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Beliefs, performance, and applicability of mathematics in learning for life: The multi-case study at secondary education institutes in Italy

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Abstract

Our study stars with the aim of discovering if there is a relationship between the beliefs and perceptions that Italian High School students have towards mathematics and some factors as grade, macro area, type of school and academic performance. The methodological proposal that this study follows is based on the combination of quantitative and qualitative method. Regarding the quantitative design, the instrument used has been a survey filled out by 4845 students living in Italy. The qualitative methodology has focused on the discourse analysis of 12 in-depth interviews with the participation of secondary school teachers. Among the main results we found that the perception of mathematics as a useful subject just to count, calculate and measure can be considered among the causes of the decrease academic performance of the students of the Second Grade Secondary School compared to the Primary School, because many students consider utility of math just in its arithmetic aspect. In addition, while changes about beliefs by grade, macro area and type of school are not significant, we found correlations between some particular beliefs and performance in mathematics, confirming a connection between beliefs towards this discipline and academic performance. The novelty of our research is found in having specifically detected which are beliefs and perceptions related to academic performance. That opens the door for future research.

Keywords: Beliefs about Mathematics, Mathematics, Mathematics Learning, Motivation, Secondary Education

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A recent investigation affirms that knowing scientific subjects (science, engineering, and math) from the first years of school involves not only "receive" passively the products built from science, engineering, and math, but also "do" science, engineering, and math (Simó et al., 2020). Understanding the scientific knowledge that built but not received makes difficult to image academic performance in those disciplines joined to talent as innate ability, a special intellectual ability that a person must learn things easily: every student can build his own scientific knowledge. Even if this innate ability should exist, this should be not relevant to explain a superior performance; the thing that count is a continuous and deliberate training of our potential, being talent the result of a journey (Margiotta, 2018).

The stereotypes and the pre-existing beliefs about these subjects requiring innate abilities hinder the academic path of students (Copur-Gencturk et al., 2020) put at risk the learning process. We can't ignore reality: there are a lot of learning difficulties that students meet in these subjects, especially in

math. Those difficulties show in low performance that we can meet in the last Italian report of National Institute for the Evaluation of the Educational and Training System (Invalsi, 2019); this Institute do periodic and systematic checks about students' abilities and knowledge and about general quality of educational offer of Educational Institutions. Previous studies found that the cause of learning difficulties in mathematics come from a negative attitude towards mathematics that screen in three different dimensions: self-efficacy, emotional dimension, and belief toward the subject (Di Martino & Zan, 2010). Regarding the self-efficacy, other authors show how math's performance is related to reading comprehension (Schöber et al., 2018), although this dimension is the most difficult to detect.

Concerning emotional dimension and beliefs, the results of another research established that students' emotions and beliefs about math's learning are related between themselves, and they are determinate factors to consider in the learning process management (Esquivel et al., 2017). Regarding perceptions, we already know that teaching students the applicability of mathematics in everyday life helps them improve academic performance in this discipline (Lazarides et al., 2020), waking up their interest (Fernández et al., 2020) and would also have repercussions on their professional future (Hemmings et al., 2011); however we have expanded the research area analyzing how these perceptions change according to the independent variables type of school, territorial area and grade and also looking for which of the most common perceptions are related to academic performance. On the other hand, a recent study by Kwon et al. (2021) shows the effect of student's engaging in STEM project-based learning (PBL) activities on their perceptions towards SEM subjects and STEM careers. Results show that students increased their perceptions towards science, engineering, mathematics, and STEM careers. Another study (Vesga-Bravo & Escobar-Sánchez, 2018) was aimed at determining whether a pedagogical proposal had an impact on the beliefs of a group of seventh grade students; the used instrument allowed to know the beliefs of the students before and after the intervention, and it was showed that students beliefs changed. It's possible find strategy to change beliefs and perceptions, but with this study our intention is to understand if these are related to mathematics achievement or other factors in high school students and which ones are these beliefs and/or perceptions.

Considering this epistemological contextualization, we oriented our research about beliefs that High Schools' Italian students (14-19 years old) have on mathematic, with the goal to discover is there is a connection between these beliefs and academic performance and, if it exists, with which beliefs it is related. The intention of our research has been to investigate if the applicability of mathematics how useful subject to take decisions, to understand phenomenon of the word around us and to solve small daily problems (Rychen & Salganik, 2003) is a developed concept in High Schools' Italian students and if this perception is connected to academic performance and the other independent variables type of school, macro area and grade.

The questions that guided our investigation have been: What do High School's Italian students think about mathematics? Is mathematics considered useful in learning for life? Which are beliefs and perceptions towards math and how are they connected with students' academic performances?, Do beliefs and perceptions change by type of school, territorial area and High School grade?

Starting from those questions we established the goals referred to diagnostic of connection between perceptions about utility and applicability of mathematic in learning for life, beliefs about this subject and their connections with students' academic performances, all above analyzed according to the type of school, macro area and grade.

METHODS

The methodology that follows this multi-case study (Stake, 2005) pretend to explore more than one analysis unit to proportion bases to its generalization (Rule & Mitchell, 2015). This multi-case study is a combination of quantitative and qualitative techniques, that means a mixed design, of the exploratory-

correlational scope. The quantitative methodology, corresponding to 4845 questionnaires applied to High Schools' Italian students, and qualitative methodology, developed throw 12 semi-structured interviews to High School's mathematics teachers, made possible the analysis from both perspectives that enrich the process.

Though it applies mixed methodology typical of social science matching in one only process investigation technique, methods, qualitative and quantitative language (Johnson & Onwuegbuzie, 2004). This allows to have a better comprehension regarding what we are studying, to obtain strongholds of both methodologies and to analyze different points of view, combining the data to get convergent results. (Callejo & Viedma, 2006).

Before talking about our objectives, we want to specify what we mean by "macro-area" and by "type of educational center." The first variable refers to the geography of the Country, which we have analyzed considering North, Center and South and Islands (as the Invalsi does); the second variable refers to the distinction of Italian schools that are divided into: Professional Institutes, Technical Institutes, Scientific Lyceums, and other Lyceums. The Scientific lyceum has been distinguished from others kind of school though our investigations is related to mathematics and that school is where this subject is the most important.

In order to achieve the purpose of our study, we made the following questions to High School students: [RQ1] How was your performance in mathematics last year?, [RQ2] How was your performance in mathematics in Primary School?, [RQ3] Are there parts of your day when you use math?, [RQ4] Which are your beliefs about this subject? Regarding the actions related to the teaching staff, we have asked: [RQ5] What are the teaching methods that you use most frequently in your teaching? [RQ6] What are the main difficulties you encounter in putting these methods into practice? [RQ7] And how do you think these difficulties could be overcome?

These questions [RQ] turn our reflection into objectives that specify our research:

1. Objective 1: Detect the factors that cause a decrease in mathematics academic performance from Primary School to High School.
2. Objective 2: Diagnose the relationship between perceptions about the usefulness and applicability of mathematics in everyday life and the grade, the macro area, and the type of institution.
3. Objective 3: Diagnose the relationship between students' beliefs about mathematics and the grade, the macro area, and the type of institution.
4. Objective 4: Analyze students' perceptions and beliefs about mathematics related to academic performance.

The formulation of these objectives responds to a study that has been designed to approximate observable phenomenon. The hypotheses that we present below have been contrasted and formulated, related to the objectives of our study:

1. Hypothesis 1: the decrease in the academic performance of students in mathematics depends on the perception of its usefulness in everyday life.
2. Hypothesis 2: perceptions about the usefulness and applicability of mathematics in everyday life and the beliefs of students towards mathematics change significantly by grade, macro area and type of institution.
3. Hypothesis 3: students' beliefs towards mathematics are related to their academic performance.
4. Hypothesis 4: conceiving mathematics as a difficult subject is related to the academic performance of the students.

Participants

The participants in the surveys were 4845 adolescents of High School students residing in Italy with ages ranging from 13 to 22 years, with an average age of 16.43 years. 52% of the respondents are female and 48% male. The provinces of residence reached were 75 out of 80, in all geographical areas of Italy: North (60%), Centre (7%), South and Islands (33%). The sample from central Italy was not intentional, and teachers from all three areas of the country have been asked to participate, but many have preferred not to provide the questionnaire because students were already loaded with distance activities due to the COVID-19 pandemic. The adolescents interviewed live in more than 800 different localities, 66.6% are in rural areas, and 33.4% in urban areas.

The mathematic teachers at Italian High Schools who participated in the interview were 12. The selection of the sample of the interviewees was carried out randomly to cover all the Italian provinces, respond to gender equality and different levels of training and experience. 17% of the participants were male, and 83% were female, aged between 32 and 59 years and with teaching experience between 2 and 33 years. It is of vital importance that 42% of the interviewed teachers are graduated in Mathematics, 25% in Statistical Sciences, 17% in Physics, and 8% in Economics and Computer Engineering; we consider that this sample has an enormous potential for our study. Geographically, 58% of the interviewed teachers live and work in North Italy, 8% in the Center, and 34% the South and Islands.

Instruments

In the quantitative study, the design of a questionnaire structured in closed, open and multiple-answer questions have been chosen. The questionnaire has been prepared, in part, following the criteria of the Likert scale technique, offering a clear statement to the subject (Murillo, 2006). The independent variables have been gender, age, macro area, type of school, grade level and academic performance in the current year. As dependent variables have been considered the different perspectives that allowed us to answer the questions (RQ1, RQ2, RQ3, RQ4), objectives and hypotheses raised in the study. It is specified that the question RQ3: "Are there some occasions in your days during which you use mathematics?" It has been put as an open question and, in its coding, seven categories of answers have been identified: "to calculate, to count, and to measure", to study other scientific subject, culinary tasks, "to reason, to analyze, to interpret", "quiz and guessing games", "yes, unspecified" and "no occasion". While the RQ4 question "what are your beliefs about this discipline?" it was a multiple answer with these options (students could choose more than one belief among those): it is a difficult subject; if I understand it, it is a simple subject; it is a subject only for boys; it is a useful subject only to do the calculations; it is a subject for intelligent people; it is a language that helps us to interpret the world around us; it is a subject that improves our ability to reason; it is a subject that improves our ability to make decisions; it is a subject that improves our logical and analytical capacities; it is a subject that develops our critical spirit; it is a subject that develops our creative thinking.

The qualitative approach (Barton et al., 2009; Gibbs, 2012; Igartua & Humanes, 2009; Stake, 2007) has been focused on discourse analysis (Iñiguez Rueda, 2006; Valles, 2000; Van Dijk, 2005) of 12 in-depth interviews with the participation of High School mathematics teachers. It was decided to design a semi-structured interview with privileged observers, collecting personal information such as gender, age, working city, type of institution, years of experience and educational career. The teaching methods most used by them, and the main difficulties encountered in their application were also analyzed. Using the Google Forms tool, an informed consensus was drawn up so that the interviewed teachers gave their consent for its recording and analysis. During the interview, the participants were allowed to respond

freely, avoiding interrupting their interventions, although at certain times it was decided to insist on some elements to get the teachers to offer a clearer answer. To make quick and simple references to the interviews and to differentiate the contributions of each of the interviewees, we have opted for the coding: "E-Tnº: page". In this coding we refer to the interview (E), the teacher (T), the interview number to which reference is made (nº) and at the page where the referred event can be found (page). Therefore, if during the analysis you want to report information that appears on the first page of the interview to participant 1, this is coded as follows: E-T1: 1.

Data Collection and Analysis Procedure

For the questionnaire we created a Google Form sending this tool to Italians High Schools, asking their collaborations for our research (it was sent the link of the questionnaire created through *Google Forms* by mail). The school leaders who have wanted to, have sent this request for participation to the mathematics department of their school and the teachers who have wanted to do it, have asked for the collaboration of their students; who of them has wanted, has answered the questions of the questionnaire; everything was on a voluntary basis.

Once we obtained the necessary data, those were analyzed following the correspondent process. First, for the quantitative analysis, the .csv data were exported to an Excel file. To give a major scientific rigor to our investigation, for the quantitative analysis we used the statistical package IBM SPSS v. 25 and we established correlations between variables. Data were entered into the software, selecting the appropriate procedure to calculate the statistics, and executing the procedure to obtain the investigation reports. The interviews were all carried out by Skype and, subsequently, the transcription, recompilation and analysis of data related to the objectives and hypotheses was carried out. The interview questions used for this study were only three and they were within an interview that also analyzed other aspects through other questions. Here are the respective durations of the full interviews: 42:42, 31:02, 46:17, 33:05, 32:24, 40:51, 28:43, 33:21, 35:12, 54:11.

Ethical Consideration

The completion of the questionnaires, like the discourse of the interviews, was transcribed for the categorization of the resulting narrative, respecting the anonymity. All the subjects surveyed and interviewed were informed about the objectives of the study, the institutions that endorse it, and its voluntary nature. Not only was anonymity advocated, but also the confidentiality of the data. SMEMIU group of the National University of Distance Education (Spain).

Reliability and Validity

This criterion determines whether the instrument's measurement scales are accurate, reliability being understood as the precision of the instrument, considering the possible errors found in the factor analysis. The lower these errors are, the higher the accuracy of the measurement and of the study. To study the reliability of the instrument, we have followed the procedure of the Cronbach's α. After analyzing the reliability statistics, it can be said that Cronbach's α offers a value of 0,66 considering six items about beliefs towards mathematics, its usefulness and its benefits (it is a language that helps us to interpret the world around us; it is a subject that improves our ability to reason; it is a subject that improves our ability to make decisions; it is a subject that improves our logical and analytical capacities; it is a subject that develops our critical spirit; it is a subject that develops our creative thinking).

Regarding the content validity, the opinion, and the validation of ten expert investigating judges from the SMEMIU group of the National University of Distance Education (UNED, Spain) have been

considered in the design of the investigation instruments. It was concluded that the relevance of the items is high since the objectives of the study are related to the approach of the instruments; absence of differences was observed in the judges' assessments on the set of sections of the questionnaire and the interview script, as well as the content validity criteria.

RESULTS AND DISCUSSION

The self-evaluation of the students about the performance in the learning of mathematics decreases with the passage to other grades level. The percentage of students who declare having had a sufficient performance in Primary School is 96%; the percentage that declares to have had a sufficient performance the previous year is 88%; and the percentage that declares to have a sufficient performance in the current year is 85%. These data are corroborated with the Invalsi results (2019), which show that the mathematics performance of students gradually deteriorates as they grow and go from elementary school to grade 10 (second year of Italian High School). Follow the analysis to understand if perceptions and beliefs have any role in this phenomenon and if they are related to our independent variables.

Category 1: Perceptions of Learning Mathematics and Its Applicability in Everyday Life

When asked about an example of everyday life where they use mathematics, it was possible categorized data as follows: "To calculate, to count, to measure"; "Culinary tasks"; "To study other subjects"; "Quiz and guessing games"; "To reason, to analyze, and to interpret"; "None"; "Yes, unspecified". As seen in Table 1, 61% of the participating in the sample answered with terms of counting, calculating, and measuring. It is striking that 16.9% of the sample does not have any daily occasion where they use mathematics. 17.6% declare that they use mathematics in culinary tasks and 12.7% use it in academic aspects to study other subjects. Only 5.6% of the sample declares that it serves to reason, to analyze, and to interpret. The last two answers have not been considered in the graphics because the first is too generic ("Yes, unspecified") and does not help us in the analysis, while the second has a not very significant percentage (only 0.8%).

Table 1. Categories of Perceptions

Categories of Perceptions	Percentage
To calculate, to count, and to measure	60,9
Culinary tasks	17,6
No	16,9
To study other subjects	12,7
To reason, to analyze, to interpret	5,6
Yes, unspecified	5,0
Quiz and guessing games	0,8

The qualitative study shows that, among the main difficulties encountered in learning mathematics, there is a lack of motivation [some methods require a motivational impulse that students sometimes do not have; therefore, we must first work, whenever possible, on their intrinsic and extrinsic motivations (E-T2: 8)] and the low interest in the subject or the difficulty of keeping attention high [the main problem is one: that of awakening curiosity about problems of a mathematical nature (E-T9: 37); then keep the attention threshold high (E-T10: 41), the great difficulty of keeping students active (E-T12: 49)], which

causes an attitude of resignation towards this subject [and later also the attitude of students with low performances, who are sometimes too quit-oriented, creates difficulties (E-T3: 12)].

Regarding the daily occasions in which they use mathematics, we have seen that 61% answer that they use it to count, to calculate and to measure; among those, one part declares that only the part that is studied in Primary School is useful, for example, many students specify that learning mathematics is useful only to find out if the price of a purchase is correct, basing this knowledge on operations basics of addition, subtraction, multiplication and division. All this would justify a decrease in motivation towards this subject in the High School.

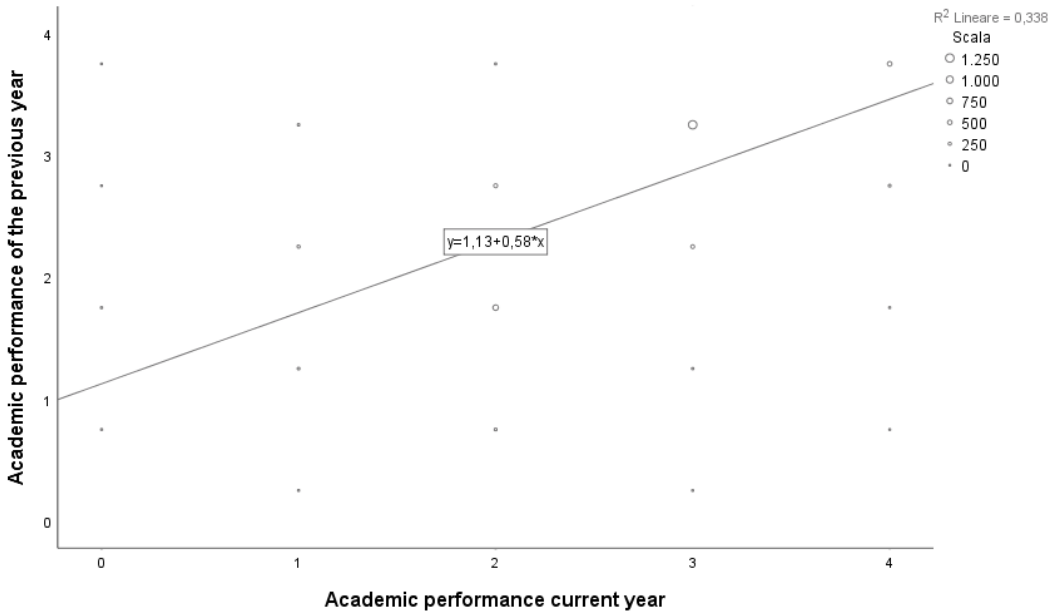

Figure 1. Scatter diagram between the academic performance of the current year and the previous year

Considering the data obtained from the interviews and the weak correlation (0.199) between the academic performance of this current year and that maintained during Primary Education, we can affirm that the factors that determine deficits in mathematics performance are not strictly cognitive but rather motivational. These are not only factors linked to the intellectual capacities of the students but also to the motivation they feel towards learning mathematics (which High School teachers perceive as scarce). The correlation between the academic performance of the current year and the previous year is strong (0.605), as seen in the scatter diagrams of the correlations presented in Figures 1 and 2 (we specify that with 0-4 of the x-axis, we have coded performance levels: very insufficient, insufficient, basic, intermediate, and advanced).

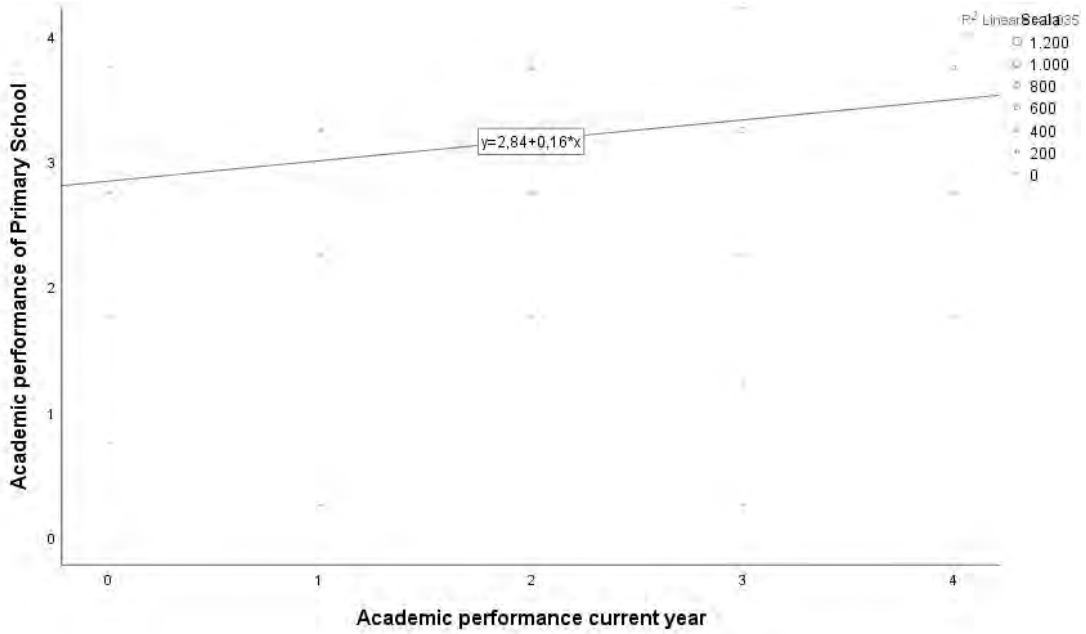

Figure 2. Scatter diagram between the academic performance of the current year and Primary School

Analyzing the responses by macro-area (Figure 3), there are no significant differences except for culinary tasks, being lower in the southern zone and islands. This data is justified as half of the sample from the South and the islands are students of the Scientific Lyceum, a type of institute frequented by students who answer that this subject is not used in culinary contexts (Figure 5).

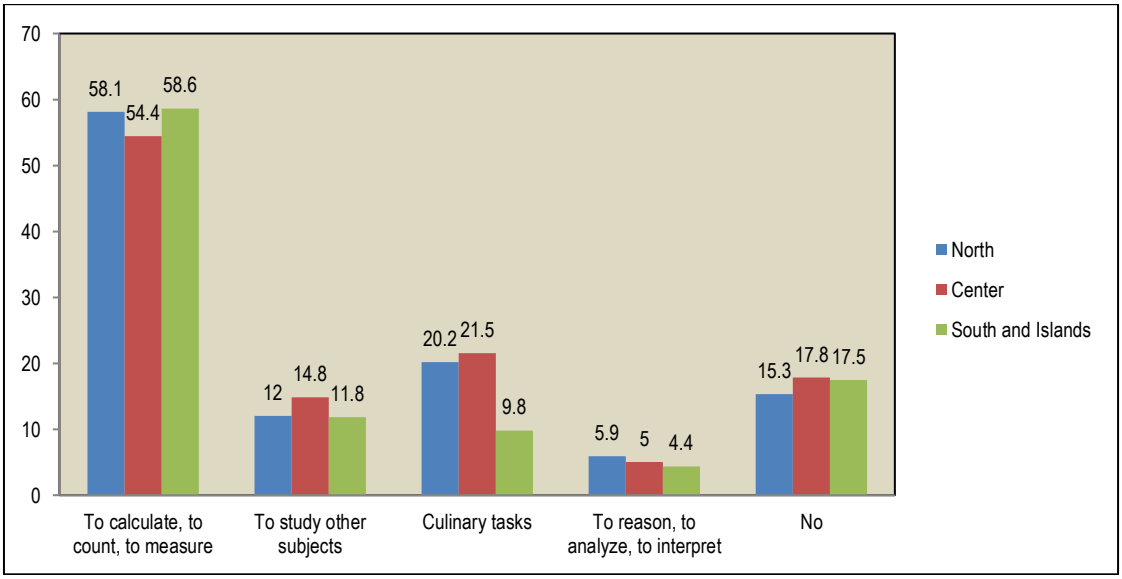

Figure 3. Perceptions on applicability of mathematics by macro-area

We observe that, except for some exceptions, geographic areas do not influence perceptions of the applicability of mathematics in everyday life. Throughout the Italian state, High School students express these same perceptions.

As can be seen in Figure 4, perceptions do not present significant differences by grade, except for answer 4 (to reason, to analyze, to interpret), for which last year of High School students stand out. This data seems important because in the last year the students are older and have a broad vision of the

subject. If they declare to use mathematics to reason, analyze and interpret it means that this student has understood the essence of the subject, assimilating that it is not a discipline that is studied for thirteen years simply to check if the amount of money returned in a certain purchase is the right one.

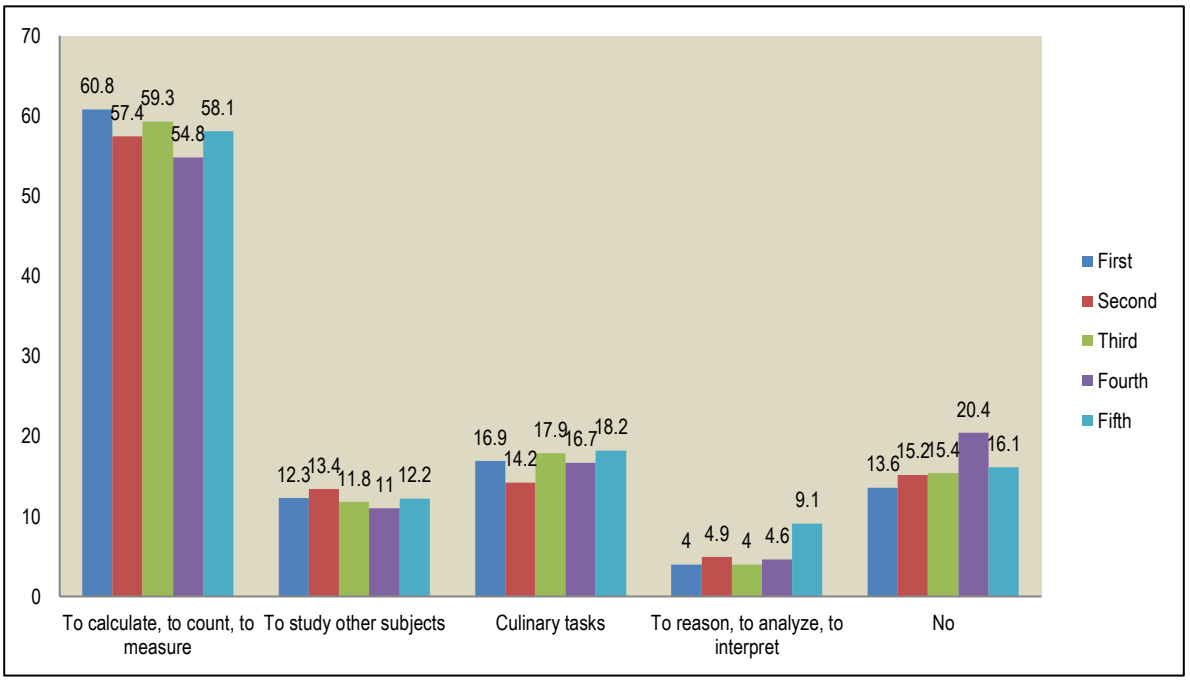

Figure 4. Perceptions on applicability of mathematics by grade

Analyzing the responses by type of institute, as shown in Figure 5, we can see that the students, especially students from other Lyceum, use mathematics on a daily basis to calculate, to count or to measure. In its applicability to culinary tasks, students from Professional Institutes stand out, probably experiencing this subject from a more practical perspective; it must be borne in mind that, among the Professional Institutes, there are also those of Hospitality and Tourism. In relation to the type of school, mathematics is used more by students of the Technician and the Scientific High School, as those are schools where this subject is used as a basis for other disciplines. Never using mathematics obtain in the study a higher percentage (18.6%) in the Technical Institutes and the lowest (12.8%) in other High Schools. Among the students who answered that mathematics is used daily to reason, to analyze, to interpret, the distribution by kind of school changes. This is the least frequent response among students at Professional Institutes (2.94%) and more frequent among students of Scientific Lyceum (7.66%), although it is considered a very low figure and, therefore, very worrying. as mathematics is a basic discipline for this institute.

Regarding academic performance, there are no correlations between this variable and perceptions about the usefulness and applicability of mathematics in everyday life. A weak negative correlation (-0.122) is observed between academic performance and the perception of not having daily occasions in which to use mathematics, which seems natural because if they do not know this discipline, they cannot apply it in their daily life.

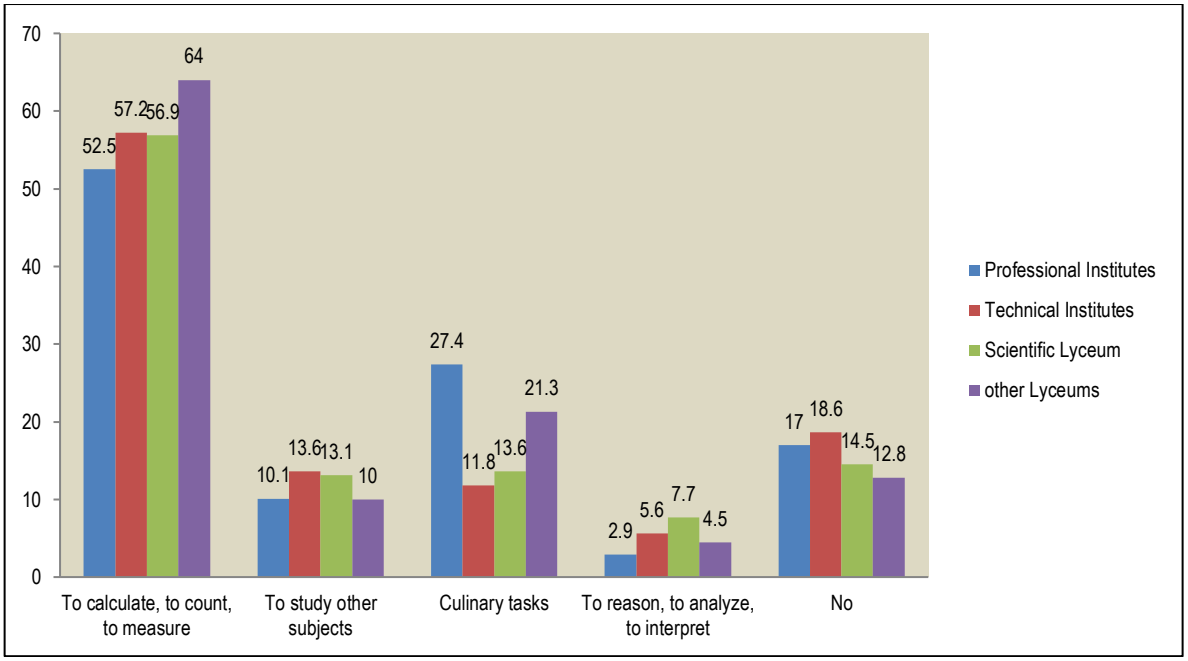

Figure 5. Perception on applicability of mathematics by type of school

Mathematics, therefore, is perceived as useful for counting, calculating, measuring, and other skills such as reasoning, analyzing, and interpreting are not perceived. Perceptions towards mathematics do not change significantly neither by macro-area, nor by grade, nor by type of school (except for some particular cases mentioned above). There are no correlations with the academic performance of the current year, which means that they do not affect or are affected by it. The most relevant data can be considered the connection between the lack of motivation towards learning this subject (which the interviewed teachers reveal) and the most common perception that it is a discipline that only serves to count, to calculate, to measure; skills, the latter, which are acquired thanks to Primary School mathematics.

Category 2: Beliefs towards Learning Mathematics in Formal Educational Contexts

Regarding beliefs towards mathematics, we distinguish positive and negative aspects. As positive aspects we highlight that 70% answered that it is a subject that improves our ability to reason. For 63.9% it improves our logical and analytical capabilities. 61.4% of the participants declare that it is a simple subject if it is assimilated correctly; and only 0.5% answer that it is an exclusive subject for the male gender. 11.8% answer that it is a subject for intelligent people and only 14.1% declare that it is a subject that only serves to make calculations. In contrast to these data, negative aspects emerge, presenting that 35.4% think it is a difficult subject; 33% think that mathematics is a language that help us interpret the world around us; 20.5% think that mathematics influence our ability to make decisions. A very small group thinks that mathematics develops our critical spirit (11.6%) and creative thinking (10.3%).

Analyzing these responses by four independent variables, we find that by macro-area there are no differences between north, center, south and islands, except in the latter, where the percentage that conceives mathematics as a difficult subject is lower, as we observed in Figure 6; meanwhile, the thinking of mathematics as a language that helps us to interpret the world around us is higher. So, beliefs about

mathematics are not related to geographic areas; this is also demonstrated by the absence of correlations between beliefs and this independent variable.

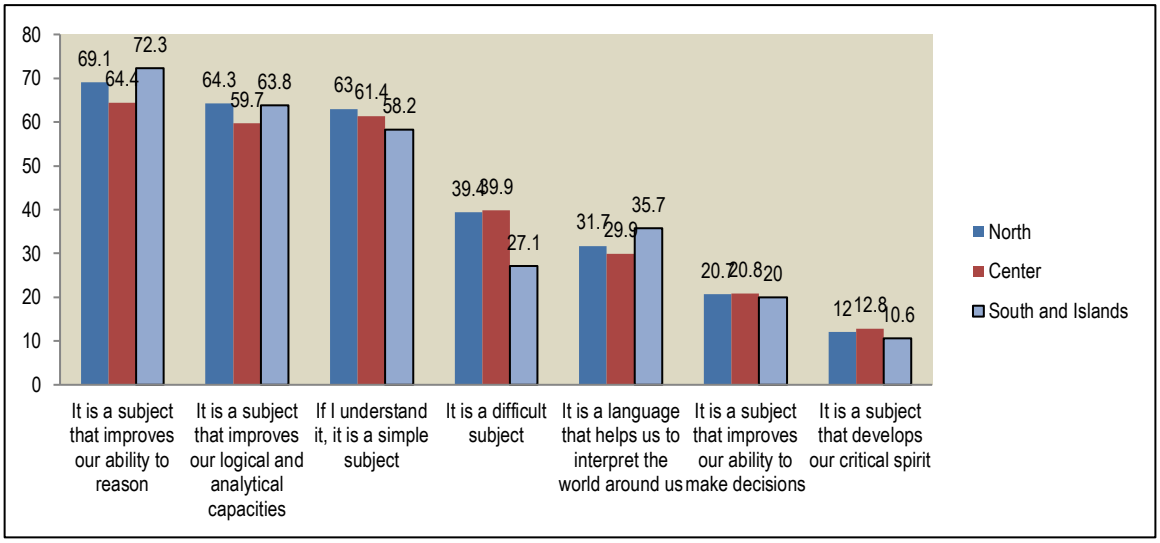

Figure 6. Beliefs towards mathematics by macro-area

As can be seen in Figure 7, most of the beliefs do not present many differences in percentage between the students of all five Italian High School grades, except that due to "to improve our logical and analytical capacities", which rises by 11 percentage points and "if I understand it, it is a simple subject" that drops by nine points; no correlations are present between beliefs and this independent variable.

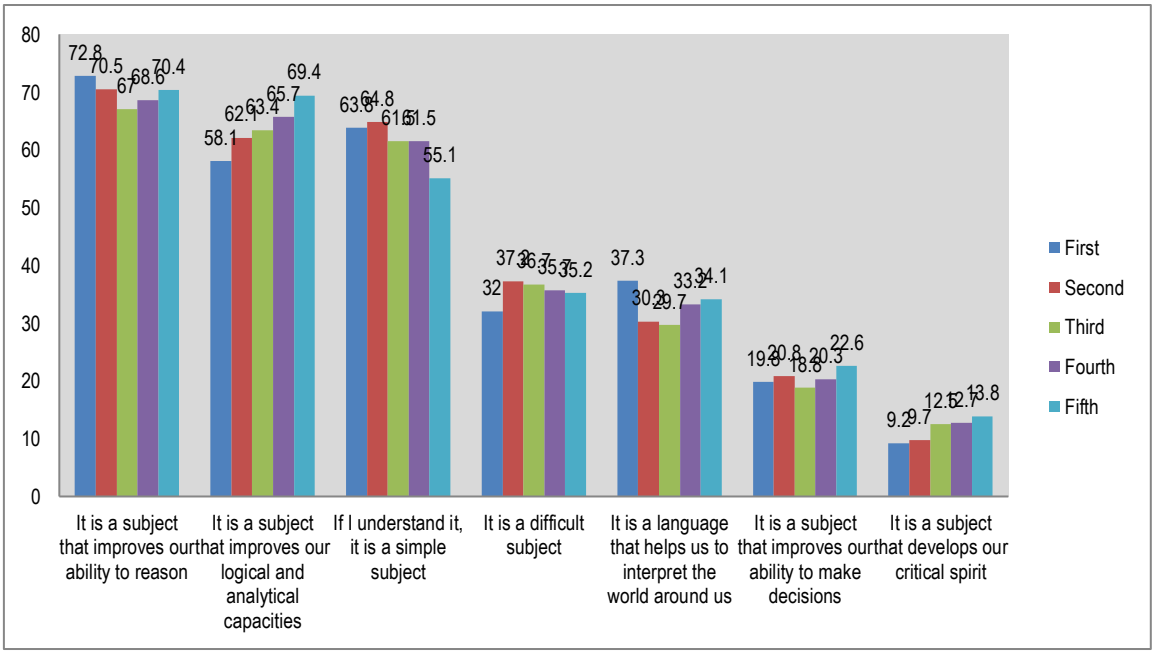

Figure 7. Beliefs towards mathematics by grade

Among the types of school, presented in Figure 8, only the Scientific Lyceum is differentiated. Students of these educational centers are the ones who think in a higher percentage than mathematics is a subject that improves the ability to reason and our logical and analytical abilities (this is in line with the highest percentage in Figure 5 with respect to conceiving mathematics as a useful subject to reason,

to analyze, to interpret, which comes from this type of center). In Scientific Lyceum, the percentage of those who think that mathematics is a difficult subject is lower and of those who think that, if it is understood, it is a simple subject, and of all other beliefs the percentages are higher compared to all the other types of schools. We observe that the percentages of the responses "it is a subject that influences our ability to make decisions" (26%) and "it is a language that helps us interpret the world around us" (41%) remain low. Regarding this type of center, the percentage of a negative response to the perception of the presence of daily occasions where mathematics is used is not lower, as can be seen in Figure 5. Mathematics is not perceived as a subject that develop our critical spirit by those students of the Scientific Lyceum, where the mathematics is among the most important subjects.

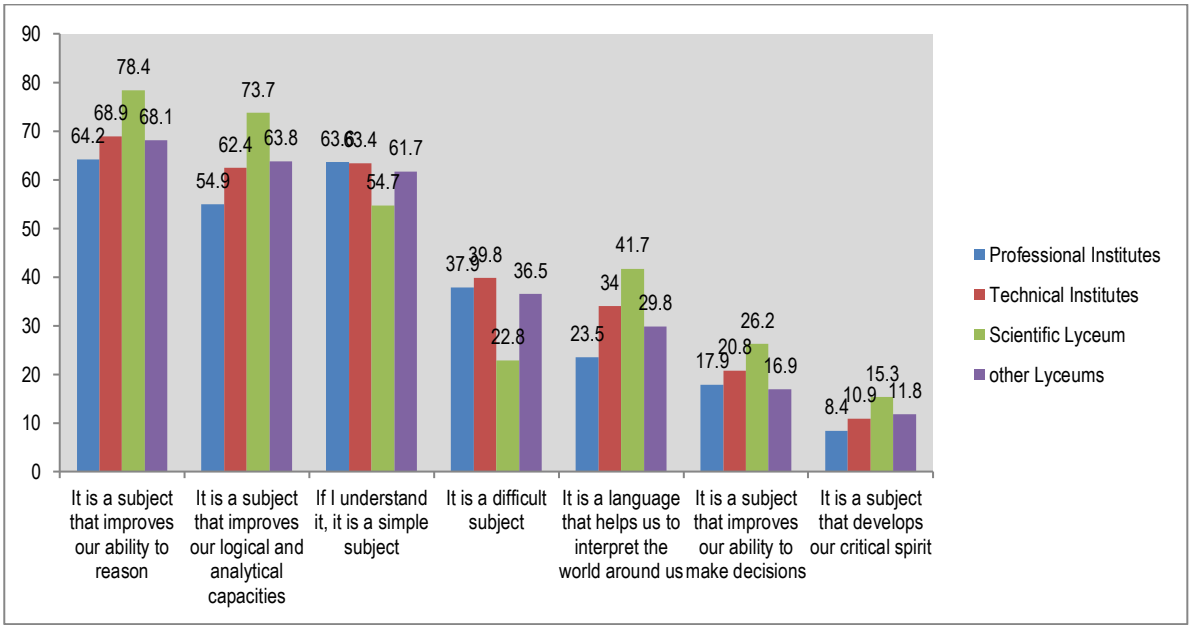

Figure 8. Beliefs towards mathematics by type of school

From the perspective of beliefs towards mathematics, two important correlations between mathematics and academic performance stand out. One is a moderate negative correlation between academic performance in current year and conceiving mathematics as a difficult subject (-0.371). There is a weak positive correlation between academic performance and thinking about mathematics as a subject that improves logical and analytical skills (0.254) in addition to our ability to reason (0.235).

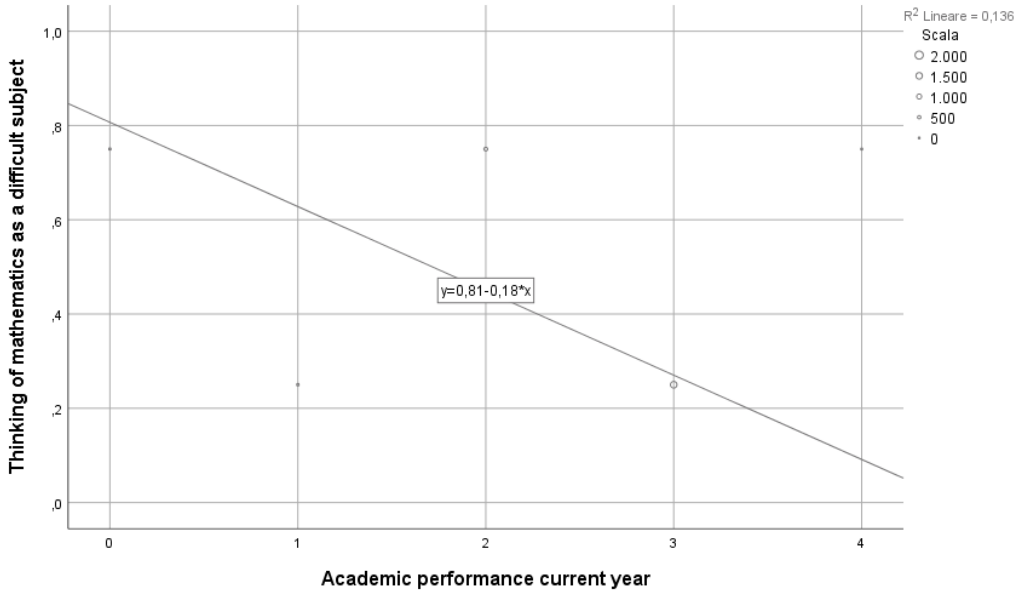

Figure 9. Scatter diagram for academic performance of current years and thinking of mathematics as a difficult subject

As we can see in Figures 9 and 10 relative to the scatter diagrams, in the first case the slope of the trend line is negative and in the second case it is positive. The first correlation presents students whose performance is at least sufficient, who do not perceive mathematics as a difficult subject. The second correlations highlight the beliefs that, among all, are related to the academic performance of the students: mathematics as a subject that improves our logical and analytical abilities and our ability to reason.

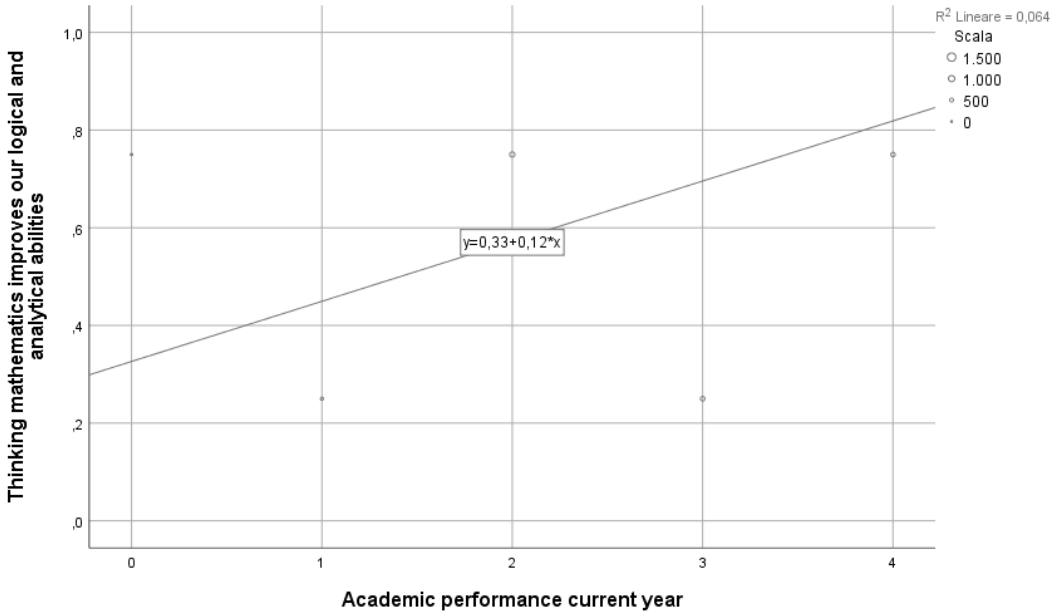

Figure 10. Scatter diagram between academic performance of current years and thinking mathematics improves our logical and analytical abilities

Beliefs towards mathematics show some moderate correlations between them. The first beliefs are to conceive mathematics as a subject that improves our ability to make decisions and to think of it as

a language that helps us to interpret the world around us (0.356). The second is to think to mathematics as a subject that improves our logical and analytical abilities and that improves our ability to reason (0.405). From these correlations we can understand that beliefs towards mathematics are not isolated, but rather walk together and are part of a larger conception that is still little known to students.

The students who declare that they use this subject to calculate, to count, to measure, have presented examples of daily life linked to their own personal interests; it is a necessary requirement for the teaching team to provide the students with situational interest, but the pillars of learning are individual interest and prior knowledge (Romine et al., 2020).

Due to the positive correlations found between the two beliefs and academic performance, we think that these two beliefs are linked to an idea of the student that recognizes the benefit that this subject provides for specific abilities (logical, analytical, and reasoning). The cause or effect of positive academic performance could be the subject of future investigations, although a previous study affirms that they are the cause (Boaler et al., 2018). Another study shows that beliefs about mathematics, from the students' perspective, are a determining factor in the academic performance in mathematics of students (Fernandez-Cezar et al., 2019).

We conclude this part with a reflection on a possible, new route: previous study affirms that the genesis of students' beliefs towards mathematics is in teachers: most of the teaching tendencies of teachers presented evidence of a relationship with students' beliefs towards mathematics, with attitudes towards the discipline and, above all, with the student's image of himself vis-à-vis the subject (Araya & Moreira-Mora, 2016). So, if beliefs were the causes of good performance (and not an effect), then the solution to the improvement of learning would pass not only through the improvement of didactic processes but also through a teacher training where qualitative methodologies of inquiry are used (González Serrano et al., 2015) to bring to light the preconceptions of the teaching teams and promote their cognitive restructuring (Menichetti et al., 2019).

The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

In discussion, it is the most important section of your article. Here you get the chance to sell your data. Make the discussion corresponding to the results, but do not reiterate the results. Often should begin with a brief summary of the main scientific findings (not experimental results). The following components should be covered in discussion: How do your results relate to the original question or objectives outlined in the Introduction section (what)? Do you provide interpretation scientifically for each of your results or findings presented (why)? Are your results consistent with what other investigators have reported (what else)? Or are there any differences?

CONCLUSION

Our starting point has been to find the reason for the reduction in the academic performance of students in mathematics from Primary School to High School, and to investigate perceptions and beliefs, looking for possible relationships with our independent variables: grade, macro-area, type of school, academic performance. Our study leads us to affirm that academic performance in mathematics depends on the performance of the previous year and does not depend on the performance of Primary Education. This is an important information because it reveals the presence of factors (not strictly cognitive) that affect performance in mathematics during the academic path students. Analyzing the decrease in academic performance with the passing of the curricular levels, as presented in the previous section, the high percentage of the common perception of mathematics as a discipline that serves to count, to calculate, to measure, stands out as justification which confirms hypothesis 1. These data are corroborated with

the teachers' interviews, detecting a lack of motivation towards learning this subject in the High School students.

Regarding the perceptions and beliefs of students about mathematics, we have not found significant changes according to the independent variables (H2 is not true). Based on the findings of the study, to be related to academic performance are in particular three beliefs, linked to it by correlations. The two most common beliefs among students that present positive correlations (mathematics as a subject that improves our logical and analytical abilities and our ability to reason) with their academic performance, also present a strong correlation between themselves (H3 is true). The third belief has a moderate negative correlation (mathematics is a difficult subject) with academic performance, which makes H4 true.

The novelty of our research is found in having specifically detected which are beliefs related to academic performance, since always investigations talk about beliefs in general. A future investigation could be thought also for the third belief, thinking of mathematics as a difficult subject, presenting a moderate negative correlation with academic performance. We believe it is necessary not to underestimate these beliefs because they could represent the key to the door that the students often close ahead of that subject.

Declarations

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JG-Q: Writing-review, editing, validation, and supervision.

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