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Geocatatum: Its influence on the development of children's geometric thinking

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Abstract. The objective of this article is to analyse the influence of the implementation of the Geocatatum platform, a didactic tool in the teaching of geometry in early childhood education. The research follows a mixed study, quasi-experimental and phenomenological design; the sample conformed of 250 children from educational institutions in the Catatumbo, Norte de Santander, Colombia. Resources and services for students and teachers are announced in the development. The results show that the virtual resources and services designed and implemented improved academic performance in geometry and the development of geometric thinking. Emerging categories to these factors were promotion of practices of application of geometry in context, effective use of tic and communicative skills.

1. Introduction

Use of updated technology at the student's hand provides tools to systematize the large amounts of data collected in the field, by virtue of the identification of multiple variables present in the environment [1]. There, the student requires the accompaniment and collective participation among the actors of the urban study, the cooperative work is therefore an ingredient for interaction among peers, whose critical dialogue strengthens and verifies their databases and allows the construction of information systems with multivariate analysis [2]. Generally, in basic education, it is thought that using computational tools improves the academic performance of students [3], and those who propose to do so ask themselves under what conditions an educational platform should be used, particularly in areas affected by violence, in which intervening variables could influence student learning or motivation, as well as discursive functions, reasoning, and the development of geometric thinking. The aim of this project is to test the advantages of using software to teach geometry in children living in the conflict Catatumbo zones.

Based on this, it became necessary to establish clear objectives of each proposed experience, of the web design visible and applicable in real contexts, oriented to young people and children, that satisfies the proposed expectations adjusted to the proposed curriculum or, in its defect, that this can serve to reform it, according to the new conditions of teaching and the educational environment. The use of computational tools or symbolic calculation systems should be previously tested in both work and educational contexts, in order to know with certainty whether the favorable results obtained in the original educational systems can also be obtained in the educational system [4]. The diffusion of contextualized educational platforms has led users to wonder about the possibility of a change in the methodology of teaching mathematics, and in particular geometry, as well as whether the use of tools



with problems of the place where the child or young person lives, using the language and jargon of the place, has an impact on the academic performance of students.

The work environment is based on geometric constructions [5]. With direct manipulation, the teaching of geometry offers an interesting development oriented to conceptualization and mathematical experimentation, to the versatility and speed with which the student can model and, consequently, elaborate his own schemes, which he will be able to compare with schemes developed by other students. One of the characteristics is to raise one or several new situations, whose resolution includes the handling of the concepts to be studied. On the other hand, the explanations of the teacher always arise from the results and comments of the students. Use of computational tools or symbolic calculation systems should be previously tested in both work and educational contexts, in order to know with certainty whether the favorable results obtained in the original educational systems can also be obtained in the educational system [4]. The diffusion of contextualized educational platforms has led users to wonder about the possibility of a change in the methodology of teaching mathematics, and in particular geometry, as well as whether the use of tools with problems of the place where the child or young person lives, using the language and jargon of the place, has an impact on the academic performance of students.

2. Method

The type of research used in this project was quantitative, descriptive method, with a quasi-experimental research design [6]. It was based on the qualitative approach since it must be taken into account that descriptive studies serve to analyze how a phenomenon and its components are manifested, and a quasi-experimental design [7].

The experiment was carried out during 2017-2018, in three phases; the population for this research was made up of all sixth grade students in the Catatumbo area; for the initial sample two groups are formed: in 2017, in group A are the sixth grade students of Guamalito, El Carmen, Tibú, Abrego-Colombia and in group B Zulía student's. In the first two semesters of the investigation the experimental group A, received classes with geocatatum, group B was the control group. By 2018, three groups were formed: group A was divided into two, group A for testing and group A for control. The technique of random numbers [8] was used to assign subjects to the test group or the control group, both groups were led by the same teacher.

The groups were compared before and after the use of geocatatum, in the final test a diagnostic test (pretest) was applied, to measure academic performance the definitive grades were used [9]. The measurement scale for the grades was established from 0.0 to 5.0 according to the curricular proposal of the educational institutions. The "t" test was applied for the comparison of independent groups [10], but before this procedure the test of normality, independence and homogeneity of variances was done, the level of significance for the calculations was 0.05 [11]. In addition, the final experiment took into account sources of disability that could hinder or provide doubtful results that were not recommended, as occurred in the first two stages of the project. The p-value as the level of observed significance, the lowest level at which the null hypothesis can be rejected for the data set under study [12], used the decision rule: if the p-value, the null hypothesis is not rejected [8]. Evaluations were used that are made on the dates stipulated, in which the student must show comprehension capacity in the resolution of each question asked, reflected in the final grade. The students who dropped out were not taken into account for obtaining the statistics.

The third evaluation was carried out according to the curricular guidelines document, implications for the evaluation [9]. In the third phase, the factors that could invalidate the test were corrected to the maximum, such as: preventing the control group from learning that there is a test group and vice versa; under no circumstances were they told that they were part of an experiment; the selection was made randomly, but the design remained quasi-experimental, the test group was already selected, with the help of the table of random numbers 255 students were selected, five of which decided not to participate, and consequently the random selection was made again to complete 250 students. Instructions on how to use the platform were given in advance, in order to avoid distractions when working on geometry concepts. Each student was provided with supporting didactic material and a user manual. The location

of the students in the computer room avoided cuts or interruptions in the development of the project. Prior to all this, a diagnostic test in mathematical knowledge was applied to the test group and the control groups, to find out if they were at the same level of mathematical knowledge. An observation and interview format were applied, and qualitative analysis was carried out to identify childhood conceptions of geometry in order to validate quantitative results [13].

3. Results

The two test groups A (85 students, mean = 2; $s = 0.3$; minimum 0, maximum 2.3) and control group A (85 students, mean = 1.5, $s = 0.78$; minimum 0, maximum 2) - were directed by the same teacher, while control group B (80 students, mean = 1.9; $s = 0.4$; minimum 0, maximum 2.5). It can be seen that none of the three groups passed in the average grade of the diagnosis (0.0-5), with a passing grade equal to or higher than 3. The best average is that of group B. When performing the chi-square test, it yields the results Pearson chi-square = 4,709, 2 degrees of freedom, $p = 0.095 > 0.05$, which indicates that the variable test and group are independent [14], *i.e.* the results did not depend on how the groups were selected. To verify normality was performed through Smirnov-Kolmogorov test (Table 1), each of the values of p are greater than 0.05, then it is accepted that the groups are normally distributed, but as the number of individuals per group is less than 50, the Shapiro-Wilk test is displayed showing that the control group A in this test differs from a normal distribution, while the others do not, despite having made random selection.

Table 1. Normality test.

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	gl	p	Statistic	gl	p
A -Experimental	0.191	84	0.053	0.941	84	0.316
B- Control	0.169	79	0.118	0.944	79	0.323
A- Control	0.192	84	0.064	0.878	84	0.019

In the variance homogeneity test a Statistician of Levene = 1.011, $df1 = 2$; $df2 = 247$; $p = 0.38 > 0.05$ was obtained, it is assumed that the variances are equal for the three groups. Once these assumptions have been verified, the "t" test is carried out for the comparison of means, the tests were carried out two by two. The results of the average per group and can be seen in Table 8 that the value "t" is within the zone of non-rejection. Therefore, the null hypothesis is accepted, and the value of $p = 0.061 > 0.05$ corroborates that there is no evidence to think that the groups differ from each other. Definitive averages of the groups were group A Test with mean = 3.5 and standard deviation 0.559; group A control mean 2.8 deviation 0.71; group B control mean = 2.4, deviation = 0.77. It can be thought that there are indications to assume significant differences of the average final grades between control group B and test group A, that is to say that the use of Geocatatum had incidence in the geometry performance in the students of test group A (Table 2).

Table 2. t-test for difference between menas.

	Test for equality of variances					t-test		
	F	p	t	gl	p	Mean difference	Interval 95%	
							Lower	Upper
Geometry A and A	0.219	0.643	2.243	85	0.032	0.449	0.041	0.857
Geometry A and B	0.792	0.383	2.087	85	0.048	0.560	0.005	1.116

The observation to experimental group A experimental, allowed to analyze the construction of geometric objects, where it was warned that it is a didactic variable taken advantage of, which favors the appreciation of the geometric properties of the objects on the part of the students, there are no difficulties in the construction of the geometric figures; activities are proposed that allowed the student to explore the properties of incenter, barycenter, orthocenter; which allowed the student to trace heights, perpendicular bisector and bisectors; the use of objects such as templates, favored the physical

appreciation of the movements in the plane and also allowed the realization of duly planned configuration and reconfiguration activities.

In the visualization of figures, the iconic presentation of the figures and subfigures in them was predominant, boys and girls explored and took advantage of these subfigures to improve the development of geometric thinking. With respect to the handling of strokes, it favored the presentation of themes and movements in the plane with the optimal use of color and squared background; the orientation of the teacher through questions, allowed greater orientation to the recognition of properties and relations in the figures, which needs to be included in the platform, in case of absence of the teacher or self-learning. In this sense, they developed activities of perceptive apprehension where they manage to recognize in the figures other subfigures; non iconic questions allowed reconfiguration, since the student had to apply his reasoning to prove a geometric property; regarding the use of the apophatic function, description of the figures and most of these statements are in correspondence with the figures; descriptions of the geometric objects improved verbal description of them and conceptualization at the end of the intervention. Concerning cognitive expansion, it can be said that arguing their reasoning led them to confront knowledge and improvement in the use of mathematical expressions and vocabulary.

The reasoning in geometry in the three groups implied relating the discursive process and the configurational process, since the statement made reference to the processes that must be carried out to resolve a geometric situation; but there were situations in which congruence did not exist, caused by difficulties in perceptive apprehension. Thus, in an experimental group concerning discursive functions, the referential function of object designation and the apophatic function, in which something is said about the object [15] had a high mastery; likewise, teamwork enhanced the discursive expansion function, which consists of the organized union of statements to make a description or an inference [16], and the discursive reflexivity function, in which each statement had a value for each child; The creation of statements centered on the figures in the three groups was significant, but the mastery of statements related to demonstrations, observations or experiences in the experimental group was significant, which did not have significant achievements for students in the control group.

Qualitative analysis allows us to observe that the students relate geometry with learning angles and the use of geometric tools such as the compass, the ruler and the transporter. It was important for them the construction of figures and representations through the manipulation of the different types of instruments, the observation of patterns on the platform, because they manifest, visualized different possibilities of the figures, rotations, translations, completeness, and their relationship with playgrounds of the region they inhabit; arguing their procedures and putting them into practice and manifest construction allowed them greater reasoning and interaction among themselves. In the analysis of conglomerates it is confirmed that the students relate the teaching of geometry with the use of geometric tools, important in the area of mathematics and for their daily lives; said that geometry classes using geocatatum, were characterized by being fun, for teaching angles, polygons, geometric figures and also by the use of tools such as the transporter, the ruler and the compass; students say that the teacher if you give them the help necessary to get out of these difficulties, generates spaces for participation and teamwork. Emerging categories were visualizing, apply, reason, express, discourse, mathematical vocabulary, conceptualize, teamwork, participation, dynamic spaces, fun classrooms. However, students do not differentiate between technological tools and geometric tools (compass, transporter, ruler). For teachers, geometry involves conceptions about figures, angles, segments, lines, angles where its main elements are location, similarity of flat figures with the construction of their context, calculation of perimeters and areas, consider that the teaching of geometry is important for mathematics because it deepens more about a mathematics used in our daily lives and affirm that geometry should have an hourly intensity equal to two hours using geocatatum, manifest the mathematics curriculum adapts to a new technology, and allows involving children in applications and everyday situations, manifesting that it is a tool where figures and problems are applied in the daily contexts of students.

4. Conclusions

Geocatatum, is a dynamic platform that improves the academic performance of students, allows teamwork, active participation of the student, allows the generation of dynamic spaces and classrooms that motivate the learning of geometry, identifies it as a tool that allows curricular adaptations in mathematics adapts to a new technology, and allows involving children in applications and everyday situations. Emerging categories to these factors were promotion of practices of application of geometry in context, effective use of tic and communicative skills.

The use of the Geocatatum platform for teaching geometry in childhood in the conflict zone of Catatumbo showed favorable incidences in comprehension levels in the students of test group A, improved the discursive, referential and apophatic function.

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