Journal on Mathematics Education
Volume 13, No. 3, 2022, pp. 465-478

Types of beliefs of secondary school students in southern Chile

Verónica Díaz[1], Luisa Castro[2], Pamela del Río[3]

[1]Universidad de Los Lagos, Osorno, Chile
[2]Liceo Bicentenario Carmela Carvajal de Prat, Osorno, Chile
[3]Liceo Bicentenario Industrial Ingeniero Ricardo Fenner Ruedi, La Unión, Chile
*Correspondence: mvdiaz@ulagos.cl

Received: 31 March 2022 | Revised: 20 November 2022 | Accepted: 22 November 2022 | Published Online: 29 November 2022
© The Author(s) 2022

Abstract

Research in mathematics education has shown that individuals' beliefs play a fundamental role in their responses to and interest in mathematics and their application of these beliefs in real-life situations. Although the literature related to the affective domain in general, and beliefs, has explored the relationship between beliefs and student educational level, there still needs to be a research gap regarding the empirical testing of this variable in the context of secondary mathematics education in Chile. Therefore, the present study, with a quantitative and exploratory methodology, aims to fill this gap by adapting the Mathematics-Related Beliefs Questionnaire MRBQ to describe and analyze students' beliefs in mathematics at two levels of secondary education. The main results of the study indicate that mostly positive beliefs are observed in the three types of beliefs studied: Beliefs about the social context, about self-concept, and mathematics education, highlighting the dimension of beliefs about the social context or classroom environment, in which students showed a highly positive perception of the role of the mathematics teacher.

Keywords: Assessment, Beliefs, Mathematics, Secondary Education

How to Cite: Díaz, V., Castro, L., & del Río, P. (2022). Types of beliefs of secondary school students in southern Chile. *Journal on Mathematics Education, 13*(3), 465-478. https://doi.org/10.22342/jme.v13i3.pp465-478

Nowadays, mathematics curricula incorporate affective components in an integrated way with the knowledge and skills of the discipline. In the case of Chile, the construction of the new curriculum for secondary education, according to the Chilean Ministry of Education (Mineduc, 2019), includes the previous experiences that the school system has been incorporating, adapts to new disciplinary knowledge, the innovations that are constantly occurring in pedagogical matters and the demands on the education system.

The importance of including the affective domain is supported by research that assures that the performance of teachers and students depends not only on their level of knowledge, but also on their beliefs, attitudes and perceptions regarding learning and the role they both play in the learning process (Attard et al., 2016; Rojo et al., 2018; Hannelotte et al., 2017; Grootenboer & Marshman, 2016). Thus, positive or negative beliefs about their ability to teach, in the case of the teacher, affect them as an educator, and beliefs about learning, in the case of the student, affect their future and affect their performance (Xie & Cai, 2020; Hidalgo et al., 2014, 2015; Wong et al., 2016; Hoffman, 2010; Erazo-Hurtado & Aldana-Bermúdez, 2015; Gamboa & Moreira, 2017; Staub & Stern, 2002; Liljedahl et al., 2012). There has also been considerable research associated exclusively with teachers' belief systems, since it is they who create the learning opportunities and crucially influence the achievement of students'

educational goals (Vásquez et al., 2020; Videla et al., 2019; Turşucu et al., 2018; Paternina & Quessep, 2017, Baumert & Kunter, 2013; Vesga-Bravo & De Losada, 2018).

While we would like both mathematics teachers and their students to have positive beliefs about mathematics and the teaching and learning of the discipline, many shared beliefs do not seem to be the case. The literature has indicated that students believe that mathematics is meaningless and is not understood by many of them (Castro-Velásquez & Rivadeneira-Loor, 2022); knowing math is being able to solve problems (Montero et al., 2015); that any mathematical problem should be solved in five minutes or less, or school math has nothing to do with the real world (Schoenfeld, 2016); and knowing mathematics means following the rules proposed by the teacher (Alastre & Borjas, 2017). In terms of beliefs about the role of teachers and the way they teach, there are two very different views. For many students, the mathematics teacher is a provider of knowledge, from whom they must learn everything they are taught, while the second view sees the teacher as a conduit who facilitates students' learning by giving meaning to what they are learning (Rojo et al., 2020). In the context of trainee teachers, Segarra and Julià (2022) found that undergraduate students in primary education have low levels of efficacy beliefs in mathematics teaching.

Based on research on beliefs in mathematics, there is no doubt that they constitute an important element of knowledge of the affective domain. However, there are large differences between the approaches working on the topic. Mostly because of cultural differences and because of the focus, which to a lesser extent is on students and, moreover, on secondary education.

The present research was based on the proposition that beliefs are the implicit or explicit conceptions that students hold as true that influence their learning of mathematics and problem solving (Op't Eynde et al., 2002). With this work we intend to contribute by carrying out a study on types of beliefs in mathematics in four groups of Chilean students.

In this context, the questions that guided our research were the following: what similarities and differences exist in the types of beliefs towards mathematics among secondary school students? do beliefs change according to the level of study? what are Chilean students' beliefs about the role of the mathematics teacher? What are their beliefs about their personal competence as learners and about the relevance of mathematics education? and what are their beliefs about their personal competence as learners and about the relevance of mathematics education? Based on these questions, the following objectives were established.

The general aim of the study is to describe and analyze types of mathematical beliefs of first- and third-year secondary school students in a region of southern Chile. While the specific objectives are:

1. Analyze students' beliefs about the social context or classroom environment.
2. Analyze students' beliefs about self-concept
3. Analyze students' beliefs about mathematics education

The importance and emphasis on the topic of beliefs in mathematics is not only assumed and accepted by instructional curriculum developers, but extends across the spectrum of international assessments, such as the PISA assessment. It provides important information for participating countries on education outcomes related to mathematical competence and survey information on beliefs that predispose students to use their mathematical competence (OECD, 2018).

Belief System in Mathematics

The theoretical framework for this research is based on the authors of De Corte et al. (2002), who present a framework of belief systems in mathematics, which are constituted by beliefs about the context, beliefs

about themselves and beliefs about mathematics education, as shown in Figure 1.

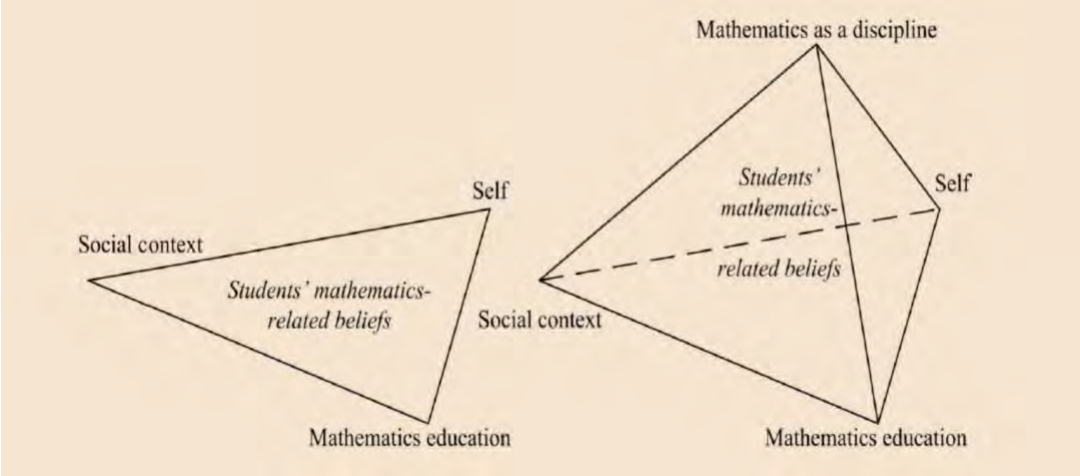

Figure 1. Representation of the structure of belief systems (De Corte et al., 2002)

In Figure 1 and to the left are the dimensions, illustrated by a triangle with the corners: mathematics education, social context (the classroom) and the self (De Corte et al., 2002, p 27). In Figure 1 on the right: an expansion of the triangle on the left side to a tetrahedron, the dimension above the triangle illustrates mathematics as a discipline.

METHODS

The research is descriptive, with quantitative and exploratory methodology (Hernández et al., 2014), applied at the end of the second semester of 2019, to a non-probabilistic sample, by convenience (Patton, 2002), made up of 92 secondary school students in a region of southern Chile.

The sample examined 39 girls and 53 boys, from the same public school. As for the distribution of students by academic years, 58.7% of them were in the first level of secondary education (13 years old) and 41.3% were in the third level (15 years old).

Data Collection Instrument

To describe and analyse students' beliefs in mathematics, an adaptation of the Mathematics-Related Beliefs Questionnaire (MRBQ), developed at the University of Leuven (Op't Eynde & De Corte, 2003) was developed in order to apply it to the Chilean educational context. This assessment instrument considered three types of beliefs according to Op't Eynde et al. (2002): beliefs about the social context, beliefs about oneself and beliefs about mathematics education. The original instrument consisted of 40 items. To complement and improve the original scale, four more items were added.

Validity and Reliability

All items were submitted to a content validation by eight experts in the field (Hyrkäs et al., 2003), considering an 85% congruence between their answers, to accept as valid, the proposition on belief, and after its pilot application, the scale consisted of 44 items. The construct validity was also verified by factor analysis, the homogeneity of the sample by means of the non-parametric Mann Whitney U test. The internal consistency of the instrument was checked using Cronbach's alpha coefficient, which was 0.92 and it is considered high according to the authors Carvajal et al (2011) whose acceptable margin for

reliability coefficients is between 0.7 and 0.9. A detailed analysis of the items was carried out, including the difficulty and discrimination of each item. The average difficulty was 0.44 and the average discrimination 0.48.

Data were collected through the application of the mathematics beliefs questionnaire in four secondary school classes, in a single session and for 120 minutes. Tables 1, 2 and 3 below show the types of beliefs about the classroom environment or social context (16 items), self or self-concept (16 items) and discipline or mathematics education (12 items) that made up the questionnaire, which were measured with a Likert scale of five response instances: (5) strongly agree, (4) agree, (3) indifferent, (2) disagree, and (1) strongly disagree, which were grouped into positive (strongly agree and agree), neutral, and negative (disagree and strongly disagree) terms.

Table 1. Beliefs about the Social Context or Classroom Environment

	Question
Q1	Our teacher thinks that mistakes are OK and good for learning.
Q2	Our teacher pays attention to how we feel in mathematics lessons.
Q3	Our teacher explains why mathematics is important.
Q4	Our teacher first shows step by step how we should solve a specific problem, and before that he gives us similar exercises.
Q5	Our teacher wants us to feel at ease when we learn new things.
Q6	Our teacher understands the problems and difficulties we experience.
Q7	Our teacher listens attentively when we ask questions or say something.
Q8	We do a lot of group work in class.
Q9	Our teacher gives us time to really explore new problems and try to get strategies for solving them.
Q10	Our teacher is happy when we try hard, even if our results are not good.
Q11	Our teacher is very nice to us.
Q12	Our teacher tries to make math's lessons interesting.
Q13	Our teacher thinks he is the best at knowing all things.
Q14	Our teacher wants us to understand the content of the math's course, not memories it.
Q15	I am not allowed to ask my classmates to help me with my homework.
Q16	Our teacher does not care about our feelings in class, because he/she is totally absorbed in the content of the mathematics course.

This type of belief about the classroom context or environment refers to the students' perception of the role of the mathematics teacher. It refers to the way in which they perceive the degree of motivation of the teacher in the class, the way in which the teacher-student interaction takes place, and even the way in which the mathematics class is taught. The Cronbach's alpha coefficient of this type of belief was 0.85, which is considered highly favourable, but lower than the original coefficient of the study ($\alpha = 0.92$).

Table 2. Beliefs about Self-Concept

	Question
Q17	I am only satisfied when I achieve good grades in mathematics.
Q18	I think I will be able to use what I have learned in mathematics and in other courses.
Q19	I think I will get an excellent grade in mathematics this year.
Q20	To be the best and to control mathematics, I want to show the teacher that I am better than many other students.
Q21	I like to do mathematics.
Q22	I hope to achieve a good result in math's papers and exams.
Q23	I want to do well in mathematics and show the teacher that my classmates are as good as me.
Q24	I can understand the mathematics course material.

Q25	Mathematics is an important subject for me.
Q26	I prefer mathematical tasks; I try hard to find a solution.
Q27	I can understand even the most difficult things we are given in mathematics class.
Q28	My main concern when I learn math is to get good grades.
Q29	If I work hard, then I can understand all the material in the mathematics course.
Q30	When I have a chance, I choose the mathematics tasks that I can learn, even though I am not sure I will get a good grade.
Q31	I am very interested in mathematics.
Q32	Considering the level of difficulty of our mathematics course, the teacher, my skills, and my knowledge, I am confident that I will achieve a good result in mathematics.

This type of self-belief considers the self-concept as a mathematics learner, i.e., their self. In particular, it includes the perception they have of their ability in mathematics and self-efficacy as a learner, and how these influence the learning process. In a general way, it refers to the student's personal competence. The reliability coefficient on this type of belief was highly favourable ($\alpha = 0.89$) and was identical to the original study.

Table 3. Beliefs about Mathematics Education

	Question
Q33	Making mistakes is an important part of learning mathematics.
Q34	Working in a group makes it easier to learn mathematics.
Q35	Mathematical learning is mainly memorization.
Q36	It is a waste of time when the teacher makes us think alone about how a new problem would be solved.
Q37	Anyone can learn mathematics.
Q38	In mathematical problems there are different ways to arrive at a correct solution.
Q39	Mathematics enables you to better understand the world you live in.
Q40	Solving a problem requires a lot of thinking and being a smart learner.
Q41	Mathematics is ever-expanding. Much remains to be discovered.
Q42	There is only one way to think of the correct solution to a mathematical problem.
Q43	Many people use mathematics in their daily lives.
Q44	Those who are good at mathematics can solve many problems in a few minutes.

This type of belief about mathematics education refers to the relevance of mathematics, specifically to beliefs about the nature of mathematics itself, to the process of teaching and learning the discipline. It encompasses the characteristics of students and teachers, teaching methodologies, learning and problem solving, and the social dynamics in the classroom. The alpha coefficient of this factor ($\alpha = 0.84$) was highly favourable and higher than the original study ($\alpha = 0.65$).

RESULTS AND DISCUSSION

The research data were analyzed in terms of mean scores and standard deviation of belief types in order to reveal students' views on the relationship between beliefs and mathematics. They were subsequently subjected to a variety of comparative analyses, using, among others, t-tests. It should be noted that the scale used is a five-point scale, where 5 is positive, 3 corresponds to neutrality and 1 is negative.

Table 4. Mean and Standard Deviation per Grade Associated with each Belief Type

Type of Belief	Social Context		Self-Concept		Mathematics Education	
Course	first	thirds	first	thirds	first	thirds
M	4,15	4,36	3,82	3,49	3,76	3,70
SD	0,87	0,85	0,53	0,47	0,78	0,70

With respect to grade, Table 4 shows that third-year students are significantly more positive than first-year students, on the social context or classroom environment and more neutral on the remaining two types of beliefs ($p < 0.0005$).

Figure 2 shows the percentage distribution of the total results for both grades and for the three types of beliefs considered in the research: beliefs about the social context, beliefs about self-concept and beliefs about mathematics education.

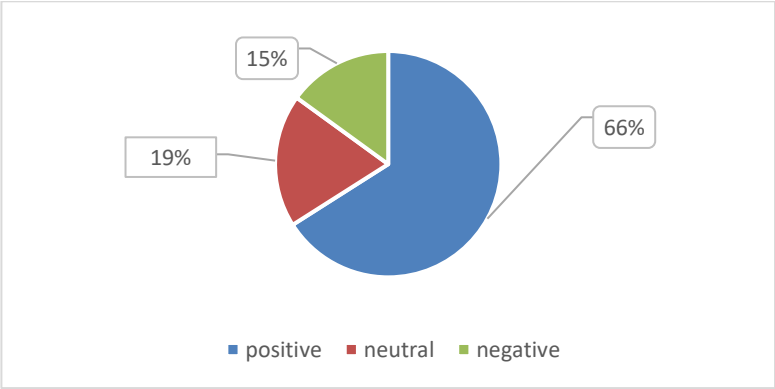

Figure 2. Results on Dimensions of Beliefs and Mathematics

In general, according to the results, a favourable range of 66% of all students' positive beliefs is evident. However, the remaining 34% were neutral, considered indifferent, and disagreed and strongly disagreed, considered as negative beliefs.

Beliefs about the Social Context

Figure 3 presents, from the mean scores, the result obtained by the first- and third-year students regarding the belief about the context or social environment of the mathematics class.

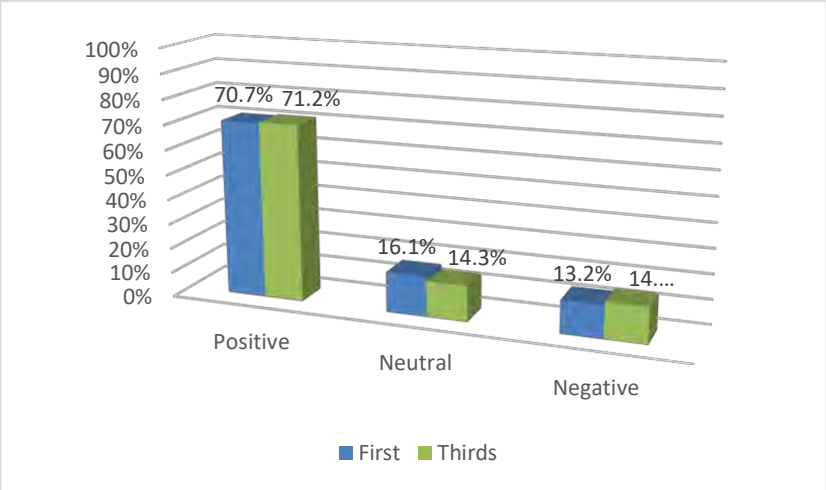

Figure 3. Percentage Distribution of Beliefs about the Social Context

The results show a high level of positivity regarding the statements about the social context or

environment of the mathematics class, with an average of 70.95 % agreeing or strongly agreeing, subtly surpassed by the third-year classes.

Beliefs about Self-Concept

The results concerning beliefs about self-concept or self-concept as a student of mathematics are presented in Figure 4.

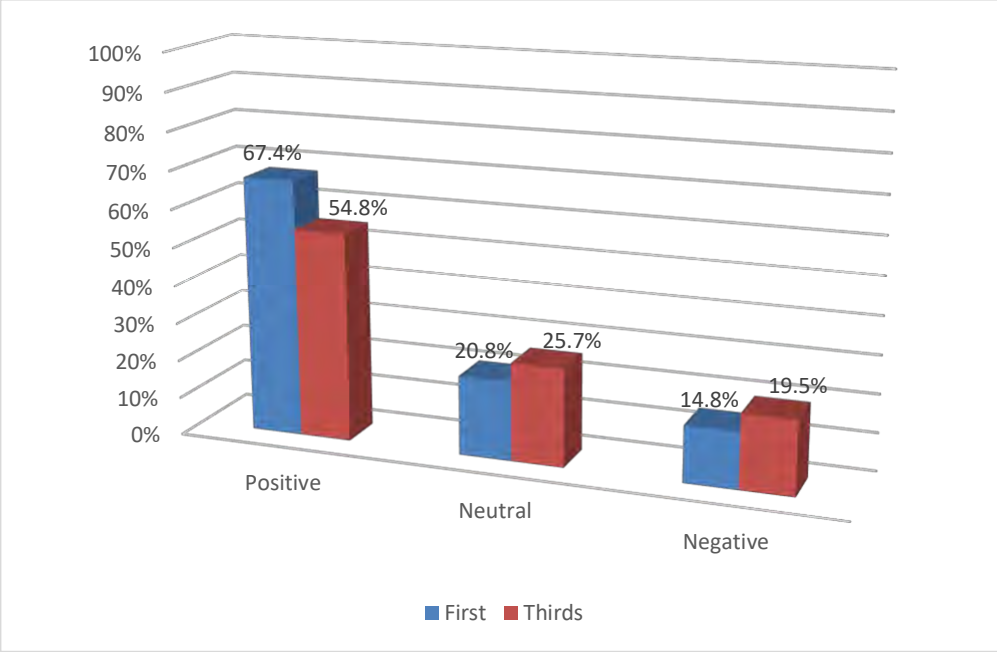

Figure 4. Percentage Distribution of Beliefs about Self-Concept

The results for the first and third grades show an average of 61.1% positive responses. It is worth noting that the mean number of indifferent responses, considered as neutral, was 23.25%, exceeding the mean number of negative responses (17.15%). The grade with the highest mean for this belief associated with the self-concept as a student of mathematics is verified in the first years.

Beliefs about Mathematics Education

Below is the average score (Figure 5) obtained by all students regarding the belief about mathematics education in which they are trained.

The first and third grades show a positivity associated with the statements of agreement and strongly agree, which on average reach 63.7% with respect to beliefs about mathematics education. The average indifferent response, considered as neutral, was higher than the negative one comprising the options of disagree and strongly disagree, with 19.55% and 16.7% respectively. According to the results, the first grade has the highest mean for beliefs about mathematics education as a discipline (3.76), but with a very slight difference compared to the third grade (3.70) (See Table 4).

Given the differences in academic level between the study groups considered, the similarities in the patterns of results are striking. And although small differences were evident, all students demonstrated high positivity in all three dimensions assessed, with belief in the social context standing out. The high positivity in all dimensions coincides with the study on the beliefs of 3rd grade children in Chile, in the framework of the Chile-Finland bilateral project (Tuohilampi et al., 2014) with a small difference in favour of Finland, in terms of self-concept beliefs.

Mathematics is often perceived as difficult and many students drop out of science, technology,

engineering, and mathematics disciplines as a result, closing doors to science, engineering, and technology careers (Li & Schoenfeld, 2019). However, according to our results on the belief about mathematics education, a good number of positive ratings were achieved in both study groups on this dimension. This result is in line with that of Zakaria and Musiran (2010), whose reports indicate that the beliefs of mathematics teacher trainees are positive about the nature of mathematics. We would have expected the same for self-concept belief. Despite finding that the mathematical self-concept was positive for students in general, the belief about personal mathematical competence of the third-year students was comparatively lower than the first-year students, however, there are significant differences in favour of our two study groups with respect to the research of Diego-Mantecón et al. (2008). The authors, improving on a similar questionnaire analysed according to nationality, age, and gender, concluded that in beliefs about personal competence, Spanish students are clearly positive, while English students tend to be neutral and almost negative.

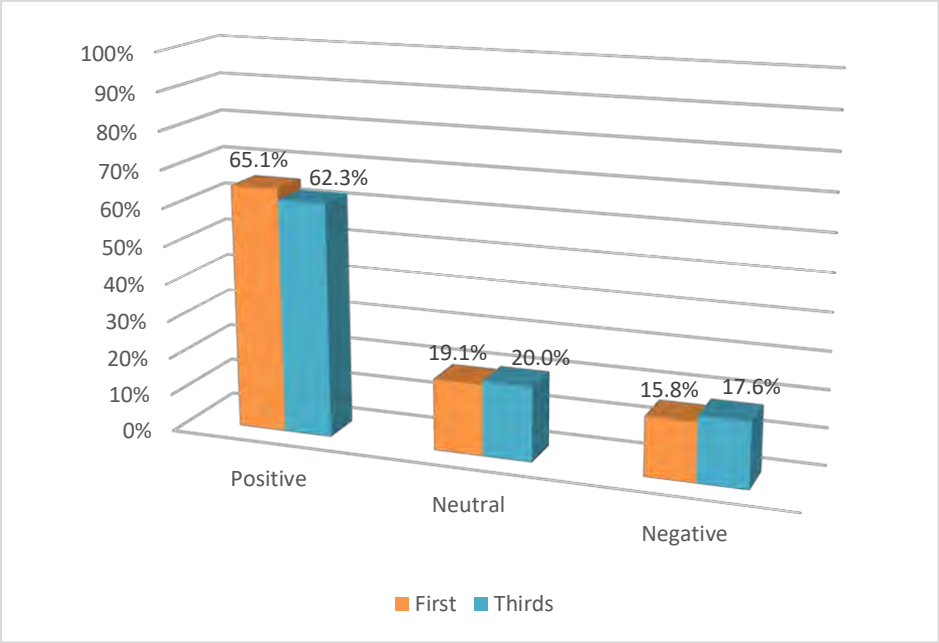

Figure 5. Distribution in Percentage of Beliefs about Mathematics Education

However, this pattern of results is inconsistent with the explanatory model used by Nagy et al. (2010) in a study with students at six educational levels from 7th to 12th grade in Sydney, Michigan and four states in Germany. According to the authors, convergent or divergent gender differences do not predict differences in mathematical self-concept. Furthermore, their results indicate that self-concept development may be very similar in Western cultural settings.

There are several factors that affect the development of self-concept positively or negatively from childhood onwards. Determining these factors and eliminating those that have negative effects would support the development of positive self-concept (Erdogan & Sengul, 2014).

Many different factors are also considered to affect students' mathematical self-concept (such as mathematical achievement, mathematical attitude, motivation, parents' educational level, family socio-economic status, the quantity and quality of instruction, the classroom environment). Studies in this area also support the existence of a relationship between mathematical self-concept and academic performance in mathematics (Guay et al., 2003; Marsh et al., 2005). In this sense, it would be useful to repeat the study to understand the effects of other factors.

CONCLUSION

The purpose of this research was to describe and analyze the types of beliefs of students from two different levels of secondary school in public education. An adaptation of the Mathematics-Related Beliefs Questionnaire MRBQ (Mathematics-Related Beliefs Questionnaire MRBQ) was developed in order to apply it to the Chilean educational context. In terms of the belief assessment instrument, this research considered beliefs about the social context, beliefs about the self and beliefs about mathematics education. It should be noted that this is the first article that describes and analyses types of mathematical beliefs of first and third year secondary school students in a region of southern Chile.

According to results, in general, mostly positive beliefs are observed in the three types of beliefs studied in first year and third-year secondary school students. Third-year secondary school students are significantly less positive than first-year secondary school students in the dimension of self-concept as a mathematics learner, i.e., they believe less in their personal competence.

As far as the mathematics education dimension is concerned, there is not much difference between the two groups of students, which indicates that they believe almost similarly in the relevance and significance of mathematics. Both groups of students are highly positive on the dimension of the social context or classroom environment. They recognize the teacher's contribution, i.e., they believe that the mathematics teacher fulfils his/her role.

The novelty of our research lies, first, in having filled a research gap in secondary education, achieving an empirical verification of the three types of beliefs recognized by the specialized literature in the affective domain: second, in knowing the beliefs of students at different levels of study, regarding their self-concept, the social context and mathematics education, with an adaptation of the original evaluation instrument. Finally, the authors Op't Eynde and De Corte (2003) described the MRBQ as a comprehensive instrument to assess the belief system in mathematics. In this work, it was adapted to the Chilean educational reality, with significant differences in its results that allow us to infer that the adapted questionnaire is sensitive to the educational and cultural context.

Declarations

Author Contribution : VD: Conceptualization, methodology, writing the original draft, drafting-revising and editing, supervision.
LC: Conceptualization, data collection, formal analysis, validation.
PDR: Conceptualization, data collection, formal analysis, validation.

Funding Statement : This research received no external funding.

Conflict of Interest : The authors declare no conflict of interest.

Additional Information : Additional information is available for this paper.

REFERENCES

Alastre, V., & Borjas, H. (2017). Creencias de los estudiantes sobre el aprendizaje de la matemática. *ARJÉ. Revista de Postgrado FaCE-UC*, *11*(20), 325-332. http://www.arje.bc.uc.edu.ve/arj20/art31.pdf

Attard, C., Ingram, N., Forgasz, H., Leder, G., & Grootenboer, P. (2016). Mathematics education and the affective domain. In K. Makar, S. Dole, J. Visnovska, M. Goos, A. Bennison and K. Fry (Eds.). *Research in Mathematics Education in Australasia: 2012-2015* (pp. 73-96). https://doi.org/10.1007/978-981-10-1419-2_5

Baumert, J., & Kunter, M. (2013). The COACTIV model of teachers' professional competence. In M. Kunter, J. Baumert, U. Klusmann, W. Blum, S. Krauss and M. Neubrand (Eds). *Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers: Results from the COACTIV* (pp.25-48). Boston, MA: Springer. https://doi.org/10.1007/978-1-4614-5149-5_2

Carvajal, A., Centeno, C., Watson, R., & Bruera, E. (2011). A comprehensive study of psychometric properties of the Edmonton Symptom Assessment System (ESAS) in Spanish advanced cancer patients. *European Journal of Cancer*, *47*(12), 1863-1872. https://doi.org/10.1016/j.ejca.2011.03.027

Castro-Velásquez, M. & Rivadeneira-Loor, F. (2022). Posibles causas del bajo rendimiento en las matemáticas: una revisión a la literatura. *Polo del Conocimiento*, *7*(2), 1089-1098.DOI: https://doi.org/10.23857/pc.v7i1.3635

De Corte, E., Op't Eynde, P., & Verschaffel, L. (2002). Knowing what to believe: The relevance of students' mathematics beliefs for mathematics education. In B.K. Hofer and P.R. Pintrich (Eds.). *Personal Epistemology: The Psychology of Beliefs about Knowledge and Knowing* (pp. 297-320). Mahwah, NJ. Lawrence Erlbaum Associates. https://psycnet.apa.org/record/2001-18187-014

Diego-Mantecón, J., Andrews, P., & Op't Eynde, P. (2008). Mejora y evaluación de un cuestionario de creencias de matemáticas en función de nacionalidad, edad y sexo. *Investigación en Educación Matemática*, *1*(1), 325-334. http://funes.uniandes.edu.co/1265/1/Diego2008Mejora_SEIEM_325.pdf

Erazo-Hurtado, J. D., & Aldana-Bermúdez, E. (2015). Sistema de creencias sobre las matemáticas en los estudiantes de educación básica. *Praxis*, 11, 163-169. https://doi.org/10.21676/23897856.1562

Erdogan, F., & Sengul, S. (2014). A study on the elementary school students' mathematics self- concept. *Procedia - Social and Behavioral Sciences*, *152*(7), 596-601. https://doi.org/10.1016/j.sbspro.2014.09.249

Gamboa, R., & Moreira, T. (2017). Actitudes y creencias hacia las matemáticas: un estudio comparativo entre estudiantes y profesores. *Actualidades Investigativas en Educación*, *17*(1), 514-559. http://dx.doi.org/10.15517/aie.v17i1.27473

Grootenboer, P. J., & Marshman, M. (2016). *Mathematics Affect and Learning: Middle School Students' Beliefs and Attitudes about Mathematics Education*. 1st ed. Springer.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Akademic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology*, *95*(1), 124-136. http://dx.doi.org/10.1037//0022-0663.95.1.124

Hannelotte, L. T., Sylke, W. M., & Johannes, E. H. (2017). The relation between mathematics self-concept, test and mathematics anxiety, achievement motivation and mathematics achievement in 12 to 14-year-old typically developing adolescents. *Psychology, Society, & Education*, *9*(1), 89-103. https://doi.org/10.25115/psye.v9i1.465

Hernández, R, Fernández, C. & Baptista, P. (2014). *Metodología de la Investigación* (6.a Edición). México DF: Mc Graw Hill. https://www.uca.ac.cr/wp-content/uploads/2017/10/Investigacion.pdf

Hidalgo, S., Maroto, A., Ortega, T., & Palacios, A. (2014). Influencia del dominio afectivo en el aprendizaje de las matemáticas. En V. Mellado, L. Blanco, A. Borrachero y J. Cárdenas (Eds.). *Las emociones en la enseñanza y el aprendizaje de las ciencias y las matemáticas* (pp. 218-238). Extremadura: Grupo de Investigación DEPROFE. https://dialnet.unirioja.es/servlet/libro?codigo=533150

Hidalgo, A., Maroto, A., & Palacios, A., (2015). Una aproximación al sistema de creencias matemáticas en futuros maestros. *Educacion Matemática*, *27*(1), 65-90. https://www.redalyc.org/pdf/405/40540690004.pdf

Hyrkäs, K., Appelqvist-Schmidlechner, K., & Oksa, L. (2003). Validating an instrument for clinical supervision using an expert panel. *International Journal of Nursing Studies*, *40*(6), 619-625. http://dx.doi.org/10.1016/s0020-7489(03)00036-1

Hoffman, B. (2010). I think I can, but I'm afraid to try: The role of self-efficacy beliefs and mathematics anxiety in mathematics problem-solving efficiency. *Learning and Individual Differences*, *3*(20), 276-283. http://dx.doi.org/10.1016/j.lindif.2010.02.001

Li, Y., & Schoenfeld, A.H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education*, *6*(1), 44. https://doi.org/10.1186/s40594-019-0197-9

Liljedahl, P., Oesterle, S., & Bernèche, C. (2012). Stability of beliefs in mathematics education: A critical analysis. *Nordic Studies in Mathematics Education*, *17*(3-4), 101-118. https://www.researchgate.net/publication/294263765_Stability_of_Beliefs_in_Mathematics_Education_A_Critical_Analysis

Marsh, H.W., Trautwein, U., Ludtke, O., Koller, O., & Baumert, J. (2005). Academic self-concept, interest, grades and standardized test scores: Reciprocal effects models of causal ordering. *Child Development*, *76*, 397-416. https://doi.org/10.1111/j.1467-8624.2005.00853.x

Mineduc (2019). *Bases Curriculares 3° y 4° Medio*. (1ª edición). Santiago de Chile: Ministerio de Educación. https://hdl.handle.net/20.500.12365/14364

Montero, Y., Pedroza, M., Astiz, M., & Vilanova, S. (2015). Caracterización de las actitudes de estudiantes universitarios de Matemática hacia los métodos numéricos. *Revista Electronica de Investigacion Educativa*, *17*(1), 88–99. https://www.scielo.org.mx/pdf/redie/v17n1/v17n1a6.pdf

Nagy, G., Watt, H., Eccles, J., & Trautwein, U. (2010). The development of students' mathematics self-concept in relation to gender: Different countries, different trajectories? *Journal of Research on Adolescence*, *20*(2), 482-506. https://doi.org/10.1111/j.1532-7795.2010.00644.x

OECD (2018). *PISA 2021 Mathematics Framework* (Second Draft). OECD:Paris. https://www.oecd.org/pisa/pisaproducts/pisa-2021-mathematics-framework-draft.pdf

Op't Eynde, P., & De Corte, E. (2003). Students' mathematics-related belief systems: design and analysis of a questionnaire. *Proceedings of the Annual Meeting of the American Educational Research Association*. Chicago. https://files.eric.ed.gov/fulltext/ED475708.pdf

Op't Eynde, P., De Corte, E., & Verschaffel, L. (2002). Framing students' mathematics-related beliefs: a quest for conceptual clarity and a comprehensive categorization. In G. Leder, E. Pehkonen and G. Törner (Eds.). *Beliefs: A Hidden Variable in Mathematics Education*? (pp. 13-37). Dordrecht: Kluwer Academic Publishers.

Paternina, A., & Quessep, D. (2017). Creencias y concepciones: una mirada a la evaluación matemática en la educación superior. *Boletín Redipe*, *6*(4), 150-159. file:///C:/DESCARGAS/Dialnet-CreenciasYConcepciones-6119353%20(1).pdf

Patton, M. (2002). *Qualitative Evaluation and Research Methods* (3rd ed.). CA Sage Publication. Retrieved from:https://www.academia.edu/28766598/Qualitative_evaluation_and_research_methods

Rojo, V., Madariaga, J.M., & Villarroel, J.D. (2020). Secondary education students' beliefs about mathematics and their repercussions on motivation. *Mathematics*, *8*(3), 368. https://doi.org/10.3390/math8030368

Rojo, V., Villarroel, J.D., & Madariaga, J.M. (2018).The affective domain in learning mathematics according to students' gender. *Revista Latinoamericana de Investigación en Matemática Educativa*, *21*(2), 182-198. https://doi.org/10.12802/relime.18.2123

Segarra, J., & Julià, C. (2022). Mathematics teaching efficacy belief and attitude of pre-service teachers and academic achievement. *European Journal of Science and Mathematics Education*, *10*(1), 1-14. https://doi.org/10.30935/scimath/11381

Schoenfeld, A. H. (2016). Learning to think mathematically: problem solving, metacognition, and sense making in mathematics (Reprint). *Journal of Education*, *196*(2), 1-38. https://doi.org/10.1177/002205741619600202

Staub, F., & Stern, E. (2002). The nature of teachers' pedagogical content beliefs matters for students' achievement gains: Quasi-experimental evidence from elementary mathematics. *Journal of Educational Psychology*, *94*(2), 344-355. https://doi.org/10.1037//0022-0663.94.2.344

Tuohilampi, L., Hannula, M., Varas, L., & Giaconi, V. (2014). Challenging western approach to cultural comparisons: young pupils' affective structures regarding mathematics in Finland and in Chile. *International Journal of Science and Mathematics Education*, *13*(6). https://doi.org/10.1007/s10763-014-9562-9

Turşucu, S., Spandaw, J., Flipse, S., Jongbloed, G., & De Vries, M.J. (2018). Teachers' beliefs systems about improving transfer of algebraic skills from mathematics into physics in senior pre-university education. *International Journal of Science Education*, *40*(12), 1493-1519. https://doi.org/10.1080/09500693.2018.1486520

Vásquez, C., Seckel, M., & Alsina, Á. (2020). Belief system of future teachers on education for sustainable development in math classes. *Uniciencia*, *34*(2), 1-30. https://doi.org/10.15359/ru.34-2.1

Vesga-Bravo, G., & De Losada, M. (2018). Creencias epistemológicas de docentes de matemáticas en formación y en ejercicio sobre las matemáticas, su enseñanza y aprendizaje. *Revista Colombiana de Educación*, *74*, 243-267. https://doi.org/10.17227/rce.num74-6909

Videla, M.V., Rojas, F., Ulloa, R., Chandía, E., Ortíz, E., & Perdomo, J. (2019). Creencias y conocimiento matemático escolar al comienzo de la formación inicial docente en estudiantes de Pedagogía

General Básica. *Pensamiento Educativo. Revista de Investigación Educacional Latinoamericana*, *56*(2), 1-19. https://doi.org/ 10.7764/PEL.56.2.2019.9

Wong, N. Y., Ding, R., & Zhang, Q. P. (2016). From classroom environment to conception of mathematics. In R. B. King and A. B. I. Bernardo (Eds.). *The Psychology of Asian Learners* (pp. 541–557). Singapore: Springer. https://doi.org/10.1007/978-981-287-576-1_33

Xie, S., & Cai, J. (2020). Teachers' beliefs about mathematics, learning, teaching, students, and teachers: Perspectives from Chinese high school in-service mathematics teachers. *International Journal of Sciences and Mathematics Education*, *13*(2), 265-287. https://doi.org/10.1007/s10763-020-10074-w

Zakaria, E., & Musiran, N. (2010). Beliefs about the nature of mathematics, mathematics teaching and learning among trainee teachers. *The Social Sciences*, *5*, 346-351. https://doi.org/10.3923/sscience.2010.346.351