Beliefs about mathematics and academic performance: A descriptive - correlational analysis

G A Rincon¹, R Fernández Cézar², and C F Hernandez¹,³
¹ Secretaria de Educación Municipal, San José de Cúcuta, Colombia
² Universidad de Castilla-La Mancha, Toledo, España
³ Universidad Simón Bolívar, San José de Cúcuta, Colombia

E-mail: gersonadriano@gmail.com

Abstract. The purpose of this report has been to analyze students' beliefs about mathematics and its relationship with their academic performance. The methodology used is quantitative, coupled to two study analyzes, the descriptive and the correlational, based on a non-experimental type design, correlational-causal transverse, since it seeks to explain the relationship between the variables. The technique used for data collection was a structured questionnaire, of questions of the Likert Scale type, which was applied to 121 students of 3 grade of primary basic education, belonging to a public educational institution of “San José de Cúcuta, Colombia”, selected by non-probabilistic sampling. This instrument was submitted to the respective analyzes that determined its validity and reliability. For academic performance the instrument of characterization of skills and procedures used by third grade students in the area of mathematics was used, designed by the all to Learn program of the “Ministerio de Educación Nacional, Colombia”. The results show that beliefs about mathematics, from the perspective of students, are a factor in the academic performance of that area.

1. Introduction
Teachers and researchers in the teaching-learning processes increasingly focus on defining and clarifying the obstacles and barriers that arise for students while they learn. Therefore, academic performance, high rates of absences, high drop-out rates not only in middle and higher levels of education, but also in primary school are reasons that have worried government education institutions as teachers of different educational levels and the community in general [1]. Within this broad field, there is a great interest in the study of the affective domain of mathematics in disaggregated beliefs, attitudes and emotions in relation to the teaching/learning of Mathematics [2].

It is a fact that today’s complex society demands the need to learn mathematics in order to function properly, in which technological advances and the progressive importance of the media force people to adapt to new ways of socializing as a result of social change [3]. But it is also evident that, despite its importance and usefulness, mathematics is usually seen and valued by most people and especially students as a subject without use in life, difficult, boring, abstract, in general impractical, perceiving that their learning requires a high level of dedication, concentration and intelligence not suitable for everyone [4]. Beliefs that most likely influence the loss of the subject of mathematics and even the repetition and dropout [5].

Bearing in mind the above, a change in the perception of the area of mathematics is required, by the students and possibly the teachers who orient it especially in the primary basic, in general, in Colombia
it tends to be of other specialties, which, due to the need for the service, the teaching managers are responsible for guiding all areas of a course. In this context, the present work was developed to determine to what extent there is a relationship between the emotional domain towards mathematics and the student's academic performance.

Because the “Ministerio de Educación Nacional (MEN)”, Colombia, through the “Programa Todos a Aprender (PTA)” in recent years is carrying out a curricular restructuring in the area of elementary school mathematics, among other areas, relying on quality referents emanating from the MEN, such as general education law [6], curriculum guidelines [7], basic competency standards [8], basic learning rights [9] and finally learning meshes [10].

It is clear that all these referents seek to improve academic performance; therefore, it is important to be clear about this concept, from the perspective of human development and considering that the student is a builder of his own learning. Academic performance can be considered as a complex and integral educational phenomenon that involves both students with their achievements and experiences in both basic education and the various institutional dimensions that contribute to the integral formation of this [11].

Therefore, the conceptualization of academic performance is complex, using different denominations such as: school aptitude, academic performance or school performance, but generally the differences in concept are only explained by semantic issues, for example, in most books, teaching experience and school environment are used as synonyms [12]. This author expresses that one of the variables most used by teachers and researchers for academic performance are grades; Therefore, there are studies that aim to calculate some reliability and validity indices of this criterion considered as 'predictive' of academic performance. The grades reflect the assessments and/or exams where the student must demonstrate their knowledge of the different areas or subjects [13].

Academic performance is a construct which can take qualitative or quantitative values which give an existence of approximation to the dimension and evidence of the profile of skills, knowledge, attitudes and values developed by the student in the teaching-learning process” [12]. Several factors are involved in academic performance, including personal aspects such as cognitive, biological and socio-affective aspects of the student and contextual aspects such as social and cultural [14]. In a student, an “unsatisfactory academic performance is one that falls below the expected performance” [15].

For this reason, the importance of establishing this relationship as a component that facilitates a possible explanation and thus avoiding repetition, student drop-out and strengthening permanence in the education system can be evidenced.

Considering the previous problem, the following questions arise from the point of view of the researchers: What are the beliefs, attitudes and emotions towards the mathematics of elementary school students as components of the affective domain and their relationship with the academic performance?

This article presents the advancement of the previous question: is there a relationship between beliefs in mathematics and academic performance?

2. Method

2.1. Design

The research approach is quantitative; in terms of design, it is non-experimental, correlational-causal cross-sectional [16], since it allows determining the relationships between beliefs about mathematics and academic performance.

2.2. Population and sample

The population was made up of students, between male and female gender. The sample was made up of 121 third-grade elementary students, who agreed to voluntarily participate in the study, aged between 8 and 11, enrolled in 2019 at the Mariano Ospina Rodríguez Educational Institution, Monseñor Luis Pérez Hernández headquarters, municipality of San José de Cúcuta, Colombia.
2.3. **Research techniques and instruments**

The technique used to obtain affective domain data in the present investigation was a survey. The instrument used was a questionnaire divided into 3 sections, the first of general information, the second of the affective domain towards mathematics, consisting of 13 items associated with beliefs on mathematics, 15 items associated with attitudes towards mathematics and 10 items associated with emotions towards mathematics and the last section is mathematical processes in teaching practice, the reliability of the instrument was validated with the Cronbach Alpha test, obtaining the result of 0.713. This research progress will present the results of the correlation between beliefs about mathematics and academic performance in mathematics. The established variables are:

2.3.1. **Beliefs about mathematics.** It consists of a 13-question Likert scale questionnaire. The students responded with respect to the questionnaire through one of the following alternatives: One (1, which means "I strongly disagree") through, five (5, which means "I strongly agree") depending on their level of approval.

2.3.2. **Academic performance.** In this variable, the characterization instrument of the skills and procedures used by third grade students in the area of mathematics, designed by the PTA of the MEN, was considered. It contains 8 tasks, each task consisting of 4 exercises, associated with basic skills, which in turn are related to the basic learning rights [9] and the axes of progression of numerical and variational thoughts [10], the instrument it is applied in two moments, the first moment will be the application of tasks 1, 2 and 3. The application was carried out in the form of a child-to-child interview with concrete material set in a school store and the second moment the application of Tasks 4, 5, 6, 7 and 8 individually test style know or multiple choice questionnaire with only one answer, they were also placed on each table concrete material to facilitate operations.

2.4. **Process**

The written permission and authorization were requested from the rectory of the educational institution. The data was obtained during class development, in coordination with the classroom teacher. Before the students answered the questionnaire, the pertinent indications were given. There was the collaboration of an assistant in the application of the questionnaire.

2.5. **Information processing and analysis**

The Excel spreadsheet was used to present the results and the SPSS software was used for statistical hypothesis contrasts and correlation calculations. To determine the degree of association (correlation coefficient) between the study variables, Spearman's Rho was used with which the dependence or independence of two random variables can be determined [17]. The Spearman Rho correlation coefficient is the coefficient using when the variables are ordinal and / or the normality assumption is breached (non-parametric approximation). This coefficient is very useful when the number of pairs of subjects (n) to be associated is small (less than 30). It is a dimensionless value that ranges between -1 and +1. The zero value is given when there is no correlation between the analyzed variables; the value -1 implies a perfect correlation of an inverse (or indirect) character and the value +1 a perfect correlation of a direct type (when one grows, so does the other) [18].

2.6. **Hypothesis testing**

Procedure that consists in contrasting a claim about the ownership of a population and using statistical evidence to confirm or refute it. In accordance with the above, for this pilot study, in the hypothesis test, the following were proposed:

- H1: There is a relationship between beliefs about mathematics and the academic performance of students.
- H0: There is no relationship between beliefs about mathematics and students' academic performance.
3. Results

3.1. Beliefs about mathematics
The perception of students in relation to beliefs about mathematics in the sample studied is shown in Table 1. 37.2% of the students surveyed do not have a positive or negative belief towards mathematics, followed by 25.6% agree.

| Level of beliefs about mathematics | number of students | Percentage | Accumulated percentage |
|-----------------------------------|--------------------|------------|------------------------|
| Strongly disagree                 | 5                  | 4.1%       | 4.1%                   |
| Disagreement                      | 22                 | 18.2%      | 22.3%                  |
| Neither rejects nor accepts       | 45                 | 37.2%      | 59.5%                  |
| Agree                             | 31                 | 25.6%      | 85.1%                  |
| Totally agree                     | 18                 | 14.9%      | 100.0%                 |
| **Total**                         | **121**            | **100%**   | **100%**               |

3.2. Academic performance level
The average number of exercises correctly performed per task in relation to their academic performance of the sample studied is shown in Table 2, the majority of 59.5% students answered on average 3 of the four questions per task being at a high level and 23.1% answered 4 of the 4 questions in the eight tasks at a higher level.

| Average questions per task | number of students | Percentage | Accumulated percentage |
|----------------------------|--------------------|------------|------------------------|
| 1                          | 2                  | 1.7%       | 1.7%                   |
| 2                          | 19                 | 15.7%      | 17.4%                  |
| 3                          | 72                 | 59.5%      | 76.9%                  |
| 4                          | 28                 | 23.1%      | 100.0%                 |
| **Total**                  | **121**            | **100%**   | **100%**               |

3.3. Beliefs about mathematics and academic performance
Table 3 shows the Rho correlation of Spearman between the variable’s beliefs about mathematics and academic performance, a positive correlation is observed, that is, by increasing the perception in beliefs about mathematics, the academic performance of students increases and vice versa. Indicating a strong correlation between the study variables with a value of r = 0.883 and a statistically significant p-value of p <0.01. Where we can affirm that the null hypothesis (H0) is rejected if the p = 0.000 <0.01, resulting in sufficient statistical evidence to accept that there is a relationship between the Beliefs on Mathematics and academic performance in the 3rd grade students of the 2019 year of the Marian Institution Ospina Rodriguez, Monsignor Luis Pérez Hernández headquarters of the Municipality of San José de Cúcuta, Colombia.

| Correlations                  | Academic performance | Beliefs about mathematics |
|------------------------------|----------------------|---------------------------|
| Spearman’s Rho               | Correlation coefficient | 1.000 | 0.883 |
|                              | Sig. (bilateral)      | 0.000 |       |
|                              | N                    | 121  | 121   |
| Beliefs about mathematics    | Correlation coefficient | 0.883 | 1.000 |
|                              | Sig. (bilateral)      | 0.000 |       |
|                              | N                    | 121  | 121   |
4. Analysis and discussion
In the present investigation, the majority of the 40.5% of the respondents think they have a positive tendency to agree with the beliefs towards mathematics in agreement with Vázquez, Bellón & Fernández [19].

In relation to academic performance, the vast majority 82.6% of the students answered well on average 3 or 4 exercises that were had for each of the 8 tasks being at high or higher levels, influenced by pedagogical practices with mastery of contents of mathematics by the teacher Caciá, Reyes, Rosales and Marroquín, [20]; which allows a better understanding and learning of the topics of mathematics by students, as stated by López-Quijano [21], Authors such as Lester, Garofalo and Kroll [22] point out that students' beliefs about solving problems tend to affect their self-confidence in that activity, increasing or decreasing it.

In this pilot study the research hypothesis is confirmed because it is confirmed that there is a significant relationship between the beliefs in mathematics and the academic performance of the students of third grade of primary basic education of the educational institution under study to have obtained results similar to Vázquez, Bellón & Fernández [19] and Bazan & Aparicio [23], who observed positive and significant values in all cases in a way that increases the qualifications based on the attitudes influenced by the positive beliefs towards mathematics.

Also, the correlation between beliefs about mathematics and academic performance, the study variables, is strong (r = 0.883), presenting certain relationships with the results obtained by Pintrich, Anderman and Klobrucar [24] and by Navas, Sampascual and Castejón [25], where they show the achievement of success in the relationship of controllable internal or intrapersonal causes such as effort, ability, dedication to motivational and cognitive aspects. The results of these studies have confirmed that those students who attributed success to internal causes and control were less anxious, with more expectations of success, more domain-oriented, self-effective and metacognitive and, in addition, performed better. Additionally, students who believed that their failure was due to unstable and uncontrollable factors were less domain oriented, less effective, had lower expectations of achievement and lower academic performance.

5. Conclusions
We analyzed the partial results (research progress) of the relationship between beliefs about mathematics and studied the link with their academic performance in an institution of primary elementary education, specifically in 3rd grade. As corresponds to a pilot study, the purpose of this study has not been to generalize this relationship but to have an approximation (partial results) in order to determine more precisely the relationship between these variables in a subsequent study that includes a larger number of students of all the degrees of different educational institutions of technical and university secondary level of the “Departamento del Norte de Santander, Colombia”. in order to establish a triangulation between the antecedents and the theoretical positions that support it, to give an account of the logics that explain their perceptions about beliefs, attitudes and emotions as constructs of the affective domain and the pedagogical practice in the mathematical processes of the teachers, in function of academic performance and in light of each of the hypotheses raised.

Based on the results, we can conclude the existence of a relationship between students' beliefs about mathematics and their academic performance, indicating that the greater or better the perception of beliefs about mathematics, the better the academic performance and vice versa, bone at a lower Also lower perception is academic performance.

As it turns out, there is a significant positive relationship between beliefs about mathematics and academic performance in students.

Accordingly, for this population under study, the hypothesis of the pilot study has been confirmed, in the sense that there is a significant positive correlation between beliefs about mathematics and students' academic performance.
References

[1] Abalde E, Barca A, Muñoz J & Ziemer M 2009 Rendimiento académico y enfoques de aprendizaje: Una aproximación a la realidad de la enseñanza superior brasileña en la región norte Revista de Investigación Educativa 27 303

[2] Fernández R, Hernández C, Prada R & Ramírez P 2018 Dominio afectivo y prácticas pedagógicas de docentes de matemáticas Espacios 39 25

[3] Ignacio G, Barona G, & Nieto L 2006 El dominio afectivo en el aprendizaje de las matemáticas Electronic Journal of Research in Educational Psychology 4 47

[4] Araya R 2014 Relación entre la dimensión afectiva y el aprendizaje de las matemáticas Revista Electrónica Educare 18 117

[5] Jerez J 2014 Creencias sobre la matemática en estudiantes de primer año de educación media de la UEB “Maporal” municipio Rojas, estado Barinas (Barbula: Universidad de Carabobo)

[6] Ministerio de Educación Nacional 1994 Ley 115 de Febrero 8 de 1994, Ley general de Educación (Colombia: Ministerio de Educación Nacional)

[7] Ministerio de Educación Nacional 1998 Serie Lineamientos Curriculares: Matemáticas (Colombia: Ministerio de Educación Nacional)

[8] Ministerio de Educación Nacional 2003 Potenciar el Pensamiento Matemático: ¡Un Reto Escolar! Estándares Básicos de Competencias en Matemáticas (Bogotá: Ministerio de Educación Nacional)

[9] Ministerio de Educación Nacional 2016 Derechos Básicos de Aprendizaje Matemáticas (Colombia: Ministerio de Educación Nacional)

[10] Ministerio de Educación Nacional 2017 Mallas de Aprendizaje y DBA (Colombia: Ministerio de Educación Nacional)

[11] Zuluaga Y, Rengifo C & López H 2012 La práctica pedagógica de los docentes universitarios en el área de la salud y su relación con el desempeño académico Revista Latinoamericana de Estudios Educativos 8 95118

[12] Edel R 2003 El rendimiento académico: Concepto, investigación y desarrollo REICE Revista Iberoamericana Sobre Calidad, Eficacia y Cambio en Educación 11

[13] Navarro R E 2003 El rendimiento académico: Concepto, investigación y desarrollo REICE Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación 1(2) 1

[14] Barrios M & Frias M 2016 Factores que influyen en el desarrollo y rendimiento escolar de los jóvenes de bachillerato Revista Colombiana de Psicología 25 63

[15] Martí E 2003 Representar el Mundo Externamente. La Construcción Infantil de los Sistemas Externos de Representación (Madrid: Machado Grupo de Distribucion S. L.)

[16] Arias F 2012 El Proyecto de Investigación. Introducción a la Metodología de Investigación Científica (Caracas: Editorial Episteme)

[17] Pérez-Tejada H 1998 Estadística para las Ciencias Sociales, del Comportamiento y de la Salud (México: Cengage Learning)

[18] Aguayo C M, Monge L 2007 Como realizar paso a paso un contraste de hipótesis con SPSS para Windows: (III) Relación o asociación del análisis de la dependencia (o no) entre dos variables cuantitativas. Correlación y regresión lineal simple (Huelva: Fundación Andaluza Beturia para la Investigación en Salud)

[19] Vázquez M, Bellón E & Fernández R 2014 Dimensión afectiva hacia la matemática: Resultados de un análisis en educación primaria Revista de Investigación Educativa 32 57

[20] Caciá D, Reyes M, Rosales C and Marroquín E 2012 Factores que Inciden en el Rendimiento en Matemática de Niñas y Niños del Primer Ciclo del Nivel de Educación Primaria en Escuelas Públicas de Guatemala (Guatemala: Ministerio de Educación de Guatemala)

[21] López-Quijano G 2014 La enseñanza de las matemáticas, un reto para los maestros del siglo XXI Praxis Pedagógica 14 55

[22] Lester F, Garofalo J and Kroll D 1989 Self-confidence, interest, beliefs and metacognition: Key influences on problem solving behavior Affect and Mathematical Problem Solving: A New Perspective ed McLeod D B and Adams V (New York: Springer-Verlag)

[23] Bazán J and Aparicio A 2006 Las actitudes hacia la matemática - estadística dentro de un modelo de aprendizaje Revista Semestral del Departamento de Educación 25 1

[24] Pintrich P, Anderson E and Klobucar C 1994 Intraindividual differences in motivation and cognition in students with and without learning disabilities Journal of Learning Disabilities 27 360

[25] Sampaucal G, Navas L and Castejón J 1994 Procesos atribuicionales en la educación secundaria obligatoria: Un análisis para la reflexión Revista de Psicología General y Aplicada 47 449