ISSN: 1692-7257 - Volume 2 – Number 42 - 2023

Revista Colombiana de Tecnologías de Avanzada

Received: April 11th, 2023
Accepted: June 20th, 2023

DIDACTIC STRATEGY THROUGH THE GEOGEBRA SOFTWARE FOR THE TEACHING OF POLYGONS IN FOURTH GRADE STUDENTS AT THE SANTA TERESA PRESENTATION SCHOOL – CÚCUTA

ESTRATEGIA DIDÁCTICA POR MEDIO DEL SOFTWARE GEOGEBRA PARA LA ENSEÑANZA DE LOS POLÍGONOS EN ESTUDIANTES DE CUARTO GRADO EN EL COLEGIO DE LA PRESENTACIÓN SANTA TERESA – CÚCUTA

MSc. Nini Johanna Soto Bayona*, PhD. Henry de Jesús Gallardo Pérez*
MSc. Marling Carolina Cordero Díaz*

* **Universidad Francisco de Paula Santander,** Facultad de Ciencias Básicas, Grupo de Investigación Arquímedes y Grupo de Investigación CINERA.
Av. Grancolombia No. 12E-96, B. Colsag, Cúcuta, Norte de Santander, Colombia.
Tel.: 57 3205684052, 57 3002156202, 57 3124340159
E-mail: {ninijohannasb, henrygallardo, marlingcarolinacd}@ufps.edu.co

How to cite: Soto Bayona, N. J., Gallardo Pérez, H. de J., & Cordero Díaz, M. C. (2023). ESTRATEGIA DIDÁCTICA POR MEDIO DEL SOFTWARE GEOGEBRA PARA LA ENSEÑANZA DE LOS POLÍGONOS EN ESTUDIANTES DE CUARTO GRADO EN EL COLEGIO DE LA PRESENTACIÓN SANTA TERESA – CÚCUTA. REVISTA COLOMBIANA DE TECNOLOGIAS DE AVANZADA (RCTA), 2(42), 51–58. https://doi.org/10.24054/rcta.v2i42.2687

Abstract: Education is in constant search of educational quality, for this reason different ways have been investigated to change the traditional education, by making use of new teaching strategies in which the use of technological tools is included. Nowadays, for the teaching of the area of mathematics, it is about leaving the conventional; for this reason, teachers have seen the need to use educational software, among which is the Geogebra software for the teaching of various topics, which must be addressed according to the grade in which students are. The main purpose of this project is to create a didactic strategy using Geogebra software for teaching polygons to fourth grade students. To carry it out, it was necessary to make use of a mixed research approach because in this way it was possible to collect all the necessary information to fulfill the objectives and thus provide a solution to the problem addressed in the study. Likewise, a recurrent triangulation was taken into account that allowed linking qualitative and quantitative methods to fulfill the established objectives. The research was carried out with the participation of 31 students to whom a test with open questions was applied to perform the diagnostic test, which allowed identifying the strengths and weaknesses of the students with respect to the subject of polygons. In addition, participant observation was carried out in order to carry out the different activities for the teaching of polygons and a semi-structured interview. The results showed that there is, in the first instance, apathy for the subject, which is reflected in the academic results of the students. When analyzing the results of the pre-test it can be said that there are deficiencies in terms of the subject matter because a large majority of students did not obtain favorable results and show deficiencies in the identification of the properties of polygons, but these deficiencies were improved after carrying out didactic activities using Geogebra software, as evidenced by the results of the post-test, which significantly

surpassed those of the pre-test, and the students developed skills for the identification of polygons and their properties, stating that the activities developed with the software were fun and applicable to the context in which they find themselves.

Keywords: Teaching, Learning, Polygons, Geometry, Software, Geometric Thinking.

Resumen: La Educación está en constante búsqueda de la calidad educativa, por este motivo se han indagado diferentes maneras para cambiar la educación tradicional, al hacer uso de nuevas estrategias didácticas en las que se incluye la utilización de herramientas tecnológicas. Ahora bien, para la enseñanza del área de matemáticas en la actualidad se trata de salir de lo convencional; por esto, los docentes han visto la necesidad de emplear software educativo, entre los cuales se encuentra el Software Geogebra para la enseñanza de diversas temáticas, las cuales deben ser abordadas de acuerdo al grado en el que los estudiantes se encuentran. El desarrollo de este proyecto tiene como propósito principal crear una estrategia didáctica por medio del software Geogebra para la enseñanza de los polígonos en estudiantes de cuarto grado. Para llevarlo a cabo se requirió hacer uso de un enfoque de investigación mixto porque de esta forma fue posible recolectar toda la información necesaria para darle cumplimiento a los objetivos planteados y así dar una solución a la problemática abordada en el estudio. De igual forma, se tuvo en cuenta una triangulación recurrente que permitió vincular métodos cualitativos y cuantitativos para cumplimiento de los objetivos establecidos. La investigación se realizó con la participación de 31 estudiantes a quienes se les aplicó un test con preguntas abiertas para realizar la prueba diagnóstica, el cual permitió identificar las fortalezas y falencias que tenían los estudiantes con respecto a la temática de los Polígonos. Además, se realizó observación participante para de esta manera poder llevar a cabo las diferentes actividades para la enseñanza de los polígonos y una entrevista semiestructurada. Los resultados arrojaron que existe en primera instancia apatía por la asignatura que se refleja en los resultados académicos de los estudiantes. Al hacer un análisis de los resultados del pre-test se puede decir que existen deficiencias en cuanto a la temática porque una gran mayoría de los estudiantes no obtuvieron resultados favorables y presentan deficiencias en la identificación de las propiedades de los polígonos, pero estas falencias encontradas se lograron mejorar después de realizar actividades didácticas haciendo uso del software Geogebra, ya que así se evidenció en los resultados del postest superan de manera significativa a los del pre-test y los estudiantes desarrollaron habilidades para la identificación de polígonos y sus propiedades manifestando que las actividades desarrolladas con el software fueron divertidas y de aplicabilidad al contexto en el que se encuentran.

Palabras clave: Enseñanza, Aprendizaje, Polígonos, Geometría, Software, Pensamiento Geométrico.

1. INTRODUCTION

Currently, support tools are implemented for the teaching and learning process of students in the different areas of knowledge. However, for the teaching of geometry, due to its complexity, it is necessary to develop active didactic strategies to achieve meaningful learning (López and García, 2008). On the other hand, in education, international external tests such as Pisa evaluate the fundamental areas in mathematics and it is found that Colombia has not obtained favorable results in the competencies that are evaluated in this area and that students should handle. In addition, in 2018 the area of mathematics was the lowest score that the country obtained, since only a total of 391 was achieved, which shows that students do not have the basic knowledge and instead of having a better performance over the years, Colombia presents a setback in the results, since in 2015 it had achieved a better score in the areas evaluated by PISA (OECD, 2018).

On the other hand, in education it is important to use new teaching methods to motivate students to learn and reinforce their knowledge through the

implementation of new technology. It is worth mentioning that some teachers are afraid of change and refuse to make use of technological tools in the classroom (Canizales, 2004). According to Ospina (2017), the use of ICT in education is related to the interest it awakens in children and young people thanks to the fact that it motivates them to participate in class since the use of technologies is something of their everyday life. Now, geometry is part of mathematics and is related to the various human capabilities involving the spatial sense, visualization and perception. Additionally, this branch of mathematics contributes to the formation of individuals and therefore it is essential to highlight it in school curricula (Camargo y Acosta, 2012).

Research on the implementation of information and communication technologies in the educational scenario has not only been approached from particular positions; rather, there is a national, regional and global interest in finding ways to implement them in academic spaces (Herrera and Ochoa, 2022). Therefore, it is necessary to observe three institutional contexts: national, regional and global. A large number of teachers see the need to articulate their educational practice with the tools provided by Information and Communication Technologies in order to provide new spaces that make it possible to improve the teaching and learning processes carried out in the classroom (Morales, 2021).

The use of software such as Geogebra, when properly implemented, that is, when certain parameters are taken into account so that it is possible to achieve learning objectives, can lead to significant learning (Lazo 2009). Likewise, it is found that the significant learning proposed by Ausubel mentions that it is important to defend and practice this type of learning because in this way a real change is achieved in the subject. This is due to the new knowledge that students acquire throughout their integrated education and this is how they can build their own knowledge (Viera, 2003). On the other hand, the teaching process in the area of mathematics has been considered somewhat complex, but most of the time the learning of this discipline is done in a traditional way. For this reason, the use of didactic strategies in the classroom is considered, where it is pertinent to make use of tools such as Geogebra for the teaching of specific topics in the area. This educational software includes different areas of mathematics such as geometry, algebra and calculus. It can also be used in other disciplines such as physics (Cardeño y Córdoba, 2013).

In this sense, Geogebra offers different tools for strengthening the topics addressed in the area of geometry that also allow the creativity of students to be developed because being able to make figures taking into account their coordinates in a certain way helps to awaken the creativity of students, which is important to keep them motivated in their learning process (Arteaga, 2019). The theory of creativity is considered as a process because it is required to carry out a series of steps that will allow the development of creativity, which is a fundamental part of the formative processes in the educational sector. It is a non-linear process because it is not necessary to be carried out in a particular order, since the important thing is that the creative process can take place. Additionally, it is part of a way of being, thinking and feeling, so it cannot be concluded that creativity is something simple to develop (Benlliure, 2019).

Through the application of strategies in the educational field, it was found that fourth grade students were presenting low academic performance in the area of geometry, in particular several shortcomings were found in relation to polygons. This was also evidenced in the SAI test reports (2022) of the students, where it was noted that the students in the area of mathematics reached an average of 327.3 being the lowest compared to the other areas evaluated. For this reason, it was considered necessary to seek didactic strategies for students to identify, recognize and strengthen the concept of polygon and its elements, which included the use of ICT in the classroom to arouse motivation and interest in students and lead to the construction of practical theoretical knowledge that leads to the improvement of spatial thinking and its impact on the learning of geometry.

2. MATERIALS AND METHODS

In order to achieve the purpose of the research, it was necessary to create a didactic strategy for the teaching of polygons in fourth grade students; the process required first diagnosing the students' previous knowledge for the identification of polygons; based on these results, didactic activities for the learning of polygons were designed through Geogebra software. Next, an evaluation of the didactic strategy designed for the learning of polygons in fourth grade students was carried out,

and finally, a booklet on the use of Geogebra for the teaching of polygons was elaborated.

The educational research (Álvarez, 2006; Elliott, 2000) is based on the socio-critical paradigm that encourages constant self-reflection (Alvarado, 2008; Habermas, 1988). In the development of the research process, a mixed approach was used (López, 2019; Peña, 2002) that allows combining quantitative and qualitative looks in the realization of the phase related to the fieldwork (Núñez, 2017) multimethod type, in such a way that it favors the reconstruction of the phenomena that arise in that educational environment with flexible applied techniques in the fieldwork open to the diversity of thought and the social realities of the context (Gallardo, 2017; Hernández, 2018). A concurrent triangulation design was used, which allows confirming results and cross validation between quantitative and qualitative data (Pereira, 2011)

3. RESULTS AND DISCUSSION

Students were tested to diagnose their knowledge about polygons; it is evident that students do not distinguish the existing polygon classes and therefore it is difficult for them to differentiate them. The students recognize simple concepts that they should know according to the academic level in which they are, but they present deficiencies when applying this knowledge in problem situations. An interview conducted with a focus group allowed identifying that there is a certain apathy for the subject generated mainly by the lack of understanding of concepts, which is reflected in the academic results of the students and the difficulty they have in approaching the subject related to polygons.

At a general level, it was evidenced as the main problem that students did not recognize the components of a polygon or its structure, they did not recognize the elements of a polygon, its vertices, edges and number of sides. Only 35% recognize convexity arguments, 32% identify the correct figure when comparing between regular and irregular polygons, 29% identify properties of polygons, 32% identify the notion of vertexes. There is good handling and identification of the properties of the triangle, but not of the square and rectangle, and very few can identify properties in polygons with five or more sides.

From this it can be deduced that students do not know the subject matter of polygons and therefore it is difficult for them to have a clear understanding of their own characteristics. This means that, to cite one case, when they are asked to draw a certain polygon, they are not able to identify it because their knowledge is not sufficient to differentiate them easily.

On the other hand, the interview allows us to identify that student present deficiencies in the knowledge of specific topics of geometry because these topics are rarely worked on in the classes and when they are approached, it is done very quickly, mainly in a theoretical way and without showing applications of learned concepts.

Based on the information gathered and, taking into account these characteristics defined in the performance of each student, different strategies to implement in the teaching of geometry were analyzed. The research focused the work on the use of software as a basis for establishing motivation in students in the study and learning of geometry. In particular, a strategy was designed based on the application of Geogebra software, which is characterized by being a dynamic software with a striking interface and very easy to use, which is very useful at all educational levels involving the study of geometry and related subjects. Additionally, its multiple tools help the teacher to create activities from scratch and according to the students' needs and to monitor the students' progress.

However, through the observation made during the application of the software for teaching polygons, it was observed that the students managed to understand the topic, even though at the beginning of the activity there were some inconveniences due to the lack of knowledge about its use and applications. However, the students participated actively during the class and stated that they found everything that could be done in Geogebra very fun. They also stated that each of the activities they developed around the topic of classifying polygons according to their number of sides was very useful because sometimes they had doubts about it and this was able to clarify them. In addition, it was possible to identify that the students enjoy this type of activities because it makes it easier for them to learn and identify the elements that make up each of the polygons and this makes them want to participate actively in the activities.

On the other hand, it was evident that there is a good management of the group by the teacher and it was observed that the students were motivated throughout the class and indicated that this type of activities seem fun and entertaining to better understand these topics handled in the subject. It is worth mentioning that at the end of the observation it was evident that when students perform activities that do not involve the traditional methodology, they show greater interest in the class, since they are doing something different from what they are used to. On the other hand, it is deduced that it is possible to contribute to achieve meaningful learning because through each activity developed it is possible to make use of previous knowledge to carry out the construction of new knowledge.

In this sense, meaningful learning is achieved in the terms proposed by Ausubel, since the active pedagogy used evidences a change in the students, both in the approach to the theoretical aspects of geometry and in manifestations of development of their spatial thinking. Thus, the new knowledge that the students acquired throughout their training leads them to reach their own knowledge in accordance with the proposal of Viera (2003).

On the other hand, it was corroborated that the use of new technologies in the classroom turns out to be favorable when the educational intention is kept in mind because it is clear what is to be achieved and for the construction of the exercises this criterion is kept in mind, which helps students to be interested, but also to learn through different experiences.

It was evident from the active participation of the students that the use of Geogebra software for topics related to the area of geometry is appropriate because it offers different tools that allow the development of different topics in a fun and attractive way for the students. In addition, since it is easy to use, it allows students to actively participate in classes and strengthen their knowledge without being tedious, since they can easily access the use of the modules incorporated in the tool and its applications in the solution of problem situations.

The use of Geogebra as an educational tool helps to recreate dynamic environments that make it easier for users to understand the topics presented and represents a different way of appropriating knowledge, so students do not perceive geometry as something tedious, but learn in dynamic environments to achieve significant learning, a result that is in line with the conclusions presented by Sanchez (2022).

Participant observation made it possible to evidence the actions carried out by students in the use of the tool for exploration of polygon concepts in geometry. It was appreciated that the strategy favors self-learning and collaborative work since the students carried out the academic activities proposed only with the initial guidance of the teacher and, the motivation generated by the use of the software led them to approach each one autonomously the proposed problems and reach results that they then socialized with their classmates. It was also found that many of them, on their own initiative, relied on their classmates or supported others to carry out the workshops and problem situations proposed, thus showing evidence of collaborative work.

In addition to observation, a semi-structured interview was conducted through the participation of students in focus groups in order to evaluate the results of the use of Geogebra software in the exploration and learning of polygons and to verify the effectiveness of the implementation of this type of strategies in which the use of new technologies is involved. The results obtained are presented in Table 1, which shows three categories generated from the students' perceptions.

Table 1: Categories identified in the strategy evaluation

CATEGORIES	RESULTS
MOTIVATION	In first instance, the students mentioned that before, when geometry topics were explained to them, they found it very boring because they felt that it is not something that will be useful for their future. They also argued that they are always asked to do the same type of activities in which they have to draw and they find it tedious because sometimes they do not have the necessary implements and do not correctly perform the figures according to what is indicated. Some students explained that the traditional methodology in this type of activities is too boring for them because they think that it becomes routine and does not even awaken any interest in learning.
EFFICIENCY	It can be concluded that before thinking about implementing this didactic strategy in the students there was not the slightest interest on the part of the students because they usually consider that it is tedious to learn geometry because it becomes very monotonous to perform the same type of activities all the time. Therefore, when teachers make the decision to perform activities that are not common or have never been done by students, it generates a positive impact on each of them, but these activities must be planned so that they can contribute to meaningful learning. The impact of ICT, within the knowledge society has brought great changes, in terms of form and content, the effect has been massive and multiplying, so that the sense of knowledge has permeated society in general, and one of the great implications and modifications is education.
METHODOLOGY	Regarding whether the Geogebra activities helped students to strengthen their knowledge of the subject. It was evident that the students said that they were indeed very useful because most of them argued that it was a topic in which they used to get confused and usually do poorly in the evaluations, but when they began to use Geogebra they were able to make a kind of contrast between these classifications of polygons that allowed them to learn to differentiate them. It is worth mentioning that this educational software includes different areas of mathematics such as geometry, algebra and calculus. In addition, it can be used in other disciplines such as physics. On the other hand, other students mentioned that Geogebra is a very complex tool and that at first, they thought it would be a bit tedious to use because the interface seemed a bit complicated, but as they progressed in the construction of each of the figures, they improved their skills in terms of handling this software. It is important to mention that implementing these tools in the classroom increases motivation and this was what the students also evidenced in the interview because they said that the first thing, they did at the beginning of the class was to ask the teacher if she was going to continue working in Geogebra because they were all the time waiting to see what kind of polygon they were going to build. On the other hand, regarding whether they found it complex to use this software, the students responded jointly that not at all because the teacher explained very well what they were supposed to do and also guided them all the time, which helped them to become familiar with the educational software, additionally they mentioned that the teacher had a lot of knowledge about its management, which contributed to understand more each of the activities that were developed in Geogebra and that an adequate construction of knowledge was achieved. The theory is basically focused on how one is learning and it is also associated with constructivism, which is already known to be when an individual begins to construct new knowledge from experiences, that is, from action.

Taking into account these categories identified in the use of the tool by the students, a booklet was developed for didactic use in which academic activities are presented and uploaded for the use of Geogebra software in the learning of polygons with fourth grade students between the ages of 8 and 10 years old.

The usefulness of the didactic strategy is based on the diagnosis carried out in order to strengthen the development of variational thinking in fourth grade students, in addition to promoting the understanding of the properties of polygons, so that students, thanks to the strengthening of geometric understanding, can acquire a better management of their creative skills such as insight, reflection, the vision of new perspectives, imagination, among others.

The strategy is developed in three phases. The first contains activities that induce the student, in an autonomous way, to become familiar with the software and make some first applications in aspects related to points, straight lines and affines. The second, which is the central phase, allows the student to design polygons and explore their properties. The third phase focuses on addressing solutions to problem situations posed by the student.

4. CONCLUSIONS

In first instance in the investigation, it was found that fourth grade students of the Santa Teresa presentation school have a deficiency in terms of knowledge that allows them to carry out the identification of polygons. Taking into account that this subject is a fundamental part of the teaching of geometry. In addition, next year the students will have to take the Evaluate to Advance tests and for this reason it is important to identify where the students are failing in order to apply the necessary measures to improve or strengthen this previous knowledge so that they can achieve significant learning.

On the other hand, technological tools are currently used as a great support for the teaching and learning processes of students, since they contribute to achieve learning objectives in the educational system. Therefore, in the subject of geometry the use of Geogebra software is considered relevant and through observation it was possible to identify that when a clear strategy is determined to address a topic of this type of software it is favorable for the motivation of students because it makes them participate actively and want to perform the activities without them seeing it as an obligation or feeling evaluated. Furthermore, it has many tools that allow the construction of figures so that they learn to differentiate each one of them.

Nevertheless, it is not only a matter of implementing this type of tools, but it is also necessary to evaluate the impact generated by this type of activities within the classroom because it is in this way that it is possible to know what changes should be made or what activities the students definitely enjoy doing. It could be evidenced that the students mentioned that they found interesting the amount of functions of the software and that they could change the color among other things that makes its implementation in the classroom fun. However, they found the Geogebra interface a bit boring and this made them think that it was difficult to handle. Finally, it is very useful to show the students a primer describing in detail the basic functions of the application that will allow them to use it without major problems.

REFERENCES

Alvarado, L. y Gracía, M. (2008). “Características más relevantes del paradigma socio-crítico. Sapiens”. Revista de investigación, Vol. 9, No. 2, pp. 187-202

Álvarez-Gayou L. (2006). *Cómo hacer investigación cualitativa*. Paidós, México.

Arteaga, E., Medina, J. y Martínez, J. (2019). “El Geogebra: una herramienta tecnológica para aprender Matemática en la Secundaria Básica haciendo matemática”. Revista Conrado. Vol. 15, No. 70, pp. 102-108.

Benlliure, V. (2019). *Teoría y práctica de la creatividad*, Valencia: Universidad de Valencia.

Camargo, C y Acosta, M. (2012). *La geometría, su enseñanza y su aprendizaje*, Valencia: Universidad de Valencia.

Canizales, J. (2004). “Estrategias didácticas para activar el desarrollo de los procesos de pensamiento en el preescolar”. Investigación y Postgrado. Vol. 19, No. 2, 179-200.

Cardeño, J. y Córdoba, F. (2013). *Innovación en la enseñanza de las matemáticas*. Bogotá: Fondo Editorial ITM

Elliott, J. (200). *La investigación-acción en educación*. Buenos Aires: Ediciones Morata

Gallardo H, Vergel M, Villamizar F. (2017). “Investigación intervención y enfoque

multimétodo en ciencias humanas y educación matemática". Logos, Ciencia y Tecnología. Vol. 9, No. 2, pp. 85-96

Habermas, J. (1988). *La lógica de las ciencias sociales. Madrid*: Editorial Tecnos

Hernández, R. y Mendoza, C. (2018). *Metodología de la investigación: las rutas cuantitativa, cualitativa y mixta*. México: McGraw Hill.

Herrera, J. y Ochoa, E. (2022). "Análisis de la relación entre educación y tecnología". Cultura, Educación y Sociedad. Vol. 13, No. 2, pp. 47-68.

Lazo, M. (2009). "David Asubel y su aporte a la Educación". Revista Ciencia UNEMI, Vol. 2, No. 3, pp. 20-23

López, O. y García, S. (2008). *La Enseñanza de la Geometría*. México: Instituto Nacional para la Evaluación de la Educación.

Morales, A y Damián, A. (2021). "Estrategia didáctica fundamentada en el uso de GeoGebra para mejorar la comprensión del concepto de semejanza de triángulos". Innovación educativa, Vol. 21, No. 87, pp. 11-33

Núñez, J. (2017). "Los métodos mixtos en la investigación en educación: hacia un uso reflexivo". Cuadernos de Pesquisa, Vol. 47, No. 164, pp. 632-649.

OECD. (2018). *Results from PISA 2018*. Colombia - Country Note - PISA 2018 Results.

Ospina, C. (2017). *Las Tic como herramienta de motivación en el aula*. Bogotá: Universidad de la Sabana

Pereira, Z. (2011). "Los diseños de método mixto en la investigación en educación: Una experiencia concreta". Revista Electrónica Educare, Vol 15, No. 1, pp. 15-29

Sánchez, R. y Borja, A. (2022). "Geogebra en el proceso de Enseñanza-Aprendizaje de las Matemáticas". Dominio de las Ciencias. Vol. 8, No. 2, pp. 33-52

Viera, T. (2003). "El aprendizaje verbal significativo de Ausubel. Algunas consideraciones desde el enfoque histórico cultural". Universidades. No. 26, pp. 37-43.