Level of development of mathematical logical thinking in the students of the agricultural areas of the Universidad Francisco de Paula Santander, Ocaña, Colombia

C L Garcia Quintero¹, and C M Durán Chinchilla²
¹ Grupo de Investigación Ambiental, Agropecuario y de Desarrollo Sostenible, Universidad Francisco de Paula Santander Seccional Ocaña, Colombia
² Grupo de Investigación de la Facultad de Educación, Artes y Humanidades, Universidad Francisco de Paula Santander Seccional Ocaña, Colombia

E-mail: clgarciaq@ufpsoso.edu.co, cmdurancufpseso.edu.co

Abstract. The Francisco de Paula Santander branch school in Ocaña, Colombia; especially the zootecnhics program, concerned about the low performance of students in the mathematics or related areas. (Especially in the new students), decide to carry out a study that allows determining what is the level of development of logical thinking in the students of the agricultural areas. For it, a mixed research with the focus of exploratory research was implemented. A workshop was applied and designed based on the principles of Feuerstein, which led to the development of different mental and cognitive operations; these workshops allowed to determine elements such as identification, evocation, comparison, analysis, synthesis, classification, deduction, induction, and divergent and inferential reasoning; there are also some basic mathematical operations such as fractions, decimals, mixed numbers, and conversion. In this case, more than 50 students from third semester in zoology classes took the workshop. The results gave a diagnosis, the evidence that the students have not developed the capacity for abstraction, inference, or the application of algorithms. The idea is that the results will design pedagogical strategies that will help improve the academic performance of students in the area of mathematics.

1. Introduction

Finishing high school implies to the student taking important decisions that will affect his future. When deciding on professions there are factors such as the economic availability and taste to develop the activities of a profession for the rest of his life. We all are born with the ability to develop mathematical intelligence. However, the different capacities in this sense, depending on the stimulation received during it training in this area during the school period, through the development of different academic and didactic activities that of some they encourage and develop mathematical logic; In this regard, socioeconomic, environmental, cultural and academic conditions can influence the development of these mathematical skills and abilities.

To understand what mathematics logic is, it is necessary to first understand that logic is the science studying reasoning. "Reasoning", consists of obtaining statements (called conclusions) from other statements (called premises) with the adequate criteria, so that we can have the guarantee that if the premises are true, then the conclusions obtained must also be necessarily [1] in this sense. The mathematical reasoning, then, is considered as the skill of using numbers and performing basic operations, symbols and interprets information to solve problems of daily life. In what refers to
mathematical logic, is a discipline that addresses methods of reasoning at an elementary level, which facilitates techniques to establish whether an argument is valid or not, in this sense, the logic of mathematics is intended to reason and search methods to solve, in the first place, mathematical problems, and second, to argue its resolution [2].

Some scholars have stated that, for the development of mathematical logic, it is essential to carry out different reasoning activities. In such a case, thinking is a complex act that leads to the formation of mental representations from operations of identification, ordering, analysis, synthesis, comparison, abstraction, generalization, coding, decoding, and classification. All of which leads to the development of mathematical logical thinking. This requires exercising throughout the teaching-learning process so that based on these, the student is facilitated, in any subject; assimilate their contents [3]. In this sense, the development of this skill demands the execution of exercises in which the cognition process is done attending to the three mental events of attention, coding, and recovery. This can be called mathematical-logical intelligence, that is, the ability to relate elements to argue situations of daily life, so it is necessary to have the ability to observe or calculate the likely effect of some actions on things or ideas and how these related to each other [4]. Mathematical-logical intelligence is used to recognize abstract patterns. To list, set priorities, organize or plan things for the future, that is, the hemispheres of the brain are put into operation, which involves linguistic, spatial and memory abilities, which allows to acquire skills when finding important information in a text, make graphs, summarize, follow numerical sequences, decipher codes, read symbols, among others.

It is important to consider the indications by the “Ministerio de Educación Nacional (MEN)”. It refers to the fact that teachers of schools and colleges must understand that not only with mathematics can logical thinking be developed in students, the learning of mother tongues or foreign, the reading of extensive and profound literary texts, in philosophy, in natural and social sciences, in any of the curricular areas or the transversal axes of school work can and should be developed logical thinking [5]. It is, therefore, necessary to make clear that logical thinking is not part of mathematical thought, but logical thinking supports and perfects mathematical thought, and with it -in any of its types- logical thinking can and should be developed.

These types of skills develop throughout life and have a serious impact on the teaching-learning process. Mathematical logic allows students of any academic program to improve their performance. This involves understanding logical concepts, reasoning, solving mathematical, social, abstract or logical problems, performing mathematical procedures, checking hypotheses, relating, categorizing, schematizing, and looking for causes, among other skills. All of them improve academic performance, especially in the area of mathematics which has become one of the subjects of greater desertion and which of course is of great concern for higher education institutions.

In view of the previous assessments, with regard to the “Universidad Francisco de Paula Santander Seccional Ocaña (UFPSO)”, it has been noted with concern that students who enter to pursue careers have weaknesses in the basic mathematical area, calculation, statistics, and other areas related. These weaknesses, in some cases, have caused students to choose their professional career, choose those that supposedly do not have "so many mathematics.” One of the careers that attract the most attention is the agricultural area, along with social communication and law, since they are the curricula that have less mathematics as subjects.

Considering the above, the animal husbandry program, concerned to determine and characterize the level of development of mathematical logical thinking of students in the livestock area, conducted a study in which the level of logical-mathematical thinking of its students was identified in relation to the practical activities of their environment and own of some subjects of the program and in turn characterize and determine the level of logical thinking that the student applies to participate in the preparation, discussion and decision making in their environment.

2. Methodology
In the execution of the study, exploratory quantitative research was first addressed. This allows us to have a broad perspective on the phenomenon under study, which gives raise to subsequent guidelines
and that gives space to other investigations of deepening on the topic addressed. The population universe consisted of 50 students of the zootechnics program. They voluntarily decided to participate in the study [6]. A logical reasoning test was used as a collection technique in the first instance, in which reasoning questions were raised Table 1.

| Table 1. Logical reasoning test.                                                                 |
|--------------------------------------------------------------------------------------------------|
| **Maria and Juan**                                                                               |
| María has a brother named Juan. John has as many brothers as sisters. María has twice as many brothers as sisters. How many boys and girls are there in the family? |
| **The old lady in the market**                                                                    |
| An old lady was taking eggs to the market when her basket fell out. How many eggs did she have? They asked her |
| How many eggs did she have? They asked her                                                    |
| I don't know, I remember counting them in groups of 2, 3, 4, and 5, there were 1, 2, 3 and 4 left over, respectively. |
| ¿How many eggs did the old lady have?                                                            |
| **Uncle and nephew**                                                                             |
| An uncle says to his nephew, "I'm three times as old as you were when I was the age you are. When you are as old as I am now, the sum of the two ages will be 70". ¿How old are you both now? |
| **The coin collection**                                                                           |
| A trader decides to sell a collection of gold coins to three collectors. The first buys half of the collection and half a coin; the second buys half of what is left and half a coin and the third buys half of what is left and half a coin. ¿How many coins did the merchant have? |
| **The stubborn frog**                                                                             |
| Searching for water a frog fell into a 30 m deep well. In its attempt to get out, the stubborn frog managed to climb 3 meters each day, but at night it slipped and went down 2 meters. ¿Could you tell how many days it took the frog to get out of the well? |

Subsequently, students were asked to evaluate under logical reasoning the zoometric indices of the different animal species, the data found should represent them through concepts, compare algorithms and argue abstractions.

The analysis of information was evaluated quantitatively, determined the number of students who managed to reach the proposed objective.

3. Results

Mathematical skills and logic help to relate to society, to face problems and difficulties and to overcome conflicts. Mathematical logical thinking develops sequentially. This means that it starts with basic understanding and ends with abstraction. In the case of the study, the zoo technician must often make decisions based on morphometric metrics and zoometric indices established for each species. In this case, zoometry studies animal forms through body measurements, thus acquiring great importance because it quantifies this conformation, establishing specific measurements and their normal variation for a given race or population. For such a case, students must apply mathematical logic, to determine the structural morph structure which also establishes the degree of homogeneity, existing in a racial group [7].

The body measurements are made directly on the animal; although the technology allows to realize them through images recorded in paper or videotapes. They are grouped in elevations, diameters and perimeters. To perform them, we use certain instruments called, generically zoo meters, which are of a different type such as the tape measure, zoometric cane, calibrator and goniometer [8].

The zoometric indexes are morphological relationships, by means of which the intensity of certain characters is referred to that presented by another, relatively to a base 100, to which the other measurements made are compared. Anamorphosis (IAN) = Thoracic perimeter/(height at the cross x 100). Pelvic (IPE) = (Rump width/rump length)x100. Indices related to productive aptitudes: Milk capacity; Thoracic dactyl (IDT) = (Reed perimeter/chest width)x100. Costal dactyl (IDC) = (Reed perimeter/chest width)x100. Meat capacity: Transverse Pelvic (IPT) = (Rump width)/height at the withers)x100. Longitudinal pelvic (IPL) = (Length of the rump/height at the withers)x100 (10).
From the previous explanations and regarding the application of the reasoning test, some indicators were taken into account: proportional logic, in which the following actions are considered: propositions, logical methods, deductive method, and inductive method. The numerical system which allows knowing the behavior with respect to the numerical system using the following actions: numerical decomposition, mathematical reasoning and divisibility and finally the geometry that comprises the following actions or indexes: Area of geometric figures and space and geometric reasoning. Measurement values: High, medium and low, as indicated in Table 2 below.

| Table 2. Measurement values. |
|-----------------------------|
| Variable | Indicator | Indexes | Values/indexes |
|---------|-----------|---------|----------------|
| Mathematical logical reasoning | a. Mathematical logic | 1. Inductive method | High=8-10 |
| | | 2. Deductive method | Medium=6-7 |
| | | | Low=0-5 |
| | b. Numerical system | 1. Decomposition | |
| | | 2. Severability | |
| | | 3. Mathematical reasoning | |
| | c. Geometry | 1. Areas of the plane | |
| | | 2. Geometric reasoning | |

To measure the degree of mathematical logical reasoning: A general purpose reasoning test was applied whose indicators evaluate: a) Mathematical logic b) Number system. c) Flat geometry (Table 3), to later establish the degree of mathematical logical reasoning (Table 4).

| Table 3. Specifications on the degree of mathematical logical reasoning. |
|-----------------------------|
| Indicators | Items | Total | Percentage |
|---------|-------|-------|------------|
| Mathematical logic | 9-10-2 | 3 | 60 |
| Number system | 5-6-7-8 | 4 | 20 |
| Flat geometry | 1-3-4 | 3 | 20 |
| Total | | 100 |

| Table 4. Mathematical-logical reasoning degree perception. |
|-----------------------------|
| k | Intervals | fi | hi | % |
|----|-----------|----|----|---|
| 1  | 0-2       | 32 | 0.64 | 64 |
| 2  | 3-5       | 11 | 0.22 | 22 |
| 3  | 6-8       | 04 | 0.08 | 8 |
| 4  | 9-10      | 03 | 0.06 | 6 |
|    |           | 50 | 1.00 | 100 |

The measurement of logical-mathematical reasoning was executed through the application of 10 exercises; as shown in Table 3, thirty-two (32) students are in the range of those who answered between none and two questions.

Regarding the evaluation of the analysis capacity of morphometric variables and zoometric indices, the following data were obtained: as shown in Table 5. The students made an interpretation of the variables proposed and related to the productivity index proposed for the race. In this case, the results of the test showed that 32 students did not understand the problem statement. This means that the degree of mathematical logical reasoning, as evaluated in the studied population, is predominantly in a low degree. In addition, the level of knowledge applied in the evaluation of the zoometric parameters has a direct relationship with the degree of reasoning of the mathematical logic [9].

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| Table 5. Zoometric coefficient in creole cows of the nucleus white Orejinegro at the UFPSO. |
|---------------------------------------------------------------|
| Cows(n=3) | Indexes | media | DE | MN | Max | CV |
|-----------|---------|-------|----|----|-----|----|
| Cephalic (ICEF) | 38.67a | 4.59 | 32.00 | 44.90 | 0.12 |
| Corporal (IC) | 82.71a | 9.00 | 67.06 | 92.86 | 0.11 |
| Corporal-lateral (ICL) | 90.18a | 5.97 | 80.88 | 96.50 | 0.07 |

Finally, it can be indicated that establishing the relationship of zoometric indices, morph-structural variables and productivity are decisions that the zoo technician must make in his professional life. The ability to make decisions in this area is related to the logical and mathematical thinking that the individual has. In the case of the zootechnics students, the results were low, in this sense, 80% of the students did not understand the relationships that should be established.

As evidenced, mathematical logic establishes an important connection not only in the development of the ability to establish calculations but also in numerous topics such as language analysis, linguistics, artificial intelligence, and argumentation [10]. In this sense, the mathematical logic becomes one of the constituents of the cognitive system of human beings. It gives rise to generate the bases for the capacity of reasoning in any area of knowledge [11]. In such a way, it is important that educational institutions give relevance to the development of logical-mathematical skills, which allows young people to access knowledge [12], which requires teachers to use their creativity, organizing activities that stimulate and develop logical thinking, reasoning, argumentation, and problem-solving.

4. Conclusions
It is important to refine the processes of permanent assessment of the different actions of students when they interpret and deal with mathematical situations and from them formulates and solves problems.

The articulation of higher education with the secondary levels are basic for students to understand the articulation of concepts and the sequence of knowledge in all areas but especially mathematics, not to pigeonhole them in an instrumental mathematics, if not in a Mathematical thinking that allows you to apply it in all areas of your personal and professional life.

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