RESEARCH ARTICLE

# Teachers' Conceptions of Mathematical Competencies

## Concepciones de los docentes sobre las competencias matemáticas

## Concepções de professores sobre habilidades matemáticas

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ABSTRACT

This research describes the teachers' conceptions of mathematics competencies as regulators in the quality of education in the different educational institutions of Florencia, Colombia. In line with the above, the purpose of this paper is to characterize the conceptions of mathematical competencies of teachers in the municipality of Florencia focused on curricular, didactic and learning assessment contents, in order to identify if there are significant differences between the emerging categories in relation to their function, capacity and performance of their applicability by teachers. Given the mixed nature of the inquiry, we opted for a descriptive scope where the situations, habits and attitudes of the teaching staff in relation to the dependent and independent variables of the sample are exposed. The data were collected through the implementation of structured surveys to 73 mathematics teachers, which were analyzed by the ANOVA variance index of the Statistical Package for the Social Sciences program, finding multifactoriality in the conceptions by identifying and describing 16 emerging categories related to mathematical thinking, classroom work and content evaluation instruments, resulting in the Socio-Cultural Significant Learning as the most prevalent. Therefore, the research is a strategic description of the reality of teachers' knowledge about the implementation of the educational components (competencies) described by the Ministry of National Education.

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**Conflict of interest:**

**The authors declare that they have no conflict of interest.**

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## Resumen

La investigación describe las concepciones de los docentes sobre las competencias en matemáticas como reguladoras en la calidad de la educación en las diferentes Instituciones Educativas de Florencia, Colombia. En consonancia con lo anterior, el fin del presente documento es la caracterización de las concepciones de las competencias matemáticas de los docentes del municipio de Florencia enfocadas a los contenidos curriculares, didácticos y de evaluación del aprendizaje, para identificar si existen diferencias significativas entre las categorías emergentes en relación a su función, capacidad y desempeño de su aplicabilidad por parte de los docentes. Dada la naturaleza mixta de la indagación, se opta por un alcance descriptivo donde se expongan las situaciones, costumbres y actitudes del profesorado ante las variables dependientes e independientes de la muestra. Los datos se recogieron a través de la implementación de encuestas estructuradas a 73 docentes de matemáticas, las cuales fueron analizadas por el índice de varianza ANOVA del programa *Statistical Package for the Social Sciences*, encontrando multifactorialidad en las concepciones al identificar y describir 16 categorías emergentes relacionadas con el pensamiento matemático, trabajo en el aula e instrumentos de evaluación de los contenidos, resultando el Aprendizaje Significativo Socio Cultural el de mayor prevalencia. Por lo anterior, la investigación es una descripción estratégica de cara a la realidad del saber docente sobre la implementación de los componentes educativos (competencias) descritos por el Ministerio de Educación Nacional.

## Resumo

A pesquisa descreve as concepções dos professores sobre as competências em matemática como reguladores da qualidade da educação nas diferentes Instituições Educativas de Florencia, Colômbia. Em consonância com o exposto, o objetivo deste documento é a caracterização das concepções das competências matemáticas dos professores do município de Florença com foco nos conteúdos curriculares, didáticos e de avaliação de aprendizagem, para identificar se existem diferenças significativas entre as categorias .emergindo em relação à sua função, capacidade e desempenho de sua aplicabilidade pelos professores. Dado o carácter misto do inquérito, optou-se por um âmbito descritivo onde as situações, costumes e atitudes do corpo docente são expostas às variáveis dependentes e independentes da amostra. Os dados foram recolhidos através da aplicação de inquéritos estruturados a 73 professores de matemática, os quais foram analisados pelo índice de variância ANOVA do programa Statistical Package for the Social Sciences, encontrando multifatorialidade nas concepções ao identificar e descrever 16 categorias emergentes relacionadas. , trabalhos de sala de aula e instrumentos de avaliação de conteúdo, sendo a Aprendizagem Sociocultural Significativa a mais prevalente. Portanto, a pesquisa é uma descrição estratégica voltada para a realidade do conhecimento docente sobre a implementação dos componentes educacionais (competências) descritos pelo Ministério da Educação Nacional.

## Introduction

The present investigation is developed in the city of Florencia, department of Caquetá, in southern Colombia, this city is characterized by being within the Amazon region, it is known for having high areas in flora, fauna and being a representative trophic zone in forests, most of its inhabitants are of indigenous descent and consists of approximately 110,000 inhabitants, however, teachers are from all regions of the country due to the need for service and the method of selection by competition to existing vacancies, also, because it has the only public university in the sector, the University of Amazonia.

It is circumscribed in the area of mathematics in the state sector of the country, and given the importance of mathematical competencies and the conceptions that teachers have of them in the development of learning, the document is oriented to describe specific information on the conceptions of mathematical competencies in a group of middle school teachers in Florencia (Caquetá). For this purpose, a documentary review was carried out with the purpose of creating a theoretical framework related to mathematical competencies in curricular contents, didactic approach and learning assessment. In this sense, the justification of the work is based on the need to generate information on the topic of study, due to the scarce research related to mathematical conceptions. Additionally, the review allows carrying out a descriptive methodology, mixed with a simple random sampling in the description of teachers' conceptions of mathematical competencies.

The general objective is oriented to characterize the conceptions of mathematical competencies in teachers of the municipality of Florencia, taking into account curricular contents, didactics and evaluation. To achieve this, three specific objectives were established: to describe the teachers' conceptions of mathematical competencies in the curricular contents that are oriented in class, in the didactic approaches applied by them, and in the evaluation of learning. Finally, the research question is expressed as follows: What are the conceptions about mathematical competencies held by the teachers of the Educational Institutions of Florencia? The results confirm that, although the mathematical competencies obtained relatively low values in their level of significance, only the Socio-Cultural Significant Learning (ASSC) represented a statistically significant difference.

## Theoretical framework

The Ministry of National Education is responsible for solving unsatisfied needs, among which is identified the lack of quality education, as stipulated in Law 115 of 1994 or the General Law of Education, proposing a curricular transformation of all classes focused on improving education itself. According to the report of the Organization for Economic Cooperation and Development (OECD), Colombia is among the ten countries with more students with low school performance in mathematics, due to the lack of institutional policies that strengthen competencies in the area, both in elementary school, vocational high school and higher education.

Therefore, academic performance refers to the level of success that a student achieves in his or her educational performance related to learning objectives, which are evaluated through standardized methods (projects, exams or grades) (Grasso, 2020). Similarly, academic performance is related to the quality of education basically in two aspects, the first emphasizes that a quality education should be characterized by having a trained faculty, optimal educational resources, relevant curricular programs, efficient management of the educational system, and a favorable learning environment. The second aspect describes the academic performance of students in acquiring the skills, knowledge and competencies they are expected to develop in their educational process.

This relationship between academic performance and the quality of education, can provide students with the necessary tools to obtain academic achievements as well as their motivation in areas such as mathematics, however, studies conducted by Méndez, *et. al.* (2018) from the Faculty of Education Sciences of the University of Amazonia, point out that the learning of mathematics in Caquetá is not the best:

> studies show that, in elementary and middle school, they do not develop the necessary skills that allow them to have a basic knowledge in the handling of mathematical and applicative concepts, which is why they cannot develop mathematical solutions of a higher academic level, as is the case of those seen at university. (p.2).

Other research such as that of Ramírez (2016) agrees with that described by Méndez *et al.* (2018) on the perspective of the educational level from middle school to higher education in the south of the country:

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> The higher the level of adequate application of mathematics, the greater the success of future professionals, who will have tools that will enable them to achieve personal success and that of the country in general, placing the nation in an appropriate growth of its economic, natural, social, political and human resources, which in turn will be responsible for generating growth in all aspects of the country. (p.33)

These research works on the quality of education in the area of mathematics are based on the need to describe and analyze processes in the teaching work, therefore, it has been necessary to mention the subject of conceptions, not without clarifying that there is little research that covers the analysis of teachers' conceptions of mathematical competencies both nationally and internationally, so there is still no unity of criteria on these (Pareja and Martinez, 2008).

The definition of conceptions used in this research is based on the following premises Moreno and Azcárate (2003), described as follows:

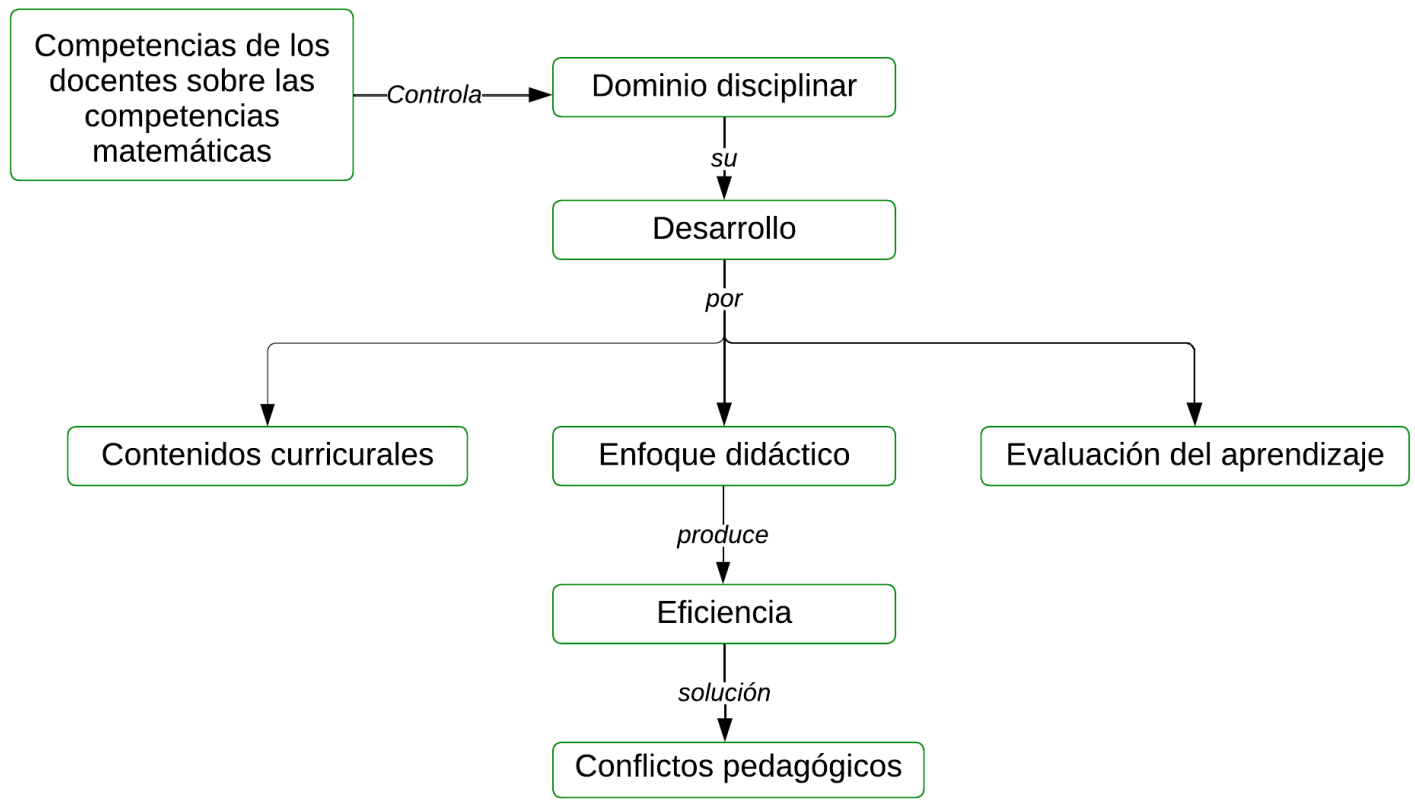
> conceptions are implicit organizers of concepts, which are essentially cognitive in nature and include beliefs, meanings, concepts, propositions, rules, mental images, preferences, etc., that influence what is perceived and the reasoning processes that are carried out. (p.267).

Similarly, Brousseau (2007) highlights his concept of conceptions in relation to the fact that they are cognitive structures that students build to understand and interpret mathematical concepts, which are developed through student interactions with other individuals (teachers and students) and the environment.

From the previous referents, the conceptions about mathematical competencies were described, allowing teachers to approach a critical development of mathematics teaching. Under these conditions, González (2008) describes these competencies as an internal form that privileges the mastery of the discipline with the purpose of structuring itself, therefore, this refers to the development of mathematics competencies in curricular contents, didactic approach and learning assessment (Figure 1) (Becerra, 2017; Listón and Zeichner, 1993).

**Figure 1**

***Functionality of Teachers' Conceptions of Mathematical Competencies***




Source: Authorship

According to research by Becerra (2017); Listón and Zeichner (1993); Pareja and Martínez (2008), teachers' conceptions of mathematical competencies are explained in curricular content, didactic approach and learning assessment.

***Teachers' conceptions of mathematical competencies in curricular content (COMCC).*** **The COMCC refer to: 1. Learning and cognition (AC); 2. Disciplinary Conceptual Domain (DCD); 3. Transfer of Knowledge (TC); 4.**

They are characterized by guiding the student towards different solution paths, achieving self-assessment of their performance in a cognitive development of learning (Resnick, 1996).

*Teachers' conceptions of mathematical competencies in the didactic approach (CDCMED).* The didactic approach develops different emergent categories, as is the case of social constructivism (S.C.) described by Gregorio (2002) as the daily activities in the classroom. The second emerging approach is phenomenological (PF), which relates the problems faced by mathematics teachers in achieving meaningful learning by students. This learning is usually based on specific disciplinary contexts and on the solution of everyday life problems (see the contributions of Radford, 2013; Freudentha, 1983; and Puig, 1997).

The third approach is the Semiotic Approach (SA); it controls and "analyzes mathematical culture, understood as a process of mathematical culturization, and distinguishes and analyzes the three essential aspects that characterize it as a scientific discipline: the conceptual field, phenomenology and functionality" (Socas, 2012, p.1). The last one is that of the Anthropological Approach (EA), which is characterized by the "focus on the social determinations of the phenomena investigated, its pattern of analysis of human cultures based on the praxeological model, its institutional and epistemological approach to teaching" (Castela, 2017, p.8).

***Teachers' conceptions of mathematical competencies in learning assessment (CPMEA). The CPMEA*** **has seven emerging categories: 1. Evaluation of the Performance Process (EPR); 2. Evaluation in the Process of Skills Development (EPDA); 3. Evaluation of the Valuative Dimension (EDV); 4. Evaluation of the Theoretical Dimension (EDT); 5. Evaluation in the Practical Dimension (EDP).**

The purpose of assessment should always be to help the student to learn, therefore it is of vital importance to describe the general aspects of these approaches, Diaz, *et. al.* (2003) describe that: "the mechanisms through which one participates in assessment are varied, involving individual and collective activity (p.2) (see also Serrano de Moreno, 2002; Nieto, *et. al*., 2003). Therefore, competencies were transformed into efficient skills from which mathematics solves pedagogical conflicts in which teachers use traditional mathematical models, which would produce according to Prieto and Contreras (2008) a change of disciplinary knowledge in relation to Mathematical Competencies based on their evaluation:

> **If it is accepted that evaluative practices are not merely technical or control processes, it is necessary to comply with a series of requirements so that their results effectively reflect the students' learning and the development of the respective skills. This implies that the teacher carries out a complex process of transformation of disciplinary knowledge for its didactic presentation, in order to facilitate its understanding by the students; that he/she defines the evaluation criteria, designs evaluative instruments in accordance with the above and determines how he/she will communicate and work with the results, articulating disciplinary content, its didactics and the way of evaluating it (p. 255). (p. 255).**

## Methodology

## Methodological approach

The research has a mixed approach, since it analyzes qualitative and quantitative data simultaneously to respond to the problem statement. The scope is descriptive, since it seeks to identify situations, habits and attitudes of teachers and their relationships with the study variables (Van Dalen and Meyer, 2006).

The design is non-experimental, "since it observes the phenomena as they occur in the natural context and subsequently analyzes them, i.e. the variables are not deliberately manipulated, no situation is constructed, only the already existing reality is observed without any intervention" (Mello, 2017, p.6). The sampling system is probabilistic, due to the fact that chance is the main reason for selection, so the systematic and randomized rules govern this system.

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This in turn allows the sample to be truly significant in the population (Tamayo, 2004). Sampling is simple random, each teacher in the population has the same probability of being selected for the sample, and does not allow the influence of external factors that predispose the objective selection of the sample (Tamayo, 2004).

## Categories of analysis

The survey is used to study populations through the analysis of representative samples in order to explain the study variables and their frequency. For the research, 13 questions focused on the creation of knowledge were taken into account and it is here where three main categories to be identified are based: Curricular contents, didactic approach and learning assessment in the conception of mathematical competencies. Thus, the most uncertain environment is the one formed from the individual knowledge of those who make it up (teachers) and build it from the information and data collected in relation to the emerging categories based on the research of Pareja and Martinez (2008) (Table 1).

**Table 1**

***Description of study variables***

| Conception of mathematical competences (CPM) | Independent variables | Emerging categories (dependent variables) |
|---|---|---|
| Curricular contents (CPMCC) | Numerical, metric, spatial, random and variational thinking (Questions 1-7) | Learning and Cognition (AC); 2. Disciplinary Conceptual Domain (DCD); Knowledge Transfer (KT); 4. Teaching (E); 5. Meaningful Learning (E); 6. Socio Cultural (ASSC). |
| Didactic approach (CPMED) | Classroom work, resources and methodologies in the development of classes, classroom work to develop a specific topic of study (Questions 8- 9). | Social Constructivism (S.C); 2. Phenomenological Approach (FE); 3. (ES); 4. Anthropological Approach (EA). |
| Learning assessment (CPMEA) | Instruments to evaluate the contents worked on in class, resolution of mathematical exercises and/or problems proposed in evaluation instruments and extra-class activities proposed by the teacher (Questions 10-13). | 1. Evaluation of the Performance Process (EPR); 2. Theoretical Dimension Evaluation (EDT); 5. Comprehensive Evaluation (EI); 6. Evaluation in the Performance Process (EPD); 7. Evaluation in the Practical Dimension (EDP). |

**Source: (Pareja and Martínez, 2008).**

The survey responses are ordered, segmented, categorized and classified, in iterated form according to Becerra's (2017) methodology, based on their semantic and syntactic affinity in relation to the category of mathematical competencies (CPM).

### Participants

The population under study is constituted by 90 teachers of the area of mathematics in exercise in secondary education in Educational Institutions of the public sector in the urban area of the municipality of Florencia, department of Caquetá. The sampling frame used is the Dane register (2018) and the Departmental Secretary of Education of Caquetá. The sampling model applied corresponds to the calculation from a known (finite) population, as follows: , where n: required sample size, N: population of 90 teachers, Z: coefficient 1.96 corresponding to 95% confidence, E: degree of error of 5% (0.05) and response variability indexes P; Q: 50% (0.5).

### Instruments for obtaining information

The primary source of information used was the structured survey technique, applied directly in the the environment where the study phenomenon occurs (a representative sample of the population), in

order to obtain qualitative and quantitative measurements of testimonies that would help to confront theory with practice in the search for objective truth.

The survey used is validated within the framework of the research "*Concepciones sobre competencias matemáticas en docentes de educación básica, media y universitaria"* by Pareja and Martínez (2008) and the application of the Crombach Alpha analysis performed by the specialists in methodological processes Perdomo and Vargas (personal communication, January 4, 2018), who established a reliability index of form and content of 0.81 and 0.81 correspondingly.

In turn, the work is based on secondary sources from theses, scientific articles, reflections by theoreticians and other documents that support teachers' conceptions of mathematics competencies.

**Field work**

The fieldwork was carried out in three methodological phases:

***Phase of reflection and preparation of the project.*** In this first phase, the research problem was formulated, in order to
then select the methodological strategy in identifying the sample, contexts and dates.

*Fieldwork implementation phase*. At this point, the survey was implemented to 73 mathematics teachers in 13 educational institutions in the municipality of Florencia, and the techniques for the generation of information were adjusted for their respective filing and preliminary analysis.

***Final analysis and writing phase.*** This final phase corresponds to the analysis of the information obtained in the conducting the field work and writing the final report.

**Data analysis**

With the results of the emerging categories, a statistical study was established in relation to the analysis of variance ANOVA performed in the *Statistical Package for the Social Sciences* (SPSS) program, which made it possible to contrast the null hypothesis that the means of N populations (N>2) are equal, against the alternative hypothesis that at least one of the populations differs from the others in terms of its expected value:

> Ho: The conceptions of the mathematical competencies of Curricular Content, Didactic Approach and Assessment for Learning do not present significant differences in their level of significance based on their emergent categories among the 73 teachers surveyed.
>
> $H_1$ : The conceptions of the mathematical competencies of Curricular Content, Didactic Approach and Assessment for Learning present significant differences in their level of significance based on their emerging categories among the 73 teachers surveyed.

This contrast of the two hypotheses is important to test in order to generate the experimental results with respect to the dependent variable.

## Results

The results of the teachers' conceptions of mathematical competencies were delimited according to the recounting and analysis of teachers' opinions in three themes or categories: (a) Teachers' Conceptions of Mathematical Competencies and Curricular Contents (CDCMCC); (b) Teachers' Conceptions of Mathematical Competencies and Didactics (CDCMD); (c) Teachers' Conceptions of Mathematical Competencies and Evaluation (CDCME).

**a. Conceptions of mathematical competences and curricular contents.**

Figure 1 represents the prevalence of the emergent categories arising from the seven questions related to mathematics curricular content, established by numerical, metric, spatial, random, and variational thinking.

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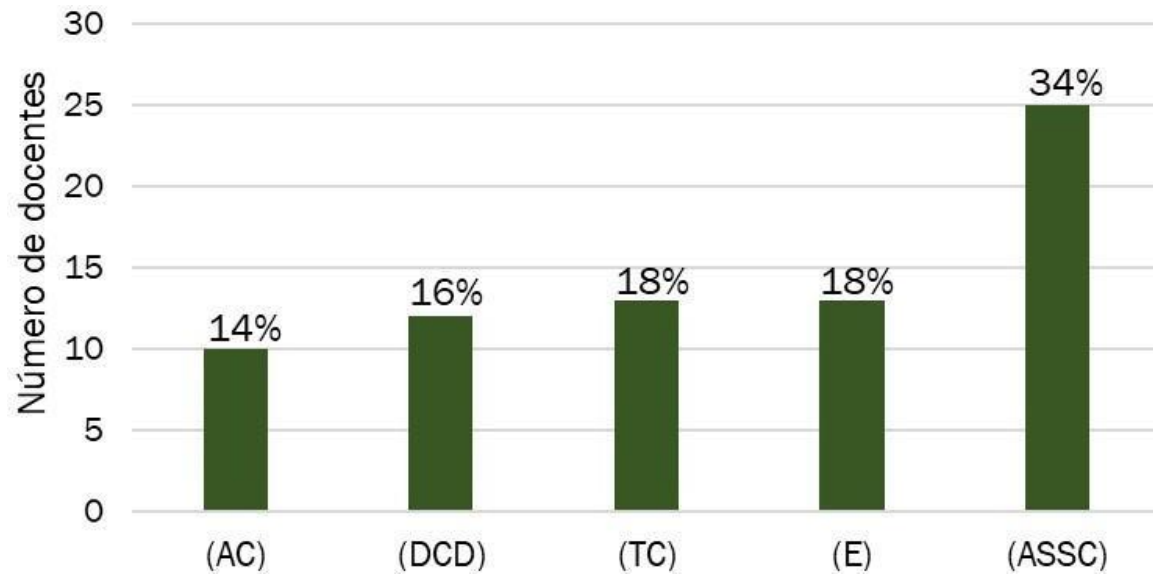
**Figure 1**

*Prevalence of emergent categories on conceptions of mathematical competences and curricular contents.*




Source: own authorship

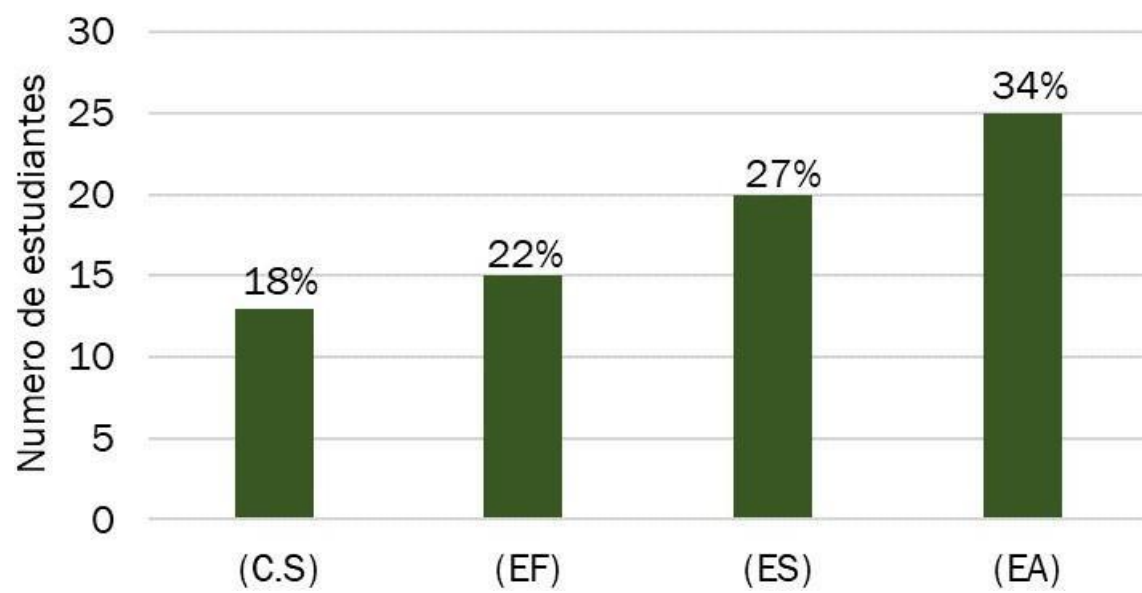
Basically, the emerging category with the highest percentage of the sample is Socio-Cultural Significant Learning (ASSC) with 34 % prevalence, the second place is shared by Teaching (E) and Knowledge Transfer (CT) with 18 %, followed by Disciplinary Conceptual Domain (DCD) represented by 16 %, last and not least, 14 % of teachers describe Learning and Cognition (AC) of curricular contents.

### b. Conceptions of mathematical competences and didactics

Within questions 9 and 10 of the structured survey, four (4) emerging categories related to the conceptions of mathematical and didactic competencies were identified. These categories obtained differentiable prevalence percentages among the study sample. The Anthropological Approach (AE) had the highest prevalence with 34%, followed by the Semiotic Approach (SE) with 27%, the Phenomenological Approach (FE) with 22% and finally the Social Constructivism (S.C.) with 18% (Figure 2).

**Figure 2**

*Prevalence of emergent categories on the conceptions of mathematical competences and didactics.*



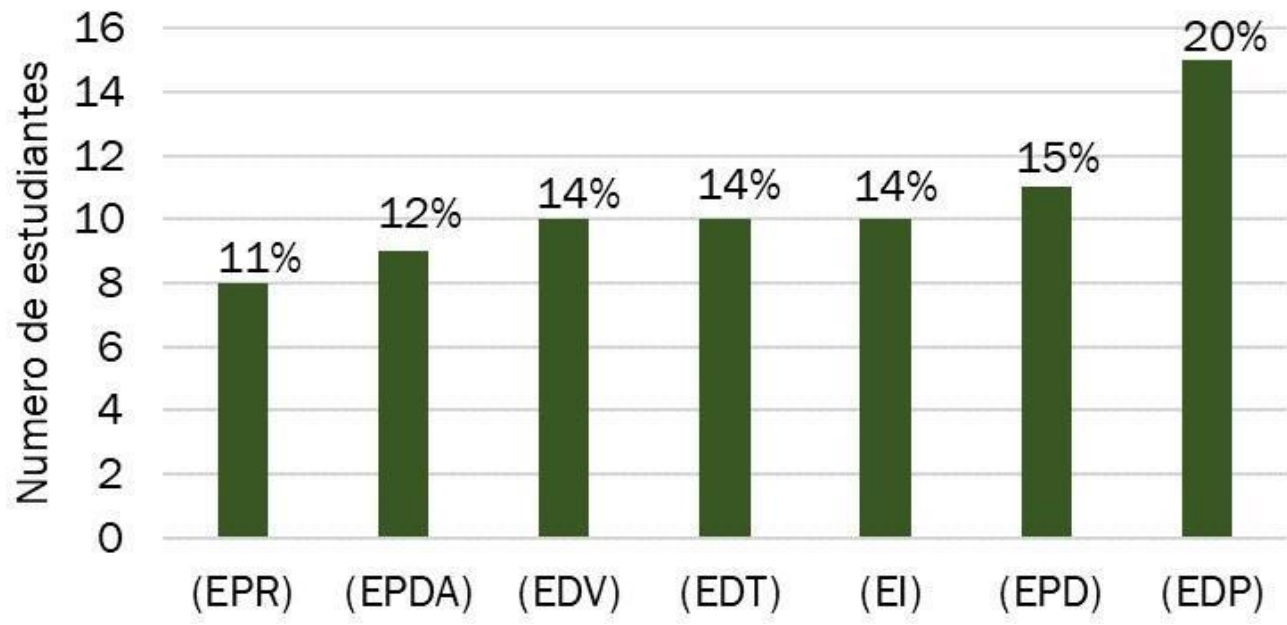

Source: own authorship

### c. Conceptions of mathematical competencies and their assessment

The conceptions of the 73 teachers about mathematical competencies and their evaluation respond to seven categories emerging from the last three questions of the survey. The Evaluation in the Practical Dimension (EDP) obtained the highest prevalence with 20% of teachers, in second place, with 15% is Evaluation in the Performance Process (EPD), followed by Integral Evaluation (EI), Evaluation of the Theoretical Dimension (EDT) and Evaluation of the Valuative Dimension (EDV) with 14% respectively. In fourth place, the Evaluation in the Process of Skills Development (EPDA) corresponds to 12% and the least significant prevalence with 11% belonging to the Evaluation of the Performance Process (EPR) (Figure 3).

**Figure 3**

*Prevalence of emergent categories on conceptions of mathematical competencies and their assessment.*




Source: own authorship

It is clear that the 16 emerging categories distributed in the Curricular Contents (CPMCC), Didactic Approach (CPMED) and Learning Assessment (CPMEA) have similar prevalence percentages in their level of significance. It is of vital importance to identify which ones present really significant differences, in order to establish which categories are the ones that teachers contextualize, know, manage and integrate the conceptions that teachers have about mathematical competencies. For this purpose, a one-factor analysis of variance called ANOVA was implemented as shown in Table 2 and 3.

ANOVA calculates several sums of squares to analyze the overall variability of the data, as well as the variability within and between groups. From these sums of squares, the corresponding mean and variance can be obtained. To calculate the sum, the following concepts must be taken into account:

*Sum of squares (SCT).* This is the sum of the squared differences between each observation and the overall mean of all groups. It is calculated by summing the squares of the deviations of each value from the overall mean as indicated by the formula: *STC* $\frac{n}{\Sigma i=1}(yi - y)^2$ (Ott, *et. al*., 2019).

*Sum of squares between groups (SCG).* It is the sum of the squares of the difference between the group mean and the overall mean. It is calculated by adding the squares of the difference between the mean of each group and the population mean, weighted by the size of each group: *SCG*$= \Sigma(ni * (Xi - X)^2)$ (Ott, *et. al*, 2019).

*Sum of squares within groups (SCD).* It is the sum of the squared differences between each observation and the mean of the respective group. It is calculated by adding the square of the deviation of each value from the mean of its group in each group separately and then adding these values in all groups: *SCD*$^{SCD= \Sigma\Sigma(Xij - Xi)^2}$ (Peña and Prieto 2005).

Once the sum of squares is obtained, the mean and variance can be calculated:

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*Averaging*. To obtain the average, the corresponding sum (SCT, SCG or SCD) is divided by the corresponding number of degrees of freedom. The degrees of freedom is a measure of the amount of information in the data that can be used to estimate a parameter.

*Variance*. The variance is obtained by dividing the corresponding sum (SCT, SCG or SCD) by the corresponding degrees of freedom. Dispersion is a measure of the distribution of data relative to the mean.

**Table 2**

***Summary of emerging categories***

| a. Conceptions of mathematical competencies and curricular content. | | | | | |
|---|---|---|---|---|---|
| ***No of categories*** | ***Groups*** | ***Account*** | ***Sum*** | ***Average*** | ***Variance*** |
| 1 | (AC) | 73 | 10 | 0,136986301 | 0,119863014 |
| 2 | (DCD) | 73 | 12 | 0,164383562 | 0,139269406 |
| 3 | (TC) | 73 | 13 | 0,178082192 | 0,148401826 |
| 4 | (E) | 73 | 13 | 0,178082192 | 0,148401826 |
| 5 | (ASSC) | 73 | 25 | 0,342465753 | 0,228310502 |
| **b. Conceptions of mathematical competencies and didactics** | | | | | |
| ***No of categories*** | ***Groups*** | ***Account*** | ***Sum*** | ***Average*** | ***Variance*** |
| 6 | (CS) | 73 | 13 | 0,178082192 | 0,148401826 |
| 7 | (EF) | 73 | 15 | 0,205479452 | 0,165525114 |
| 8 | (ES) | 73 | 20 | 0,273972603 | 0,201674277 |
| 9 | (EA) | 73 | 25 | 0,342465753 | 0,228310502 |
| **c. Conceptions of mathematical competencies and assessment** | | | | | |
| ***No of categories*** | ***Groups*** | ***Account*** | ***Sum*** | ***Average*** | ***Variance*** |
| 10 | (EPR) | 73 | 8 | 0,109589041 | 0,098934551 |
| 11 | (EPDA) | 73 | 9 | 0,123287671 | 0,109589041 |
| 12 | (EDV) | 73 | 10 | 0,136986301 | 0,119863014 |
| 13 | (EDT) | 73 | 10 | 0,136986301 | 0,119863014 |
| 14 | (EI) | 73 | 10 | 0,136986301 | 0,119863014 |
| 15 | (EPD) | 73 | 11 | 0,150684932 | 0,129756469 |
| 16 | (EDP) | 73 | 15 | 0,205479452 | 0,165525114 |

Source: Authorship

Table 2 describes the summary of the average and variance of the 16 emergent categories used to implement the analysis of variance in Table 3. When performing the analysis of variance, it was determined that the Conceptions of mathematical and didactic competencies as well as the Conceptions of mathematical competencies and Evaluation do not present differences in their level of significance between their emergent categories, because the probability index described in Table 3 is greater than the significance level of 0.05. In other words, the probability index of the mathematical and didactic competences is 0.09 > 0.05 and the probability index of the mathematical and evaluation competences is 0.07 > 0.05. In this case, the null hypothesis "$H_0$ " is accepted, which stipulates that:

The differences in the prevalence percentages of the emerging categories (CS); (DF); (ES) and (EA) that make up the didactic approach, as well as (EPR); (EPDA); (EDV); (EDT); (EI); (EPS) and (EDP) that constitute the evaluation of learning, do not show significant differences among the conceptions described by the 73 teachers surveyed (Table 2 and 3).

**Table 3**

*One-factor analysis of variance*

**a. Conceptions of mathematical competencies and curricular content.**

| *Origin of variations* | *Sum of squares* | *Degrees of freedom* | *Mean squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 1,934246575 | 4 | 0,483561644 | 3,082969432 | 0,016207906 | 2,396742944 |
| Within the groups | 56,46575342 | 360 | 0,156849315 | | | |
| Total | 58,4 | 364 | | | | |

**b. Conceptions of mathematical competencies and didactics**

| *Origin of variations* | *Sum of squares* | *Degrees of freedom* | *Mean squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 1,188356164 | 3 | 0,396118721 | 2,129923274 | 0,09657731 | 2,635951054 |
| Within the groups | 53,56164384 | 288 | 0,18597793 | | | |
| Total | 54,75 | 291 | | | | |

**c. Conceptions of mathematical competencies and evaluation**

| *Origin of variations* | *Sum of squares* | *Degrees of freedom* | *Mean squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 0,40704501 | 6 | 0,067840835 | 0,550022036 | 0,770045986 | 2,116556964 |
| Within the groups | 62,16438356 | 504 | 0,123342031 | | | |
| Total | 62,57142857 | 510 | | | | |

**Source: Authorship**

The opposite case happens with the Conceptions of mathematical competencies and curricular contents, where the probability index is lower than the confidence index, since it is found that: 0.01 < 0.05. Therefore, $H_0$ is rejected and $H_1$ is accepted: "the conceptions of the mathematical competences of the Curricular Contents present statistically significant differences in at least one group of emerging categories among the 73 teachers surveyed".

Now, it is important to identify which emerging category presents such a difference, for this, Tukey's Test is applied, which uses the honestly significant difference "HSD" determined by the multiplier ($Q\alpha$ value= 3.12), the square of the mean error (Mse= 0.15) and the size of each of the groups (n= 73).

Finally, to finish the Tukey Test, the value of HSD = 0.14 which is compared with the arithmetic mean of each of the groups (emerging categories), where it is stipulated that the Socio-Cultural Significant Learning (ASSC) has the honestly significant difference, because the difference of its arithmetic mean with the other groups is higher than that of HSD [(Socio-Cultural Significant Learning (ASSC) 0.34 – Teaching (E) 0.17 = 0.17]; [(Socio-Cultural Significant Learning (ASSC) 0.34 - Transfer of Knowledge (TC) (0.17) = 0.17]; [(Socio-Cultural Significant Learning (ASSC) 0.34 - Disciplinary Conceptual Domain (DCD) 0.16= 0.18] and [(Socio-Cultural Significant Learning (ASSC) 0.34 - Learning and Cognition (AC) 0.13= 0.21].

## Discussion

In order to determine the results of the research in each specific objective proposed, it is necessary to dimension and contextualize a series of terms and definitions that help to understand the emerging categories, in order to establish a clearer analysis of the statements described by the surveyed teachers. In the first place, it is possible to discuss the conceptions that teachers have about mathematical competencies focused on didactics (CPMED) and their learning assessment (CPMEA), since their emerging characteristics do not have a significant difference between them.

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Teachers have conceptions about Mathematical Competences and Didactics, focused on the daily context (with examples from daily life or fictitious), where the construction of mathematical components and objects of their interest is made possible (Anthropological Approach) so that an individual:

> can at every moment of his life, fully develop his human nature, requires socially and historically produced resources that are located outside him (...), therefore, the Didactic, i.e. the set of phenomena of dissemination and appropriation of any element of culture, represents the backbone of the Human (Castela 2017, p.9). (Castela 2017, p.9).

With respect to the academic interaction that the Anthropological Approach generates, it is important to see the contributions of Chevallard (1999).

In turn, teachers state that the most important thing is to use mathematical concepts and theories through problem solving (Semiotic Approach), "based on the organization of the objects of mathematics in conceptual fields and their stages of development" (Socas, 2012, p.1). Another approach identified was the phenomenological (EF), since teachers are oriented by a logical mathematics, due to the fact that these are a mediator not in a declarative way (Castro, 2011), in the same sense Waldegg (1998) describes: "by attributing to the cognizing subject the decisive role in the construction of knowledge, the phenomenological hypothesis forces, in a certain sense, to take into account the intentionality or purpose of the cognizing subject" (p.20). The last didactic emergent approach described is social constructivism (SC), which is oriented to the manifestations of importance of social interaction, "constructivist teaching is not based on designing exercises, but on designing social environments of mathematical learning and literacy, of creating a complex, exciting and speculative classroom" (Gregorio, 2002, p.128).

The second group of emerging categories, related to the teachers' conceptions of mathematical competencies, focused on the Assessment of Learning (CPMEA), did not obtain significant differences between their categories either, since the total number of respondents stated that the importance of the Assessment in the Practical Dimension (EDP) lies in the use of mathematical knowledge in the solution of problems specific to the area or other branches of knowledge; Evaluation in the Performance Process (EPD) is of vital importance for monitoring the fulfillment of responsibilities and functions by students in the mathematical learning process.

Similarly, the Comprehensive Evaluation (IE) is perceived as the implementation of performance-based evaluation strategies, due to the need of students to demonstrate their attitudes, skills and knowledge in the development of activities that require them to put their competencies into action. In perspective of the above, the Evaluation of the Theoretical Dimension (EDT) is described by teachers as the development of evaluation instruments in the conceptual foundation of mathematics, in order to determine the theoretical basis of the student body.

Next, the Evaluation of the Valuative Dimension (EDV) allows the vision of the student in its context, because it approaches "to a greater extent the reality of the evaluative act and the phenomena involved in it (...), and of the formation of evaluative judgments, whose recognition is essential to achieve greater objectivity in the practice of evaluation" (Gonzáles, 2001, p.97).

The Evaluation in the Process of Development of Aptitudes (EPDA) manifests a deficiency on the part of teachers, because they do not effectively formulate didactic, methodological and psychological foundations that stimulate the development of mathematical attitudes as the main axis of the learning process; the same happens with the Evaluation of the Process of Performance (EPR), its low prevalence describes a decrease in the systematic and structural procedure to measure the results of mathematical competencies, in order to discover to what extent learning is real and effective.

In summary, teachers, were characterized by describing an evaluative perspective as a systematic process, this means that the evaluation they perform requires strengthening their processes and approaches for the appropriate use of learning that measures the same process, giving coherence to what is expected with the actions undertaken by the mathematics competencies, this aspect is confirmed by Agudelo and Aldana (2016), who state that:

> regarding the competency perspective, the approach (...) is present in the evaluative actions and there is an awareness of it on the part of the group of teachers. It is not intended to suppress the use of this approach, but it is necessary to point out that methodological, participative and personal elements complement the notion of this concept and can be incorporated in the evaluation process as a consequence of the favoring of learning environments and diverse evaluative designs oriented to specific competencies. (83.p)

Finally, the conceptions of mathematical competencies in the curricular contents (CPMCC) do present an important difference, in the Socio-Cultural Significant Learning (ASSC), which refers to the interpretation of contents and solution of mathematical problems by exemplifying them in daily life events or imaginary events in an interesting context for the students. According to López (2002), "the influence of the social environment has gigantic challenges in the meaningful learning of mathematics (...), understanding that the essence of the child is not an ego separated from this whole process, here his learning is already social" (p.3).

The Transfer of Knowledge (TC) must be applied in the performance in daily life, thus, teachers work from the curricular contents referring to mathematical definitions and exercises (Gómez and Guzmán, 2013). In this same sense, the Disciplinary Conceptual Domain (DCD) present in the sample helps the construction of meaningful learning. The teachers manage the knowledge of the area they want to transmit to the students, for this the teacher makes a general description of the information through the Teaching
(E) and Learning in relation to cognition (AC), which is reflected in the actions aimed at developing the active participation of the student to achieve their goals, with the help of guidance in the sequence and order of the mathematical exercises structured for that purpose (Cabanes, *et. al.,* 2017).

## Conclusions

According to the results, the didactic approach applies resources and methodologies in the development of classes by allowing to understand the way in which students reason and contextualize in common the variability of ways to solve problems, in itself, the teacher's role is to direct the appropriation of learning in the use of techniques and more effective reasoning, This, in turn, will allow transforming the ideal vision of educational systems, since there is a need to implement as a central axis the study of the *educational paradigm* so that the academic community is constituted as an intercultural society where there is a sustained, permanent and dynamic process of relationship, learning and mutual communication.

As for the evaluation of class work and resolution of mathematical exercises and problems, it allows orienting perspectives and developing general aspects of mathematical competencies. This is how the evaluative characteristics associated with the measurement of learning are maintained, which in turn can originate in an inordinate proportion value judgments and systematic processes, which to a large extent can also be described as an educational need, composed of a variety of definitions and psychological, social and cultural approaches, closely involved with the motivation to learn, at the same time allows to demonstrate that the Mathematical Competences can obtain a principle of dialogical learning, since it can change the way students see mathematical problems, no longer as a way to acquire specific knowledge, but as the recognition of the self.

The conceptions of mathematical competencies in terms of curricular contents determined the construction of numerical, metric, spatial, random and variational thinking, due to the fact that teachers facilitate the application of these thoughts in a mathematical sense, but with more relevance in a Socio-Cultural Significant Learning (ASSC), which contextualizes the contents in the solution of mathematical problems in daily life events. This aspect also allows addressing interculturality within a form of learning, in a context of intercultural education, which should train students from all cultural groups towards adaptability and development within a defined cultural context. In the same way, the areas to be strengthened in order to create an intercultural society are related to education, the educational community, teachers and parents, since it is precisely these groups that make up the axes of modern society.

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