Spatial Thinking from Didactic Sequences with the Use of 3d Paper Folding in the Study of Regular Polygons in Seventh Grade Students

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Abstract
The following are the results of a research applied to seventh grade students at a District Education Institution in the city of Barranquilla. The objective was to analyze by means of a breakdown of the spatial thinking in relation to the construction of the basic concepts of the regular polygons in students through the use of the Software Paper Folding 3D. The methodology used was Research/Action, with the aim of inserting improvements in the social and educational aspects. The results obtained allowed us to see a substantial improvement after the pedagogical strategy with the incorporated program, as well as notable advances on the part of the students according to the reflections derived from the analysis of the final test.

Keywords: mathematics, spatial thinking, didactic sequence, 3D paper folding, pedagogical strategies

1 Introduction

Spatial thinking is an important part of the development of a being that is mathema-
actively and dynamic for the activities of today's environments, since it refers to the student's intuitive or rational perception of his or her environment and the objects found in it. This thought is in turn defined as the conglomerate of processes that from cognition construct mental representations, their relationships and interactions in the spaces of action of each individual [1].

Authors such as Gardner [2] have mentioned that it is the ability to think in three dimensions, as well as the ability to perceive external and internal images, recreate them, transform or modify them; to go through space or make objects go through it and produce or decode graphic information articulating these events with previous knowledge and thus deriving thoughts from more complete structures.

With the advances in research in this area, all that has to do with student learning has been strengthened. The first advances were based on pedagogical models created and some remodeled by certain thinkers and pedagogues who have undoubtedly contributed to the development of education in general. Various experts have proposed the connection of mathematical ideas and their applications with technology as an essential element in teaching to stimulate mathematical learning in students [3].

Taking into account the above, and with the mediation of the Data Protection Law in force in Colombia, a study was carried out in a District Education Institution, located in the municipality of Salgar-Atlántico; the seventh grade classroom was taken as a population with some difficulties of the students when understanding certain topics related to mathematics, specifically in the area of geometry in terms of the level of geometric-dimensional thought that they should reach due to their level of training. This information was previously provided by the academic coordination as part of the planning for the analysis process.

2 Theoretical fundament

When the term didactics is mentioned, the theories put forward by authors of different periods should not be overlooked, as they establish the didactic situations; in these situations, processes are evident that allow for the promotion of the teaching-learning process undertaken by teachers and students [4]. These approaches involve three fundamental elements: the student, the teacher and the teaching environment. In this way, it is the teacher who facilitates the environment in which the student builds his or her knowledge. Thus, the didactic situation refers to the set of interrelations between three subjects: teacher-student-middle [5]. See this relationship in figure 1.
By reviewing the term of the didactic sequences as a reference, it can be stated that they are consecutive and uninterrupted events that lead to an understanding of a specific topic [6]. A fundamental aspect in the didactic sequences destined to form competences is to consider a significant problem [7], this is due to the fact that education not only forms, but also is a scenario to solve problems of the context where different components are involved [8].

2.1 ICT as a strategy in geometry education

When ICTs are inserted into the educational sphere, each component has its meaning, i.e. each resource is educational because it fulfils or acquires an educational purpose aimed at facilitating understanding, representation of a concept, theory, phenomenon, knowledge or event, as well as promoting the development of skills, abilities and competencies of different kinds in individuals: cognitive, social, cultural, technological and scientific [11]. Recent authors have proposed that ICTs stimulate learning through activities that motivate reading, active listening, observation, reflection, interpretation and explanation of phenomena [12]. As a result, as student participation intensifies, the percentage of learning loss decreases [13].

2.2 Paper Folding 3D as a dynamic strategy for teaching the basic concepts of regular polygons

Origami is a millenary art practiced in Chinese culture, in which true works of art can be obtained from a simple piece of paper [14]. The Paper Folding 3D program promotes this manual skill by fostering the development of spatial thinking [15], presenting a collection of 90 models to bring to life paper figures with different alternatives [16]. The models are classified in several categories: mammals, birds, butterflies, houses, etc. according to the objective to be defined.
The program allows you to move, rotate and rotate the figure completely in a three-dimensional environment [17], as well as to zoom in, allowing you to view it from any angle and making the creation process very simple [18]. All you have to do is choose the figure that best suits your needs and double-click on it to start an animated tutorial that explains step by step how to create it [19]. With the above-mentioned elements, it is evident that current environments of any kind, marked by globalization [20], are embracing new dynamics and therefore learning mechanisms are being transformed into improved realities where ICT tools play a leading role [21].

3 Methodology

The research design used is action research, since it seeks to improve the educational and social system. Authors such as González et al. [22] have stated that the analysis of a social situation can be actively addressed from the event itself in order to promote tangible and immediate improvements. The population for the study was made up of the 32 students of the seventh grade, who participated in an integral way in all the research and given the possibilities of access and management were not divided into groups for their approach, on the contrary, they worked with the total group. The phases of the research were defined in blocks of action, which are illustrated in figure 2 below.

Fig. 2: Phases of the research

<table>
<thead>
<tr>
<th>Identify</th>
<th>To propose</th>
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<tbody>
<tr>
<td>Observation and reflection</td>
<td>To act:</td>
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</table>

4 Results

The most relevant findings show that in the initial or application part of the diagnostic test, students were placed on the scales shown in figure 3.
Fig. 3: Diagnostic test

![Graph 3: Diagnostic test]

Graph 3 presents the results of the diagnostic test, applied to 32 students in seventh grade D of the District Educational Institution, and indicates the difficulty that was presented in the population in terms of the basic concepts of the regular polygons. The test applied was validated by the judgment of two experts with degrees in Mathematics from the Universidad del Atlántico. In applying this test, the results were not the best, as 18 of the students answered only 0 to 2 correct questions (56%), 12 answered 2 to 3 correct questions (38%), 2 students answered 4 correct questions (6%) and none of the students answered all 5 questions correctly.

After applying the strategies with the Paper Folding 3D program, the group of students was evaluated again, finding the results detailed in figure 4.

Fig. 4: Final test

![Graph 4: Final test]

Como se puede apreciar las variaciones al comparar las dos pruebas son bastante evidentes; en la prueba final 17 estudiantes (53%) se ubicó en la categoría de sobre-
saliente; por otro lado 9 (29%) alumnos más se situaron en aceptable; 3 (9%) de los evaluados se categorización en excelente y finalmente en el nivel insuficiente solo se hallaron 3 (9%) de los 32 estudiantes.

5 Conclusions

When making the final reflections, it can be affirmed that a significant improvement was achieved in the construction of the basic concepts of the regular polygons in the students of the seventh grade of the consulted Institution, which is evidenced in the results obtained after the application of the didactic proposal and the final test, since the students showed abilities to visualize, represent, interpret and construct the different concepts of the regular polygons in this case the basic ones, so that in situations that involve the imagination and construction of figures using the origami technique, they can apply the basic knowledge obtained and the skills derived from the application of the chosen program.

With the results obtained during the research process, it is possible to recommend the following for future teaching/learning processes in the area: that the implementation of dynamic geometry software be a means of support for teaching processes in the classroom, insert ICT mediations in accordance with each subject and recommend that teachers use didactic activities developed according to the learning environments to encourage greater interest and commitment to structured topics in the student.

References


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