There is also the possibility of enriching the Pólya method with some other additional strategy, as it can be a technological tool, or with some practical experience in field exploration, for example. This with the intention of attending to the new ways in which the student is interested in their studies and sees the application of their knowledge. In fact, the learning of mathematics has been much questioned in this regard by those who seek to see the usefulness of this area in their future professional lives.

Another relevant circumstance is the result obtained in the projection of the method when performing the linearity adjustment in the correlation between the activities carried out during the development of the strategy and the academic performance obtained. When a high correlation coefficient was found, it could be verified that there is an applicable relation of the Pólya method to improve the academic performance of the students; however, the coefficient of determination indicated that it is advisable to follow more closely students who are at the null or low level of academic performance. It may be concerned with the domain of application of knowledge in the indicator of compression and extraction of the information to be applied, because they require more time for processing and execution of cognition, and thus try to boost their progress and achieve favorable results. This can be achieved with adjustments in the times of the strategy in future investigations.

Like possible adjustments, in addition, it can be considered to work with the taxonomy of Bloom in its six levels of the cognitive domain, since, in the present investigation only the four central levels were worked with.

To give a more continuous follow-up to the developed strategy, it could also be the case to carry out intermediate evaluations and verify the level of progress. Also, possibly sectioning the evaluation: starting from an independent segment to evaluate what concerns the knowledge base of Sequence three, object of this study, and another specific deferred application to solve problems. This is so that the apprentice can focus more clearly on the solution of problems at the moment of being evaluated. Another possibility for mastering the strategy itself is to work the Pólya method from other previous Sequences and even in the entire course of Logical Reasoning.

According to the results obtained in the development of the strategy and with the research evidences that precede it, it can be considered as possible lines of research to follow the Pólya method in other courses, either related to mathematics or to different fields of knowledge. In accordance with the change of attitude shown by the students who received the application of the strategy, it is proposed to test the method under academic conditions reluctant to learn, for example, groups with low interest or performance. And we can even question whether teachers make statements that truly guide students in their learning, therefore, as a line of future research can be considered to take as a target population of teachers.

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Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

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