Beliefs of Secondary Students of Coelemu, Chile, and its Rural Areas, about mathematics and problem solving

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ABSTRACT

The aim of this study was to analyze the beliefs of secondary students from Domingo Ortiz de Rozas High School of Coelemu, Chile and its rural areas regarding the subject of mathematics and problem solving due to the teaching and learning process. The research was developed under a quantitative approach of quasi-experimental descriptive design survey type (n=156). As a basis was used the closed survey of Barrantes (2008), adapted based on the feedback provided by expert judgment. The results show statistically significant differences related to origin and academic performance in their beliefs about mathematics and problem solving when considering the usefulness of the contents in the learning process and how this subject allows the development of skills. According to gender, it was observed differences in their beliefs about mathematics, however related to problem solving, no statistically significant differences were found. It was concluded that the learning experiences about mathematics and problem solving from rural sector students are related to the development of adverse attitudes towards the subject, since they do not find use and purpose of its applications in their everyday life.

Keywords*:* Beliefs; Mathematics; Problem solving.

Crenças dos alunos do ensino médio de Coelemu, Chile e suas áreas rurais, sobre matemática e resolução de problemas

RESUMO

O objetivo deste estudo foi analisar as crenças dos alunos do ensino médio da Escola Dominical Domingo Ortiz de Rozas de Coelemu, Chile e suas áreas rurais, sobre o tema da matemática e resolução de problemas devido ao processo de ensino e aprendizagem. A pesquisa foi desenvolvida sob uma abordagem quantitativa do tipo de pesquisa descritiva quase experimental (n = 156). Como base, utilizou-se a pesquisa fechada de Barrantes (2008), adaptada com base no feedback fornecido pelo julgamento de especialistas. Os resultados mostram diferenças estatisticamente significantes relacionadas à origem e desempenho acadêmico em suas crenças

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sobre matemática e resolução de problemas ao considerar a utilidade do conteúdo no processo de aprendizagem e como esse assunto permite o desenvolvimento de habilidades. De acordo com o sexo, foram observadas diferenças em suas crenças sobre a matemática, porém, relacionadas à solução de problemas, não foram encontradas diferenças estatisticamente significantes. Concluiu-se que as experiências de aprendizagem sobre matemática e resolução de problemas de estudantes do setor rural estão relacionadas ao desenvolvimento de atitudes adversas em relação ao assunto, uma vez que não encontram uso e finalidade de suas aplicações no cotidiano.

Palavras-chave: Crenças; Matemática; Solução de problemas.

INTRODUCTION

In 2015 in Chile, the new curricular bases were implemented for seventh grade. Which seek students to develop the skills of: arguing and communicating, modeling, representing and problem solving. To achieve these proposed objectives, it is fundamental the learning activities designed by the teacher, since they will allow students understand the importance of mathematics in life.

According to Thompson (1984), during the mathematic teaching process, it is possible to identify three types of teachers: a) one that focuses on routine procedures, b) those that give relevance to the learning of concepts and logic of mathematical processes and c) the one that cares about addressing problem solving. According to Sepúlveda, Oyarzún, Díaz and Opazo (2017) these differences can help or hinder the learning process.

This new curriculum is a challenge for teachers when designing activities since according to Aravena (2001), the teaching of this subject in Chile, focuses on repetition of algorithms. Consequently, Polya (1945) in Echeñique (2006) notes that the learning activities during this process, are fundamental, as these can awake interest in mathematics.

Therefore, Callejo and Vila (2003) considered important to study the development of beliefs in the area of mathematics, allowing to understand what students understand by learning and applying mathematics.

Based on these arguments it is important to analyze, what are the beliefs that second year, high school students have on the subject of mathematics and problem solving. Question that will provide us with information about students' learning experiences, usefulness and relevance that they give to their own learning process.

THEORETICAL REFERENCE

Beliefs in the subject of mathematics and problem solving

The Ministry of Education of Chile (MINEDUC) implemented in 2015 the new curricular bases for seventh grade which included new learning objectives. For teachers,

this new proposal is a challenge, since they must formalize new and complex learning objectives and work together with students' beliefs regarding this subject.

Aravena and Caamaño (2007), suggest that the development of these beliefs is due to the teaching model, which is generally of a traditionalist nature, phenomenon that according to these authors occurs more frequently in municipal establishments, where low learning results are accompanied by a low willingness to work in this subject. In this same direction Barrantes (2008) conducts a study to determine the beliefs that Costa Rican middle school students possess.

To compile the information Barrantes (2008) applied a questionnaire to eighth and tenth year high school Costa Rican students and their respective teachers of mathematics.

Finally, Barrantes (2008) concludes that, according to the educational practices of the mathematics teacher, students develop beliefs, regarding what it means to know mathematics, what mathematical problem is and what its characteristics are.

Regarding with the above, Lampert (1992) cited by Schoenfeld (1992), states that these constructions on the meaning of mathematics are consolidated during the teaching and learning process, in which learning mathematics only means following the rules that the teacher indicates for solving an exercise or simply memorize knowledge.

Seeking to conceptualize the phenomena presented, Martinez (2013), Goméz-Chacón (2008), Schoenfeld A. (1992), Lester, Garofalo, and Kroll (1989), Vilanova et al. (2005) and Chandía, Rojas D., Rojas F., and Howard (2016) include a belief in mathematics as the experiences that a student builds during the teaching and learning process of mathematical knowledge.

According to Callejo and Vila (2003), the beliefs about the subject of mathematics that predominates in students is that of a rigid, boring and mechanical science, since they do not find meaning in its learning. Therefore, Pérez and Beltrán (2011) consider relevant to study the beliefs that students have about mathematics, because allow us to understand the performance and effort that a student will make during the teaching and learning process.

That is why the research of Barrantes (2008), together with the new curricular bases proposed by the MINEDUC (2015), which seek that students understand the usefulness of mathematics in life, it is essential to analyze the beliefs that second year of high school students have at the Domingo Ortiz de Rozas High School in Coelemu Region of Ñuble and understand how during the teaching and learning process received, they have whether or not applied their knowledge in urban and rural contexts.

METHODOLOGY

RESERCH APROACH AND DESIGN

The research is assigned to a quantitative approach, which according to Monje (2011) seeks to quantify and objectify the results from a sample. The type of study corresponds to a descriptive quasi-experimental design of the survey type, for Hernández, Fernández, and Batista (2010), this type of study seeks to measure or collect information.

SAMPLE STUDY AND SELECTION CRITERIA

To select the study sample, the fundamental criterion was that the teaching and learning process would have to be under the guidelines of the new curricular bases for mathematics. In this area, the second year, high school students corresponding to 2018 meet this requirement, since they have worked for four years on this new work plan.

The sample (N) consisted of 156 students from the second year from Liceo Domingo Ortiz de Rozas, located in Coelemu, Ñuble Region. Their age range from 14 (14.10%), 15 (69.87%) to 16 years (16.03%). This high school receives teenagers from the city of Coelemu and its rural areas, which are characterized by agricultural, winegrowing and forestry activities.

The characteristics seen in the sample are that 109 students belong to the town of Coelemu (69.87%) and 47 to the rural areas (30.13%). According to gender, 76 students are male (48.72%) and 80 female students (51.28%). Finally, in relation to academic performance in the subject of mathematics, the averages fluctuate between grades 2.1 to 7.0, the average of the sample 5.4

INFORMATION COLLECTION INSTRUMENT

The instrument in the first instance collects demographic information: class, age, gender, origin and academic performance in the subject of mathematics.

The second part, allows to obtain information referring to the beliefs dimension in mathematics, which is composed of three sub dimensions and the beliefs dimension about problem solving, which is composed of four sub dimensions.

Table.1 *Dimensions and sub-dimensions on mathematical beliefs and problem solving.*

Dimension	Sub-dimension	Composition
Beliefs on mathematic subject	What is to know math?	Meaning attributed to the learning of mathematics.
	Purpose of learning -teaching mathematics	Purpose of learning math during your school training.
	Mathematics in the class	Relation of the contents presented in classes with the context of the student.
	What is a mathematical problem?	Concept that predominates around what is a mathematical problem.
Beliefs on problem solving	What characteristics do mathematical problems possess?	Characteristics that mathematical problems have.
	Usefulness of a mathematical problem	Usefulness of mathematical problems.
	Mathematical problems in the teaching of mathematics	Understand the assessment and meaning given to mathematical problems

Source: *Prepared by the authors based on the sub-dimensions analyzed in Barrantes investigation (2008) to Costa Rican students.*

INSTRUMENT VALIDATION

The closed belief survey of Barrantes (2008) was used as the basis for the construction of the instrument and to gather the information.

To validate the new questionnaire, it was submitted using the proposal by Lawshe (1975) modified by Tristan (2008), which states that if an instrument is validated by 14 experts, it must obtain an CVI (Content Validity Index) of 0.51. This new instrument, obtained a CVI of 0.67.

To determine the reliability, it was analyzed by means of Cronbach's alpha, obtaining a coefficient of 0.89. Which according to the proposal by Hernández, Fernández, and Batista (2010) reflects a high degree of reliability in their results.

COLLECTION TECHNIQUES AND INFORMATION ANALYSIS

Considering ethical aspects of research, the consent of the parents was requested to apply the questionnaire.

Subsequently the instrument was applied in the math class schedule, it was indicated that the answers were anonymous and for research purposes only.

Students were informed that they had 60 minutes to answer the questionnaire and circle their degree of agreement on each of the statements presented on a Likert scale, which contained values from 5 (Strongly agree) to 1 (Strongly disagree).

To analyze the answers, the information was entered in the SPPS 23.0 statistical software. Seven tables were constructed according to the sub-dimensions of the study.

In them were calculated descriptive statistics of central tendency (mean), dispersion (standard deviation), calculation of frequencies and percentages, in order to determine the beliefs that predominated in the students.

Finally, and with the objective of establishing statistically significant differences, between gender, origin and academic performance, a t-test was used for independent samples, with an $\alpha = 0.05$

RESULTS

The results are presented in tables with the sub-dimensions corresponding to the beliefs about mathematics and problem solving. Subsequently, a comparison analysis of means according to gender, origin, academic performance and results by dimension is performed.

SUB-DIMENSIONS ON BELIEFS IN THE SUBJECT OF MATHEMATICS AND PROBLEM SOLVING

The mean values and the standard deviation of the reagents corresponding to the beliefs in mathematics are presented in Tables 2, 3 and 4 and the beliefs about problem solving in Tables 5, 6, 7 and 8 for the total sample (N = 156).

Table.2 *What is to know mathematics?*

	M	SD	SA %	A %	NAND %	D %	SD %
To know too many definitions.	3,38	1,018	14,7	28,2	42,3	9,6	5,1
To know the fundamental theorems of learning objectives.	3,56	0,991	17,3	38,5	30,1	11,5	2,6
To know by heart procedures that serve to solve exercises.	3,88	1,018	32,1	35,9	21,8	8,3	1,9
To decide the importance of a mathematical concept.	3,68	0,990	21,8	38,5	27,6	10,3	1,9
To apply creative processes to different situations.	3,73	1,012	24,4	38,5	25,6	9,0	2,6
To solve the problems related to the subject of study without difficulty.	3,52	1,032	17,3	36,5	30,8	11,5	3,8
To solve any problem related to the subject of study.	4,13	0,914	40,4	38,5	16,7	2,6	1,9

M: Mean, SD: Standard Deviation, SA: Strongly Agree, A: Agree; NAND: Neither agree nor Disagree, D:Disagree, SD: Strong Disagree.

Source: Prepared by the authors based on the obtained results. What is to know mathematics?

In the sub-dimension, what is to know mathematics? The belief of higher value was that mathematics allow to solve any problem related to the subject of study (M = 4.13; SD = 0.914), where 40.4% say they strongly agree. In the case of beliefs that indicate

that knowing mathematics corresponds to knowing the fundamental theorems (M = 3.56; SD = 0.991), deciding the importance of a mathematical concept (M = 3.68; SD = 0.990) and applying creative processes (M = 3.73; SD = 1.012), it is observed in each of the three statements that 38.5% of the students express their agreement. With a slightly lower percentage of 35.9% and 36.5%, the students agreed to determine that knowing mathematics is knowing procedures by heart (M = 3.88; SD = 1.018) and solving problems related to the topic of study without difficulty (M = 3.52; SD = 1.032). Finally, in the statement referring to knowing too many definitions (M = 3.38; SD = 1.018), a positively low belief is observed, since 42.3% express neither agree nor Disagree.

Table.3 Purpose *of teaching-learning mathematics in secondary education*

			SA	A	NAND	D	SD
	M	SD	%	%	%	%	%
To develop mathematical skills to creatively face the solution of contextualized problems.	4,01	0,984	36,5	37,8	18,6	4,5	2,6
To provide mathematical knowledge to intelligently face real-life problems.	4,14	0,933	45,5	28,8	19,9	5,8	0,0
To enhance skills to intelligently face real-life problems.	4,09	0,904	39,7	34,6	21,2	3,8	0,6
To develop mathematical skills to creatively face the solution of problems that are not contextualized.	3,87	0,930	28,2	37,8	27,6	5,1	1,3

M: Mean, SD: Standard Deviation, SA: Strongly Agree, A: Agree; NAND: Neither agree nor Disagree, D: Disagree, SD: Strong Disagree.

Source: Prepared by the authors based on the obtained results. Purpose of teaching-learning mathematics in secondary education

In the sub-dimension purpose of teaching and learning of mathematics in secondary education, there is a high appreciation, in the beliefs that states that the purpose of this subject is to provide knowledge (M = 4.14; SD = 0.933) and enhance skills (M = 4.09; SD = 0.904) to face everyday problems.

In the statements referring to the development of skills to determine the solution to contextualized problems (M = 4.01; SD = 0.984) or routine ((M = 3.87; SD = 0.930), in both statements 37.8%, of the students agree.

Table 4. *Mathematics in the class*

			SA	A	NAND	D	SD
	M	SD	%	%	%	%	%
Frequently, mathematics has to do with reality.	3,79	1,064	30,1	33,3	26,3	6,4	3,8

M: Mean, SD: Standard Deviation, SA: Strongly Agree, A: Agree; NAND: Neither agree nor Disagree, D: Disagree, SD: Strong Disagree.

Source: Prepared by the authors based on the obtained results. Mathematics in the class

In the sub-dimension mathematics in the class, a smaller percentage (10.2%), considers that mathematics has nothing to do with reality, while over 50% of students (63.4%) agree with this statement (M = 3.79; SD = 1.064).

Table 5. *What is a mathematical problem?*

	M	SD	SA %	A %	NAND %	D %	SD %
An exercise that allows to apply a formula to a real situation.	3,87	1,014	30,8	37,8	21,8	7,1	2,6
An exercise where it is possible to apply a mathematical procedure to a real situation.	4,03	1,031	32,7	30,8	26,3	8,3	1,9
A situation that motivates to learn new concepts.	3,84	1,038	32,7	30,8	26,3	8,3	1,9
A situation that motivates to learn new procedures.	3,99	0,984	34,6	39,7	17,9	5,1	2,6
A situation that allows to develop new skills.	4,15	0,958	44,2	35,3	14,1	4,5	1,9
A situation that provides the possibility of discussion about some subject.	3,60	1,082	23,7	32,1	28,2	12,8	3,2
A situation that provides the possibility of discoveries related to some topic.	3,77	1,002	26,3	37,2	25,6	9,0	1,9

M: Mean, SD: Standard Deviation, SA: Strongly Agree, A: Agree; NAND: Neither agree nor Disagree, D: Disagree, SD: Strong Disagree.

Source: Prepared by the authors based on the obtained results. What is a mathematical problem?

According to the sub-dimension, what is a mathematical problem? There is a high acceptance regarding that a mathematical problem can solve a real situation (M = 4.03; SD = 1.031), that encourages the development of new skills (M = 4.15; SD = 0.958), that motivates the learning of new procedures (M = 3.99; SD = 0.984)

It can also be observed positive perceptions in beliefs that express that a mathematical problem motivates learning new concepts (M = 3.84; SD = 1.038) and that a mathematics exercise allows the application of a formula (M = 3.87; SD = 1.014).

A lower percentage of 32.1% and 37.2%, agree with that a mathematical problem is a possibility to discuss (M = 3.60; SD = 1.082) and to discover new knowledge (M = 3.77; SD = 1,002)

Table 6. *What characteristics do mathematical problems have?*

	M	SD	SA %	A %	NAND %	D %	SD %
They only have one correct answer.	3,76	1,287	39,1	23,1	20,5	9,0	8,3
The answer to a mathematical problem must always be known by the teacher.	3,66	1,346	36,5	23,1	22,4	5,8	12,2

M: Mean, SD: Standard Deviation, SA: Strongly Agree, A: Agree; NAND: Neither agree nor Disagree, D: Disagree, SD: Strong Disagree.

Source: Prepared by the authors based on the obtained results. What characteristics do mathematical problems have?

In the sub-dimension characteristics of the mathematical problems, it is observed that 62.2% and 59.6% of the students claim that a mathematical problem has only one correct answer (M = 3.76; SD = 1.287), which the teacher should always know (M = 3.66; SD = 1.346).

Table.7 *Usefulness of a mathematical problem*

	M	SD	SA %	A %	NAND %	D %	SD %
A technique to motivate a class.	3,25	1,173	16,0	26,9	32,1	16,0	9,0
A tool to teach mathematics.	4,33	0,886	53,8	29,5	12,8	3,2	0,6
A method to learn math.	4,39	0,847	57,7	28,2	10,3	3,2	0,6
A means to develop new skills.	4,18	0,823	39,7	42,3	14,7	2,6	0,6
A means to apply theory to practice.	3,91	0,890	28,8	39,1	26,9	4,5	0,6
A mechanism to make discoveries.	3,77	0,983	26,9	34,0	29,5	8,3	1,3

*M: Mean, **SD**: Standard Deviation, **SA**: Strongly Agree, **A**: Agree; **NAND**: Neither agree nor Disagree, **D**: Disagree, **SD**: Strong Disagree.*

Source: *Prepared by the authors based on the obtained results. Usefulness of a mathematical problem*

In the sub-dimension usefulness of a mathematical problem, a positively low value is found (M = 3.25; SD = 1.173), considering a problem as a technique to motivate a class, however in beliefs about the usefulness of a problem to teach mathematics (M = 4.33; SD = 0.886), to develop skills (M = 4.18; SD = 0.823) and to learn mathematics (M = 4.39; SD = 0.847), were positively valued.

Finally, 39.1% and 34% express to agree with the usefulness of a mathematical problem allows theory to be put into practice (M = 3.91; SD = 0.890) and to make new discoveries (M = 3.77; SD = 0.983).

Table 8. *Mathematical problems in mathematics teaching*

	M	SD	SA %	A %	NAND %	D %	SD %
To consolidate knowledge acquired.	4,19	0,820	39,7	43,6	14,1	1,3	1,3
To develop logical thinking.	4,00	0,909	34,0	38,5	21,8	5,1	0,6
To develop the theorems presented in the subject.	3,90	0,844	25,0	44,9	25,6	3,8	0,6
To contextualize different topics of mathematics with the purpose of preparing people for life.	3,87	1,033	33,3	30,8	29,5	2,6	3,8
To develop critical reasoning.	3,70	0,993	22,4	37,8	30,1	6,4	3,2
To develop creative thinking.	3,70	1,138	29,5	29,5	28,2	7,1	5,8
To develop the ability to apply concepts.	3,97	0,894	32,7	37,8	23,7	5,8	0,0

*M: Mean, **SD**: Standard Deviation, **SA**: Strongly Agree, **A**: Agree; **NAND**: Neither agree nor Disagree, **D**: Disagree, **SD**: Strong Disagree.*

Source: *Prepared by the authors based on the obtained results. Mathematical problems in mathematics teaching.*

In the sub-dimension mathematical problems in mathematics teaching, it is observed that the reagents to consolidate mathematical knowledge (M = 4.19; SD = 0.820), encourage logical thinking (M = 4.00; DT = 0.909), develop skills to apply concepts (M = 3.97; SD = 0.894) and manage to execute the theorems presented in classes (M = 3.90; SD = 0.844), obtained a high rating.

For the statements that express that mathematical problems allow to develop critical reasoning (M = 3.70; SD = 0.933), creative thinking (M = 3.70; SD = 1,138) and prepare people for life (M = 3.87; SD = 1.003) were positively valued.

STATISTICALLY SIGNIFICANT DIFFERENCES IN THE BELIEFS OF MATHEMATICS ACCORDING TO GENDER.

From the information collected, a t-student test was applied for equality of means in the dimensions: gender, origin and academic performance with the purpose of determining statistically significant differences, which are presented in the following tables.

Table 9 shows statistically significant differences with respect to their beliefs in mathematics, since female students make a positive assessment of the reagents referred to the purpose of teaching and learning mathematics allows to develop skills (M = 4.26; SD = 0.759) and enhance skills to face real-life problems (M = 4.38; SD = 0.786).

On the other hand, male students value these reagents positively, but with a lower score (M = 3.75; SD = 1.111) and (M = 3.79; SD = 0.928).

Table.9 *Comparison of means according to the sub-dimension beliefs about mathematics according to gender.*

Group statistics				T-test for equality of means			
	Gender	M	sd	t	gl	p(bi)	Direction
To develop mathematical skills to creatively face the solution of contextualized problems.	Male	3,75	1,121	3,359	154	,001	F > M
	Female	4,26	,759				
To enhance skills to intelligently face practical real-life problems	Male	3,79	,928	4,260	154	,000	F> M
	Female	4,38	,786				

*M: Mean, **SD**: Standard Deviation, **t**: Difference between the means of the two groups, **gl**: Degrees of freedom, **p(bi)**: Level of significance. Direction, **F**: Female, **M**: Male.*

Source: *Prepared by the authors based on the obtained results. Beliefs about mathematics according to the gender of the students.*

STATISTICALLY SIGNIFICANT DIFFERENCES IN THE BELIEFS ABOUT MATHEMATICS ACCORDING TO THE ORIGIN.

In Table 10 it is possible to determine statistically significant differences, since the students that come from the town of Coelemu highly value the reagents referred to know mathematics is to know procedures by heart (M = 4.01; SD = 0.938) and solve any problem related to the subject of study (M = 4.24; SD = 0.870).

On the contrary, the students from the rural sector for the previous reagents make a lower assessment (M = 3.57; SD = 1.137) and (M = 3.87; SD = 0.969).

The reagent that expresses that to understand mathematics, corresponds to know the fundamental theorems, although both groups obtain low scores, a better evaluation is observed by the students from the Town of Coelemu (M = 3.67; SD= 0.953), than those of the rural places (M = 3.32; SD = 1.045).

Table.10 *Comparison of means according to the sub-dimension beliefs about mathematics according to their origin.*

Group statistics				T-test for equality of means			
	Origin	M	SD	T	gl	p(bi)	Direction
To know the fundamental theorems of learning objectives.	Coelemu	3,67	,953	2,047	154	,042	C>R
	Rural	3,32	1,045				
To know procedures that serve to solve exercises by heart.	Coelemu	4,01	,938	2,487	154	,014	C>R
	Rural	3,57	1,137				
To solve any problem related to the subject of study.	Coelemu	4,24	,870	2,329	154	,021	C>R
	Rural	3,87	,969				

M: Mean, SD: Standard Deviation, t: Difference between the means of the two groups, gl: Degrees of freedom, p(bi): Level of significance. Direction C: Coelemu, R: Rural.

Source: Prepared by the authors based on the obtained results. Beliefs about mathematics according origin of the students.

STATISTICALLY SIGNIFICANT DIFFERENCES IN THE BELIEFS ON PROBLEM SOLVING ACCORDING TO THE PROCEDURE.

In Table 11, are observed statistically significant differences, since the students from the Town of Coelemu positively value the reagent referring to the fact that the usefulness of a mathematical problem is only a mean to apply theory to practice (M = 4.01; SD = 0.897), on the other hand, students in the rural area show a more downward valuation compared to this statement (M = 3.68; SD = 0.837).

Table.11 *Comparison of means according to the sub-dimensions on beliefs related to problem solving according to their origin.*

Group statistics				T-test for equality of means			
	Origin	Mean	DT	t	gl	p(bi)	Direction
a mean to apply theory to practice.	Coelemu	4,01	,897	2,139	154	,034	C>R
	Rural	3,68	,837				

M: Mean, SD: Standard Deviation, t: Difference between the means of the two groups, gl: Degrees of freedom, p(bi): Level of significance. Direction C: Coelemu, R: Rural.

Source: Prepared by the authors based on the obtained results regarding the origin of the students.

STATISTICALLY SIGNIFICANT DIFFERENCES IN BELIEFS ABOUT MATHEMATICS ACCORDING TO ACADEMIC PERFORMANCE.

In Table 12, it is possible to determine statistically significant differences, since students who have an academic performance above the average of the sample make a positively high assessment in the reagents referred to that knowing mathematics is knowing by heart many procedures that serve to solve exercises (M = 4.14; SD = 0.850).

On the contrary, those students who are below the average of the sample have a lower assessment with respect to the same statement (M = 3.66; SD = 1.097).

For the sub-dimension purpose of the teaching and learning of mathematics, statistically significant differences are also observed, since students with an academic performance above the average of the sample value the statements that express the purpose of the subject positively, the statement that the purpose of the subject is to develop skills (M = 4.24; SD = 0.765) and enhance skills to face real-life problems (M = 4.38; SD = 0.724), however, despite statistically significant differences, students with academic performance below the average of the sample positively value the previous reagents (M = 3.82; SD = 1.104) and (M = 3.85; SD = 0.970).

Table.12 *Comparison of means according to the sub-dimension beliefs about mathematics according to the average of the sample.*

Group statistics				T-test for equality of means			
	General academic performance	M	SD	t	gl	p(bi)	Direction
To know by heart procedures that serve to solve exercises.	Above acedemic performance	4,14	,850	3,021	154	,003	A> B
	Below academic performance	3,66	1,097				
To develop mathematical skills to creatively face the solution of contextualized problems	Above academic performance	4,24	,765	2,682	154	,008	A> B
	Below academic performance	3,82	1,104				

Group statistics				T-test for equality of means			
	General academic performance	M	SD	t	gl	p(bi)	Direction
To enhance skills to intelligently face real-life problems.	Above academic performance	4,38	,724	3,826	154	,000	S> B
	Below academic performance	3,85	,970				

M: Mean, SD: Standard Deviation, t: Difference between the means of the two groups, gl: Degrees of freedom, p(bi): Level of significance. Direction A: Above academic performance, B: Below academic performance.

Source: Prepared by the authors based on the obtained results regarding the beliefs regarding academic performance of the sample.

STATISTICALLY SIGNIFICANT DIFFERENCES IN THE BELIEFS ABOUT PROBLEM SOLVING ACCORDING TO ACADEMIC PERFORMANCE.

Table 13 shows statistically significant differences, since students with an academic performance above the average of the sample value highly reagents referred to that the usefulness of a mathematical problem is a tool to teach (M = 4.49; SD = 0.715) and a method to learn mathematics (M = 4.61; SD = 0.597).

However, in spite of the existence of statistically significant differences, students with an academic performance below the average of the sample, also value highly the previous statements (M = 4.19; SD = 0.957) and (M = 4,21; DT = 0.977).

In the case of the sub-dimension mathematical problems in the teaching of mathematics, statistically significant differences are also observed, because students whose academic performance is above the average of the sample, make a positively high assessment considering that these activities allow the development of logical thinking (M = 4.18; SD = 0.762) and prepare people for life (M = 4.06; SD = 0.876). However, despite observing statistically significant differences, students with an academic performance below the average of the sample, also make a positive assessment of these statements (M = 3.85; SD = 0.994) and (M = 3.72; SD = 1,130), but with a lower score.

Table. 13 *Comparison of means according to the sub-dimensions about beliefs related to solving mathematical problems according to the sample average.*

Group statistics			T-test for equality of means			
General academic performance	M	SD	t	gl	p(bi)	Direction
A tool to teach mathematics.						
Above acedemic performance	4,49	,715	2,215	154	,028	S> B
Below academic performance	4,19	,957				

	Group statistics			T-test for equality of means			
	General academic performance	**M**	**SD**	**t**	**gl**	**p(bi)**	**Direction**
A method to learn math.	Above acedemic performance	4,61	,597	2,965	154	,004	S> B
	Below academic performance	4,21	,977				
To develop logical thinking.	Above acedemic performance	4,18	,762	2,333	154	,021	S> B
	Below academic performance	3,85	,994				
To contextualize different topics of mathematics with the purpose of preparing people for life	Above acedemic performance	4,06	,876	2,060	154	,041	S> B
	Below academic performance	3,72	1,130				

M: Mean, SD: Standard Deviation, t: Difference between the means of the two groups, gl: Degrees of freedom, p(bi): Level of significance. Direction A: Above academic performance, B: Below academic performance.

Source: *Prepared by the authors based on the obtained results regarding the beliefs regarding academic performance of the sample.*

DISCUSSIONS

INTERPRETATION OF RESULTS FROM BELIEFS IN MATHEMATICS

From the data obtained, it is possible to determine that students conceive this subject as a useful tool to solve everyday problems, an objective that has been exposed by the Ministry of Education MINEDUC (2015) in the new curricular bases for secondary education, this due to students point out that mathematics is related to everyday topics, that is, students can identify relationships, properties, data and unknowns that are linked to their life (Salinas and Sgreccia, 2016).

The results in the t-tests indicate statistically significant differences, regarding the gender of the students, about their beliefs in mathematics, since female students express that this subject allows to develop skills and enhance skills to face problems. Therefore, it is possible to complement the conclusions of Radovic (2018) who, in his research carried out in Santiago-Chile, establishes that women with a low socioeconomic level, such as the sample of this research, exhibit unfavorable attitudes compared to men in the subject of mathematics, which is a relevant antecedent to determine how the context influences the development of beliefs.

In respect of the origin, it is possible to establish that the students from the town of Coelemu, express beliefs in the subject of mathematics associated with the ones indicated by Erazo and Aldana (2015, p.163), that is to say "perceive mathematics as a subject useful given its importance, but mechanical, which is learned through repetition".

In the group of rural origin, it is possible to verify what was pointed out by Pérez and Beltrán (2011, p.75), who establish that "mathematical beliefs allow us to understand the performance and effort that an individual will make", which is evidenced in the low

scores and assessments provided by students in the rural area, together with the low academic performance presented by students in this group, which as a whole is below the sample average $((x)^- = 5.4)$.

INTERPRETATION OF RESULTS FROM THE BELIEFS ASSOCIATED WITH SOLVING MATHEMATICAL PROBLEMS

Regarding the beliefs that second-year students have about solving mathematical problems, it is possible to determine that a belief predominates, in which this type of activity is pointed out as a method to learn mathematics that allows new skills to be developed.

The previous results express the purpose and usefulness that students give to solve mathematical problems during their learning, therefore, it is possible to verify that beliefs about mathematics affect the way students understand problem solving. Barrantes (2008).

The information analyzed in the t tests indicates that there are no statistically significant differences in beliefs about the resolution of mathematical problems according to gender, however, in the origin and academic performance of the sample, statistically significant differences are observed, regarding their beliefs in problem solving.

Based on the answers provided, it is observed that the students of the town of Coelemu and those who find themselves with an academic performance above the average of the sample, express beliefs associated with the usefulness and application of the resolution of mathematical problems to solve everyday situations, which, according to Barrantes (2006, p.4) as well as Sepulveda, Medina and Jauregui (2009), these learning experiences "affect the way a student behaves when facing a mathematical problem", that is, this group of students presents a better willingness to work on problem solving.

In the same way it is observed that the students of the rural area and that are below the average of the sample obtained a lower score in the beliefs about problem solving, which for Martinez (2013) is due to the unfavorable attitudes developed towards the learning of this subject, since they do not see the usefulness of applying the contents that are taught, which in the course of time according to Hidalgo, Maroto and Palacios (2004) generates a "downward trend in the liking and interest in mathematics as they advance in educational levels."

CONCLUSIONS

From the objectives proposed at the beginning of this investigation, it is possible to conclude that:

1. With respect to the objective that determined the beliefs about mathematics and problem solving that secondary students of the Domingo Ortiz de Rozas High School had, it is possible to determine that there are beliefs in accordance with those proposed by the Ministry of Education (MINEDUC) in the new curricular bases, which are developed due to the experiences that foster the usefulness of mathematics to acquire new knowledge and thus favor problem solving.

2. Regarding the objective that categorized the beliefs in mathematics and problem solving in the teaching and learning process, it is possible to recognize that the second year of secondary students in the sub-dimension referred to What is knowing math? They establish that such belief corresponds to solving any problem related to the topic being studied. With respect to the sub-dimension associated with the purpose of the teaching and learning of mathematics, the belief that mathematics provides the knowledge to face intelligently practical real-life problems predominates. In the case of the sub-dimensions on problem solving, specifically in the one referred to What is a mathematical problem? here the belief that allows to develop new skills and a method to learn mathematics predominates. For the characteristics of a mathematical problem there is a belief, in which this type of activity has only one correct answer, which the teacher must always know. Finally, in the last sub-dimension it is possible to determine that students point out that the role of a mathematical problem in the teaching process is to develop the theorems presented in class.

3. In relation to the objective that corresponds to establish statistically significant differences, according to the gender of the students, it is possible to determine that there are statistically significant differences, regarding their beliefs in the subject of mathematics, when considering its purpose in the process of teaching and learning in secondary education and in the case of beliefs about problem solving, no statistically significant differences were observed.

4. Regarding the objective referred to establish statistically significant differences, according to the origin of the second year students, it is possible to determine that there are statistically significant differences, with respect to their beliefs in the subject of mathematics and problem solving , since, according to the information collected in this research, students belonging to the town of Coelemu manage to see the usefulness of the contents taught in classes, a situation that does not occur with students in the rural area, which explains the lack of disposition of this group to work in activities of this subject, as well as the low learning results evidenced by the internal evaluations applied by the establishment to these students.

5. In relation to the objective associated with establishing statistically significant differences according to the academic performance of the sample, it is possible to determine statistically significant differences, regarding their beliefs in the subject of mathematics and problem solving, since those with an academic performance above the average of the sample, see the utility of the subject of mathematics and resolution of problem to develop skills necessary to face problematic situations, however those that are below the average of the sample do not show greater interest in this type of affirmations ,

such results are the reflection of the experiences of each of the individuals that conform the analyzed groups, since they do not make sense of the contents addressed in classes, which explains the learning experiences they have.

CONTRIBUTIONS OF THE AUTHORS

Each of the authors contributed to the tabulation, analysis, interpretation and conclusion of the data analyzed in each of the tables presented.

DATA AVAILABILITY

Through the following document I inform you that the investigation documents are in the following link for availability:

h t t p s : / / w w w . d r o p b o x . c o m / l / s c l / A A D 8 k J a U J s P R R O Q - qUcKBNXh7NzkmYkOEm0

It is relevant to note that to open this file you must use the SPSS program.

THANKS

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