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# Factors associated with capacities development in learning physic associate on numerical systems and Hamming code

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**Abstract.** the research uses mixed, participatory action research tools within qualitative research, and factor analysis from the positivist approach; identifies and analyses factors associated with problem solving in capacity development within the framework of the metacognitive in learning of the physic, associate to approach with operations of numerical systems and detection error with Hamming code, is apply in the childhood of public educational institutions located in the border area of the Municipality of Villa del Rosario, Colombia. For this purpose, a diagnostic test was applied ( $\alpha = 0.78$ ), which allowed the identification of difficulties and variables related to learning and application in real contexts ( $r = 0.81$ ); and a post-test ( $K = 0.7$ ), that evaluates projects as a didactic strategy. There was evidence of the construction of knowledge and the application of these to practical life, also revealed that it was possible to awaken interest and motivation in students which significantly improved their level of analysis, interpretation and reasoning. Associated factors were coexistence ( $\alpha = 0.788$ ), emotional proposal didactics ( $\alpha = 0.751$ ), metacognitive skills ( $\alpha = 0.767$ ), self-control ( $\alpha = 0.718$ ), evaluation ( $\alpha = 0.712$ ), strategies and abilities in physic through the method and its application in logical circuits with indicators cognitive, attitudinal, motor processes.

## 1. Introduction

The single-bit parity method is efficient in detecting errors when there is reliability in the communication system. In fact, the weight of the data is determined with  $m = n + 1$  bit, where  $n$  is the number of bits that contain the information. This method can only detect errors of two data that differ by one bit; that is, they have distance one and that change, by error of the system, only one bit. However, it does not correct them and, at most, it can signal an error and/or request that the byte, data, word, or block of information that presented the communication problem be resent. Of attraction, at the global level and in Colombia, test results [1], as well as curricular guidelines and basic competency standards in the area of physic and logic circuits, there is a valuable interest in solving problems, where the permanent transformation of learning approaches is sought, which allow the development of skills and competencies necessary for life. One of the difficulties of learning logic when students are unable to interpret them or propose solutions to them, while students are able to solve some of the operations posed to them, but are unable to assess the meaning of the results obtained [2]. This situation shows how they have not appropriated the meaning of logic circuit and association with mathematics, because they



only memorize concepts in a repetitive way and do not internalize the information, nor relate it substantially with other concepts they already have in their cognitive structure [3]. Nussbaum speaks of capabilities [4], points out that they belong to individual persons, and then, in a derived sense, to collectives [5]; what this means is a substantial freedom to think, choose, act and be; because promoting capabilities is promoting areas of freedom, this differs from that concept of competence, whose purpose is to homogenize society's thinking in order to favor global practices. On the contrary, every subject as a cultural identity has a history of life, some memories, some knowledge and defends local and multicultural practices according to its reality, perception and truth; therefore, it has the duty to revalue its territory and cultural heritage for its own development [6]. From the foregoing, the following questions arise: how do mathematical skills develop in childhood in border areas? Having as main question: starting from didactic strategy with metacognitive approach that factors influence in the improvement of competences in the resolution of problems on basic operations with fractional?

## 2. Methodology

The project was framed within the paradigm of mixed research, uses participatory action research tools [7] within qualitative research, and factor analysis from the positivist approach [8]. From a holistic description, analyzes the activity in particular, focused its interest in understanding, interpreting and analyzing the phenomena that occurred in the classroom, through a description as accurate as possible of reality. The research followed the phases proposed by Elliot [9] first identified the general idea by making a detailed analysis of the institutional context, the results of the tests know in the area of physic and electronic determining as a problem to investigate decoding, operations and applications in context from problem solving. Second, recognition and revision involved describing the facts of the situation. It was designed and applied diagnosis of pre-knowledge, sought to recognize difficulties, for the elaboration of the same one subtheme were covered proper of the basic thematic operations with detector codes and error correctors, where ten different problems were formulated. Thirdly, the elaboration of the general plan included actions to be carried out with the students as the main actors in research and improvement, the necessary resources and the ethical framework, decision making in supervision and design of field instruments, documentary observation, pedagogical journals, workshops and pedagogical proposal.

As a mediator, the teacher initiated the intervention that involved the following types of practices, which began with little participation and gradually increased giving priority to the participation of each student, in order to empower students with the metacognitive ability to identify errors during the learning of logic circuits, questions were proposed that promote student reflection, explain the strategies, steps and conditions to follow to apply them, the benefits of their use and criteria to evaluate their effectiveness [10]. Complementary to the explanation, the teacher models the activity from the guided and cooperative practice, it led to discover the faults in the interpretation of problems in distance and weight of binary data, One-bit transmission and reception system with error generation and detection, parity error check, with questions or activities such as, transform to binary, octal and hexadecimal system what are you talking about, what variables are explicit? And he suggests some actions to overcome the difficulties such as: read again, identify the variables, which is the real question we should ask ourselves to solve the problem, which operations should we use? An individual type of work is proposed that can be supported in principle by means of a self-questioning guide.

The total population for the research was 110 students from the municipality of Villa del Rosario, Colombia", ranging in age from 7 to 9 years, 25% from the rural sector and 75% from the urban area. The students live with their family nucleus and are classified among the low socioeconomic strata and between levels 1 and 2 Sisben [11]. It was decided to work in third grade because the results of the synthetic quality index of the institution showed that it is below international standards, shows that more than half (44%) of Colombian students do not reach the minimum performance established in the assessment of the area of physic at the time of completing secondary and the difficulties presented by university students.

From the diagnosis and documentary analysis, initial categories are proposed to analyze qualitative and quantitative information that include knowledge with subcategories of applied self-knowledge in logic circuit (AU) with subcategory of security when solving problems, and strategic knowledge with presaberes and start of work applied with digital systems; self-control category with subcategories emotional level, behavioral and cognitive, tool (H) with subcategory classroom project, learning (P) with cooperative subcategory and evaluation (E) with subcategory process measurement. The inductive categories were constructed from the information organized by deductive category. The triangulation process was structured according to content and categories of analysis. Responding to the structure of the triangulation process, the corresponding tables and analyses are included. Finally, factors are weighted by actors and their correlation and validity are estimate.

### 3. Results

Qualitative analysis allows us to observe emerging categories in learning physic associate on numerical systems and Hamming code (Table 1) such as coexistence (V). With depth in the indicators communication (CO), social behavior (CS), didactic proposal (PD), around its characteristics considered as emotional (EM), applied (A) with promotion of development of capacities (FC) through classroom projects (PA). With implications of remembrance, with graphs and representations appropriate to context, social reality, and development of manifest capabilities such as improved reflection, self-reflection, arouse interest, participation, dedication, social behavior, improved interpretation, problem solving, metric and variational thinking. Finally, cognitive meta skills (K). It manifests in indicators knowledge (CN), strategies (E) and capacities in mathematics (CP) as Aguilar indicates it with cognitive, attitudinal and motor processes necessary to understand and understand a certain situation, problem, relation, affirmation, graphic scheme or table, related to numerical, logical, algebraic or feasible elements physic as well as self-control and evaluation from the measurement of its capacities.

Triangulation [12] allows us to observe that classroom projects strengthened problem solving through cooperative, cooperation in physics prototype development, and simulation software management, collaborative work, debates arguing the reason for their answers, assimilating the meaning of fraction together with their representations and operations. Great interest was observed, and participation increased noticeably. Their level of understanding increased through the activities. In terms of achievement according to indicators in educational texts, the classroom projects allowed young to understand the process used to locate their own, improper, mixed and equivalent fractions, as well as to internalize that the decoding represented in a graph can also be represented by means of a straight line.

They like situations that involve reasoning, thinking and understanding to solve problems with fraction, raise their self-esteem, and recognize themselves as intelligent thinking beings. Emerging categories were student characteristics, personal knowledge, knowledge of abilities, strategic knowledge, strategy, metacognitive knowledge, metacognitive consciousness, motivation, conceptions. Daily pedagogical analysis, qualitative analysis of pedagogical journals shows as emerging nodes problem situations, knowledge, adaptation of problems to context, beliefs, workshop, metacognitive skills, importance of pre-knowledge in coding, error detection and correction, questions type tests know. Observations highlight the student as the center of the process and operations whit system numbers were topics where communication system has received the following characters and the strategy had greater impact and to which they gave greater importance.

Emerging categories in observation were organized in two large conglomerates, one referring to attitudes towards the proposal, workshops associated with knowledge, reflection; a second conglomerate associated with perception towards the pedagogical strategy associated with adaptation to the context, problem situations that allow skills and competencies to be developed and motivated. Emerging categories that characterize the pedagogical proposal in the analysis of the pedagogical journal were reflection improvement, arouse interest, develop skills, participation, dedication, easier, dynamizes the class, allows interaction between students. The values of the goodness-of-fit index GFI, corrected goodness-of-fit index AGFI, incremental adjustment rate, index is above 0.90, in some cases above 0.92;

the ratio of quadratic approach error SRMR values is below 0.010; and the SRMSE values are below 0.005 as proposed Hu and Bentler, these indices are acceptable [13].

**Table 1.** Analysis of thematic units referential, deductive and metacognitive category.

Category	Indicators	Phenomenological Implications	Reliability
Coexistence (V)	Communication (CO)	Dialogue, space of communication, attention, empathy	$\alpha = 0.788$
	Behavior (CS)	Companionship, positive attitude to learning, need for relationships, collaboration, understanding, cooperative learning	
Proposal didactics (PD)	Applied physic (AA)	Promotes problem solving applied to the context contains learning objectives	$\alpha = 0.751$
	Capacity development in logic and Hamming code (FC)	Covers the thematic transform to binary, octal and hexadecimal system	
		Decoding Errors Motor development Need to see and touch Improves reflection, self-reflection, arouse interest, participation, dedication, improved interpretation, problem solving, metric and algebraic thinking	
Classroom project (PA)	Easy to read and interpret Problems with tests to know Contains graphs and representations It proposes methods and ways of solution dynamizes the class, allows the interaction between the students. Deepens in digital systems design principles create logical circuits		
Metacognitive skills (MS)	Knowledge (K)	Self-recognition of knowledge and limitations, remembering	$\alpha = 0.767$
	Strategic empathic knowledge (EE)	Problem solving planning Control of activities	
	Capacities (CP)	Problem analysis Representation, interpreting, create understand	
Self-control (A)	Emotional level (LE)	Motivation, Interest	$\alpha = 0.718$
	Behavioral level (LC)	Attention, participation	
	Cognitive level (LGC)	Interpretation of information, association	
Evaluation (E)	Measurement of capacities (mp)	Feedback, Presentation of progress and project results, Debate, representation, interpretation, apply, understand	$\alpha = 0.712$

Data on the 59 items showed high agreement on factor allocation (Kappa Index = 0.93) and little difficulty in understanding since the item with the most difficult rating showed a relatively small as soon as r treatment here is of a purely real variables and geometrics nature and does not depend on properties of solutions [14] medium  $M = 4.21$ , standard deviation  $DES = 0.80$ , in view of the proposed assessment range [15].  $\chi^2 = 1374.74$   $p = 0.008$ . From the above values a more than sufficient reliability for each is derived and of the proposed factors and an equally sufficient adjustment to think of an adequate construct validity [16]. The correlation matrix showed significant values ( $p < 0.001$ ) [17].

According to diagnostic tests and post-tests with 95% reliability [18] the students have clearly defined the concept of fraction its elements and applications in the context in which it is being used ( $p = 0$ ), the students understood conceptions of decoding, system conversion, error detection in logic circuit towards conception of limit and border in sets, mixed numbers, equivalent representation, comparison

irreducible; they corrected errors made ( $p = 0$ ). The students presented a high performance at the level of problem solving involving basic operations with error detection and correction through hamming code since most of the problem situations presented in the test were solved correctly, the students do not show dependence on having to receive continuous explanation and advice, read attentively, interpret, maintain parities, correct, construct a numerical sequence, from zero to sixty, equivalent with the decimal system, analyse and through reasoning perform the correct operation that gives solution to the situation, arguing how they did it. With the resolution of item nine most of the students demonstrated to have acquired significant learning.

According to Nurmasdalifah [19], two stay cooperative learning model can help students establish friendships by sharing information and working together so as to train students in developing social skills, taking into account the results issued by the proof of knowledge in relation to external tests shows that the problem solving competence in the institution is at a low level so we designed a didactic strategy which was implemented to strengthen at a high level the competence in solving mathematical problems. Through the metacognitive approach, the students through the method and its application in logical circuits, became aware of the importance of respecting, attending, helping and following instructions, which generated a good classroom environment, which is indispensable for the good development of the classes, which leads to improve the process of teaching and learning.

The students, through the process of reflection, recognized the importance of the themes seen in previous years and the need to have this knowledge in order to be able to appropriate new knowledge with greater ease, which was remarkably relevant in a minimum number of students. This led the other students to reflect on the importance of valuing the study and making an effort to fulfil the proposed activities responsibly, carrying them out conscientiously, analysing them, understanding them until solving them, thus building significant useful learning throughout their lives.

#### 4. Conclusions

Associated factors with capacities development in learning physic associate on numerical systems and Hamming code, were work with logic circuit to deepens in digital systems design principles with logical thinking, communication indicators, social behavior; emotional didactic proposal, promotion of development of capacities; classroom projects towards remembrance, representation and social reality, and development of manifest capacities in reflection, self-reflection, interest, participation, interpretation, solution of problems, metric and variational thought; meta cognitive skills was associated with knowledge, strategies and abilities in physic through the method and its application in logical circuits with indicators cognitive, attitudinal and motor processes to understand and understand a given situation, problem, relationship, affirmation, graphic scheme or table, related to numerical elements, logical, algebraic or feasible to mathematize, as well as self-control and evaluation from the measurement of their abilities. The pedagogical proposal in physic, allows the development of metacognitive skills and promotes institutional coexistence.

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