Self-regulation in mathematics: different strategies for different levels of achievement

Autorregulación en matemáticas: diferentes estrategias para distintos niveles de rendimiento

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Abstract

This study analyses the use of learning and motivation strategies. High School students (ESO) as a function of academic performance in mathematics, with the main objective of identifying the strategies that actually seem to contribute to or explain the different types of performance. 292 ESO students were assessed on the use of learning and motivational strategies and academic performance in mathematics. The results showed that, although all students, regardless of their performance, use the strategies, only some of them appear to be weighted towards the medium and high achievers, and even fewer strategies seem to explain them. Of all the learning strategies, only some in the 'resource control' group seem to explain significantly and positively both levels of performance. When mathematical performance is average, peer help seems to be key. Effort and, marginally, the cognitive strategy of critical thinking contribute to high performance. The data also reveal differences in the case of motivational strategies. Thus, although self-efficacy seems to contribute positively in both cases, it does so only significantly when performance is high and marginally when it is average. Another notable difference is the finding of a significant negative contribution in the case of self-handicapping motivational strategies only when performance is high. It seems that variables that may explain higher performance in isolation lose impact in a realistic situation in which the student uses several strategies, and all are analysed together. The theoretical and practical implications of these results are discussed.

Keywords: self-regulation, learning strategies, motivational strategies, mathematics, middle school.

Resumen

En este estudio se analiza el uso de las estrategias de aprendizaje y de motivación de estudiantes de Educación Secundaria Obligatoria (ESO) en función del rendimiento académico en matemáticas, con el principal objetivo de identificar las estrategias que realmente parecen contribuir o explicar los diferentes tipos de rendimiento. 292 estudiantes de ESO fueron evaluados en el uso de estrategias de aprendizaje y de motivación y en rendimiento académico en matemáticas. Los resultados mostraron que, aunque todos los alumnos, independientemente de su rendimiento, utilizan las estrategias, sólo algunas parecen tener peso en los de rendimiento medio y alto, y aún son menos las estrategias que parecen explicarlos. De todas las estrategias de aprendizaje, solo algunas del grupo 'control de recursos' parecen explicar de forma significativa y positiva ambos niveles de rendimiento. Cuando el rendimiento matemático es medio, la *ayuda de los compañeros* parece ser clave. El *esfuerzo* y, de un modo marginal, la estrategia cognitiva de *pensamiento crítico* contribuye al rendimiento alto. Los datos también revelan diferencias en el caso de las estrategias de motivación. Así, aunque la *autoeficacia* parece contribuir en positivo en ambos casos, solo lo hace de forma significativa cuando el rendimiento es alto y marginalmente cuando es medio. Otra diferencia notable es el hallazgo de una contribución significativa en negativo en el caso de las estrategias motivacionales de *self-handicapping* solo cuando el rendimiento es alto. Parece que las variables que pueden explicar un mayor rendimiento de forma aislada pierden impacto en una situación realista en la que el estudiante usa diversas estrategias y se analizan todas en conjunto. Se discuten las implicaciones teóricas y prácticas de estos resultados.

Palabras clave: autorregulación, estrategias de aprendizaje, estrategias de motivación, matemáticas, Educación Secundaria Obligatoria.

Introduction

There is extensive research on learning strategies (cognitive and motivational) as an essential part of self-regulation and their impact on practice (Fung et al., 2018; Li et al., 2018). According to Ruiz-Martín et al. (2024), we know which are desirable strategies because research supports their role in learning, performance, and even well-being. However, what is truly interesting is to explore which of these strategies students actually use and, furthermore, which of them explain the different types of student performance (low, medium or high). This work focuses its contribution on this particular point. Specifically, we explore which self-regulation strategies are most frequently used by compulsory secondary education students when they have to deal with complex content such as mathematics. In addition, we are interested in identifying which of these strategies may have the greatest impact on the type of student performance (low, medium and high). Identifying which strategies are key to medium or high mathematical performance can offer clues about the type of support that should be provided depending on the academic objectives pursued.

Self-regulation and learning and motivation strategies

Self-regulation is the process of managing one's thoughts, feelings, and behaviours to achieve objectives or goals (Cleary et al., 2021; Usher & Schunk, 2018). Research in this field (Cleary et al., 2021; Pintrich, 2004) agrees that it can be conceptualised as a dynamic process involving the use of strategies, motivation and metacognition. From this theoretical framework, students can actively promote their learning and performance by regulating the processing of the information to which they are exposed, their motivational beliefs, and their behaviour in order to achieve their goals (Torrano & Soria, 2016). In practice, studies (Paz-Baruch & Hazema, 2023; Torrano & Soria, 2016) explore this possibility by focusing on the *learning strategies* (cognitive, resource control and metacognitive) and *motivation strategies* (goal orientation, self-efficacy and self-handicapping) that students deploy with regard to complex learning content such as mathematics.

Many studies have shown that direct intervention on these strategies improves performance, learning, and motivation (Theobald, 2021), but very few studies explore their actual use (Ruiz-Martín et al., 2024; Torrano & Soria, 2016), and even fewer identify which strategies explain performance. This is what this study explores. In addition to analysing the use of these self-regulation strategies according to performance level, it goes a step further and analyses which of these strategies actually explain the type of performance of each student when studied together rather than in isolation.

When analysing *learning strategies*, cognitive strategies focus on processing, transforming and organising information (Karlen, 2016), metacognitive strategies involve planning, monitoring and evaluating the learning process itself (Ohtani & Hisasaka, 2018), and resource management strategies serve to exert control over the learning environment (Theobald, 2021) *Cognitive* strategies include repetition or rehearsal, elaboration, organisation and critical thinking (Pintrich, 2004). Critical thinking is also one of the most studied cognitive strategies in relation to mathematics and is defined as drawing logical conclusions and making informed decisions to solve mathematical problems (Aizikovitsh-Udi & Cheng, 2015). Strategies that offer deeper processing of information, such as elaboration, have been shown to have a greater impact on performance than more superficial strategies (underlining or rereading) typical of repetition or rehearsal (Donoghue & Hattie, 2021). *Metacognitive* strategies include processes of monitoring and managing cognition (Ohtani & Hisasaka, 2018). Encouraging students to plan, monitor, and evaluate their learning process is known to improve their performance (Guo, 2022). Thus, metacognitive strategies have the greatest impact of all those proposed by the self-regulation model (Theobald, 2021). The final learning strategies are *resource management* strategies, used to gain control over the environment, managing effort, perseverance or other people by seeking help. Their overall impact on performance is also high (Theobald, 2021). It is important to note that effort and perseverance are volitional strategies which, although included within cognitive strategies, have a certain relationship with motivational aspects. Both the commitment to actions to stay focused on a task (effort) and the ability to maintain that effort

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in the face of obstacles and difficulties (perseverance) act through volitional mechanisms and are closely related to each other (DiNapoli, 2023). Seeking help, on the other hand, is defined as a multi-stage process in which students must first identify that a problem exists, then determine that they need help, engage in the search for help, decide why they need help, decide whom to ask for that help, and finally, request and receive that help (Newman, 2002). When the variables are analysed independently, it is clear that they are all important: effort management (Pools & Monseur, 2021), perseverance (Fung et al., 2018) and help-seeking (Sun et al., 2018) all have significantly positive impacts on performance.

Meanwhile, *motivational strategies* consist of self-efficacy, goal orientation and self-handicapping beliefs, completing the set of essential strategies that enable individuals to effectively self-regulate their own learning (Pintrich, 2004). These strategies may be even more important than cognitive or metacognitive strategies in predicting performance in STEM subjects, i.e., science, technology, engineering, and mathematics (Satrústegui Moreno et al., 2024). *Self-efficacy* is the belief in one's own ability to achieve a goal (Bandura, 2011). It influences personal thoughts, feelings, motivations and behaviours, affecting decisions and performance. With regard to *goal orientation*, the most widely used model for its explanation is that of Elliot & McGregor (2001), in which they propose a mastery/performance axis and an approach/avoidance axis. This gives rise to four different goal orientations. Approach mastery orientations encourage commitment to the task for the sake of improvement. However, when this mastery occurs through avoidance, the focus shifts to avoiding failure rather than self-improvement. In approach performance goals, the student focuses on performing relatively well compared to others, assuming that performance at or above the standard would be positive. Finally, if these performance goals are avoidance-oriented, the objective is to strive not to fail in comparison to others, causing anxiety about the possibility of underperforming. It has been proven that avoidance subtypes are negatively related to learning, while approach subtypes are positively related. Furthermore, within the approach subtypes, mastery goals have a greater positive impact than performance goals (Sorić et al., 2017). Even in recent studies (Méndez-Giménez et al., 2017) exploring the latest proposal by Elliot et al. (2011) regarding this variable (3x2 model), the results reveal that only mastery goals are clearly related to more self-determined motivation in secondary school students and the promotion of their well-being, while approach performance goals can have both adaptive and maladaptive relationships with both aspects. Recent studies show how self-efficacy appears to be the mediator between goal orientation and performance (Honicke et al., 2020), with a strong relationship with mastery and approach goals, but a weaker one with avoidance and performance goals (Huang, 2016).

Lastly, *self-handicapping* is the creation of obstacles to one's own success, with the intention of protecting or enhancing perceived competence (Funkhouser & Hallam, 2022). This strategy of defending one's own self-worth, unlike others such as self-assertion, is anticipatory in nature (Valle et al., 2007). In other words, a student displays this behaviour with the aim of protecting their self-worth before engaging in the activity. Choosing circumstances that make work impossible is an example of this type of strategy (Valle et al., 2007). The meta-analysis by Schwinger et al. (2014) shows that self-handicapping has a negative influence on performance. Furthermore, it appears to be related to the type and orientation of goals: as learning goals become higher, the use of self-handicapping strategies decreases, while greater use is made of them when avoidance goals or even performance approach goals increase (Valle et al., 2007).

Different self-regulation strategies are key to academic performance. However, previous studies have focused mainly on finding out which strategies are used in general, rather than by performance groups. Similarly, there has been no detailed analysis of which of these types of strategies actually explain performance, beyond whether they are used more or less or explain part of performance individually. In short, it is unknown which types of strategies seem to be most relevant for achieving average or high performance in demanding academic subjects such as mathematics.

Mathematical performance and self-regulation in secondary school

Self-regulation strategies for science performance are even more powerful than in other areas (Li et al., 2018), which encourages the development of studies on self-regulation in mathematics. Furthermore, they are positively related to mathematical performance in secondary school (Alyani & Ramadhina, 2022), with students with high self-regulation profiles showing higher mathematical performance (Cleary et al., 2021).

When strategies are disaggregated and studied separately, rather than as a set of self-regulation skills, we continue to find positive effects. Metacognitive strategies, for example, predict adolescents' engagement with mathematics, which enhances their performance (Wang et al., 2021). Critical thinking promotes higher mathematics performance in secondary school students, especially in lower-performing students, but loses its effectiveness in high-performing ones (Duru & Obasi, 2023). Motivational strategies are also strong predictors of mathematical performance, even above other variables such as intellectual ability (Abín et al., 2020).

Despite the available data corroborating the great value of self-regulation strategies on mathematical performance, there is little information on whether they are equally effective for students of different performance levels, or which ones are most commonly used when analysed as a whole. One of the few examples available in secondary education is the study by Paz-Baruch & Hazema (2023), which showed how high-achieving students used all strategies to a greater extent than typical-achieving students, except for the critical thinking strategy, which was more common among the latter. The study by Kim et al. (2015) offers similar results: high-achieving students showed higher levels of effort regulation and self-efficacy than low-achieving students.

Similarly, Torrano & Soria (2016) showed that the motivational strategies that seem to be used differently depending on performance level are learning goals, self-efficacy and self-handicapping. High-performing students use the first two to a greater extent, while the latter is used in lesser measure than low- and medium-performing students. In terms of learning strategies, high-performing students make significantly greater use of effort planning and monitoring than lower-performing students.

In summary, the use of different types of learning and motivation strategies and their relationship with different levels of mathematical performance is well known. However, it is not known which of these strategies explain each type of performance when analysed together, especially in Spain. Therefore, it seems necessary to make further progress in this area.

The present study

This study has two objectives. One, to analyse the use of learning and motivation strategies by secondary school students according to their level of mathematical performance. Two, to explore the contribution of learning and motivation strategies at different levels of mathematical performance. In accordance with the theoretical framework presented, the following hypotheses are proposed:

- H1: In learning strategies, a differential impact is expected across different achievement levels on mathematics performance.
  All strategies will be used to a greater or lesser extent by all students (e.g., Paz-Baruch & Hazema, 2023; Torrano & Soria, 2016). High-performing students will use learning strategies to a greater extent than lower-performing students, except in critical thinking (H1a). However, although these strategies have an impact when analysed individually (Duru & Obasi, 2023; Sun et al., 2018), when analysing all the variables taken together and by performance groups, we expect that only some of them will have an impact on mathematical performance (H1b).
- H2: In motivational strategies, a differential impact is also expected between different achievement levels on performance in mathematics.
  All motivational strategies will be used to a greater or lesser extent by students (Paz-Baruch & Hazema, 2023; Torrano & Soria, 2016), and we expect their use to be greater among high-performing students, except for self-handicapping (H2a). When analysed individually, all will

have a positive impact (Sorić et al., 2017; Sun et al. 2018), except for self-handicapping, which will have a negative impact (Schwinger et al., 2014). However, when analysing all the variables together and by performance levels, several of these individual effects will disappear, and only some of them will have a significant impact on mathematical performance (H2b), offering a more realistic view of the impact of these variables.

Method

Design

A quantitative methodology with a non-experimental cross-sectional design was used.

Participants

The study involved 392 compulsory secondary education (ESO) students from two schools located in areas of medium sociocultural level in the city of Salamanca (Spain). One hundred students were excluded from the analysis because some of their questionnaires were missing answers to certain items. The final sample of participants consisted of 292 students (42.8% female and 57.2% male). Non-probability purposive sampling was used. The age range of the students was 12-17 years old (M= 14.02 and SD=1.31). The distribution of the sample according to compulsory secondary education academic years was as follows: 1st year (n=85), 2nd year (n=50), 3rd year (n=82) and 4th year (n=75), organised into fifteen classrooms with four mathematics teachers.

Instruments

Learning strategies

The use of learning strategies was assessed using the Learning Strategies and Motivation Questionnaire (*Cuestionario de Estrategias de Aprendizaje y Motivación,* CEAM II-R2) by Roces et al. (1995), based on the *Motivated Strategies for Learning Questionnaire* (MSLQ) by Pintrich et al. (1991). Specifically, the learning strategies scale was used, consisting of 57 items organised into three dimensions: cognitive strategies (repetition, elaboration, organisation and critical thinking), metacognitive strategies and resource control strategies (perseverance, effort, study environment, peer support and teacher support). Students indicated their level of agreement with each item on a 1-7 point Likert scale (1 = no, never to 7 = yes, always). The scale had a good reliability index (α = .93), with Cronbach's alpha for the dimensions ranging from .90 to .69 (Hair et al., 2018).

Motivation strategies

The use of motivational strategies was assessed using the Spanish adaptation by González-Torres & Torrano (2012) of Midgley et al.'s *Patterns of Adaptive Learning Survey* (PALS) questionnaire (2000), consisting of 39 items organised into four dimensions: academic goal orientation (learning goals, approach performance goals, avoidance performance goals), perception of classroom goals (learning goals, approach performance goals, avoidance performance goals), academic self-efficacy, and self-handicapping strategies. Students indicated their level of agreement with each item on a 1-7 point Likert scale (1 = no, never to 7 = yes, always). The scale had a good reliability index (α = .90), with Cronbach's alpha for the dimensions ranging from .93 to .75 (Hair et al., 2018).

Academic performance

Mathematics performance corresponded to the quantitative grade for the subject. The Spanish grading scale ranges from 0 (fail) to 10 (excellent), with a pass mark of 5 or above.

Procedure

Educational centres were contacted to request their collaboration in the study, and informed consent was sought from the students' parents, following the ethical guidelines of the Declaration of Helsinki and the recommendations of the Research Ethics Committee of the University of Salamanca. Those students who had parental authorisation were assessed on their use of learning and motivation strategies through paper questionnaires. A simultaneous assessment was carried out in a large group by one of the authors of the study, lasting approximately 30 minutes, in the last term of the academic year. The educational centre provided academic performance data in mathematics for each of the students who participated in the study.

Data analyses

After verifying the normality of the variables involved in the study, non-parametric tests were used (K-S learning strategies = .065, p = .005; K-S motivation strategies = .084, p = .003; K-S performance = .136, p = < .001). Subsequently, the following were calculated: a) descriptive statistics and the Wilcoxon test to analyse the use of learning and motivation strategies by students, and the Kruskal-Wallis H test and Mann-Whitney U test with Bonferroni correction to analyse differences in the use of strategies; b) Spearman's rho correlation analysis to analyse the relationship between these strategies and academic performance, categorising them into three groups: low (0-4.99), medium (5-6.99) and high (7-10); c) multiple linear regression analysis to analyse the contribution of learning and motivation strategies to

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academic performance in mathematics. In cases where statistically significant differences were found, Cohen's d was calculated to provide an estimate of the effect size of the difference. Following Cohen's criteria (1988), the following were considered: adverse effect (<0), no effect (.0-.1), small effect (.2-.4), intermediate effect (.5-.7) and large effect (.8-≥1).

Statistical analyses were performed using SPSS Statistic 28 software.

Results

Use of learning and motivation strategies

The results obtained by students in the use of learning and motivation strategies according to performance groups are shown in Table I.

Table I. Descriptive statistics of learning and motivational strategies according to performance groups.

	PERFORMANCE			
	Low (n=33)	**Medium (n=85)**	**High (n=174)**	**Total (n=292)**
	M (SD)	**M (SD)**	**M (SD)**	**M (SD)**
LEARNING STRATEGIES	**4.44 (.92)**	**4.37 (.90)**	**4.76 (.81)**	**4.61 (.87)**
Cognitive Strategies	**4.43 (1.19)**	**4.15 (1.17)**	**4.33 (1.15)**	**4.29 (1.16)**
Repetition	5.00 (1.59)	4.69 (1.56)	4.49 (1.64)	4.61 (1.61)
Elaboration	4.60 (1.17)	4.25 (1.32)	4.63 (1.28)	4.52 (1.29)
Organization	3.98 (1.49)	3.76 (1.34)	3.89 (1.52)	3.86 (1.47)
Critical thinking	4.36 (1.57)	4.18 (1.61)	4.40 (1.49)	4.33 (1.53)
Metacognitive Strategies	**4.73 (1.31)**	**4.63 (1.14)**	**5.05 (.94)**	**4.89 (1.06)**
Resource Management Strategies	**4.40 (.81)**	**4.51 (.83)**	**5.07 (.70)**	**4.83 (.80)**
Perseverance (volitional)	4.78 (1.39)	5.04 (1.20)	5.72 (1.01)	5.41 (1.18)
Effort (volitional)	3.91 (.87)	4.09 (.89)	4.84 (.79)	4.52 (.92)
Study environment	5.39 (1.33)	5.50 (1.26)	5.80 (1.29)	5.66 (1.29)
Peer help	4.50 (1.29)	4.29 (1.19)	4.49 (1.16)	4.43 (1.18)
Teacher help	4.04 (1.89)	4.39 (1.75)	5.27 (1.59)	4.87 (1.74)
MOTIVATION STRATEGIES	**4.52 (.94)**	**4.44 (1.00)**	**4.66 (.77)**	**4.58 (.87)**
Academic Goal Orientation	**4.32 (1.37)**	**4.45 (1.44)**	**4.73 (1.20)**	**4.60 (1.30)**
Mastery goals	5.11 (1.59)	5.19 (1.53)	5.93 (1.19)	5.62 (1.39)

	PERFORMANCE			
	Low (n=33)	**Medium (n=85)**	**High (n=174)**	**Total (n=292)**
	M (SD)	**M (SD)**	**M (SD)**	**M (SD)**
Performance goals (Approach)	3.72 (1.68)	3.85 (1.88)	3.92 (1.68)	3.88 (1.74)
Performance goals (Avoidance)	4.08 (1.77)	4.29 (1.66)	4.25 (1.58)	4.24 (1.62)
Perception of classroom goals	**4.96 (1.15)**	**4.93 (1.12)**	**5.18 (.94)**	**5.08 (1.02)**
Mastery goals	5.86 (1.83)	5.68 (1.09)	6.12 (1.00)	5.96 (1.16)
Performance goals (Approach)	5.46 (1.14)	5.31 (1.50)	5.72 (1.98)	5.7 (1.78)
Performance goals (Avoidance)	3.59 (1.76)	3.81 (1.82)	3.73 (1.65)	3.74 (1.71)
Academic Self-Efficacy	**5.43 (1.32)**	**5.06 (1.55)**	**6.03 (.96)**	**5.68 (1.28)**
Self-Handicapping	**3.21 (1.41)**	**2.72 (1.29)**	**2.14 (1.08)**	**2.43 (1.24)**

Source: Own work.
Note: The totals for each of the two types of strategies analysed are highlighted in bold.

At the secondary school level, students report similar use of learning strategies and motivational strategies (Z=-.624, p=.532). In the case of learning strategies, high-achieving students show slightly higher use than other students with average (U=-34.802, p=.006) and low (U=-25.668, p=.101) performance. In the case of motivational strategies, there are no differences in their use according to student performance [χ2 (2) = 2.427, p=.297].

Learning strategies. The most commonly used are metacognitive strategies ($Z_{Cognitive}$=-14.812, p=<.001; $Z_{ResourceControl}$=-14.812, p=<.001) and resource control strategies ($Z_{Cognitive}$=-12.355, p=<.001), with higher-performing students reporting greater but not significant use (with Bonferroni correction, only p<.017 will be considered significant) of metacognitive strategies than medium-performing students (U=-30.048, p=.021) and low-performing students (U=-27.446, p=.120); as well as a significantly greater use, in this case, of resource control compared to medium (U=-59.94, p=.001) and low-performing students (U=-68.599, p=.001). Specifically, the most commonly used resource control strategies appear to be the study environment (Z_{effort}=-14.745; p=<.001; $Z_{peer\ help}$=-8.084, p=<.001; $Z_{teacher\ help}$=-6.861, p=<.001) and perseverance (Z_{effort}=-14.815; p=<.001; $Z_{study\ environment}$=-13.763, p=<.001; $Z_{peer\ help}$=-14.110, p=<.001; $Z_{teacher\ help}$=-7.929, p=<.001), with higher-achieving students making significantly greater use of them than medium students (U= -48.558, p<.001) and low (U=-60.008, p=.001) in perseverance, but without

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reaching significance with either the medium (U=-24.925, p=.025) or low (U=-30.335, p=.051) in resource control. In all cases, the effect size was >1.0, which is considered a strong effect.

According to performance groups, low- and medium-performing students would be characterised by the use of repetition as a cognitive strategy and the study environment as a resource control strategy. Meanwhile, high-performing students would be characterised by the use of elaboration as a cognitive strategy, metacognition and the study environment and perseverance as resource control strategies.

Motivation Strategies. The most commonly used is self-efficacy ($Z_{AcademicGoals}$=-14.781, p=<.001; $Z_{ClassroomGoals}$=-14.813, p=<.001; $Z_{Self-handicapping}$=-13.275, p=<.001), with higher-performing students making significantly greater use of it than medium-performing students (U=-53.690, p<.001) but not low-performing students (U=-37.914, p=.053). The least used strategies are self-handicapping ($Z_{AcademicGoals}$=14.808, p=.000; $Z_{ClassroomGoals}$=-14.812, p=.001), in which higher-performing students make significantly less use than medium (U=39.684, p=.001) and low-performing students (U=68.472, p=.000). With regard to the academic goal orientation strategy, the most commonly used is learning goals ($Z_{GoalsPerformanceApproach}$=-12.427, p=<.001; $Z_{GoalsPerformanceAvoidance}$=-14.096, p= <.001) and in relation to classroom goals, it is the learning class goals strategy ($Z_{ClassGoalsPerformanceApproach}$=-14.573, p=<.001; $Z_{ClassGoalsPerformanceAvoidance}$=-14.489, p=<.001). In both cases, it is the students with higher performance who make significantly greater use than those with medium (U=-42.341, p=.000) and low (U=-49.170, p=.006) performance for the first, and also significantly greater than those with medium (U=-37.470, p=.001) but not than those with low performance (U=-32,594, p=.040) for the second. In all cases, the effect size was >1.0, which is considered a strong effect.

According to performance groups, low- and medium-performing students are characterised by the use of mastery goals as a strategy for academic goal orientation, class mastery goals as a strategy for classroom goal perception, and self-handicapping strategies. High-performing students are distinguished by their use of academic self-efficacy and low use of self-handicapping strategies.

Contribution of the use of learning and motivation strategies to academic performance

Student performance in mathematics is shown in Table II.

Table II. Descriptive statistics of performance.

	M	SD	Min.	Max.
Total	6.87	1.85	2	10

Source: Own work.

The analysis of correlations between the use of learning and motivation strategies and different levels of academic performance in mathematics (see complete data in Appendix I) shows that only in the case of medium and high performance are some of the strategies related to performance. Table III shows the strategies in each case.

Table III. Strategies related to each level of academic performance in mathematics.

	PERFORMANCE		
	Low (n=33)	**Medium (n=85)**	**High (n=174)**
Learning strategies			Elaboration (C) (rho= .267, p=<.001)
			Critical thinking (C) (rho=.185, p=.015)
		Metacognitive strategies (rho=.187, p=.086)	
			Perseverance (RM) (rho=.128, p=.091)
			Effort (RM) (rho=.347, p= <.001)
		Peer help (RM) (rho=.339, p=.001)	
			Teacher help (RM) (rho=.144, p=.058)
Motivation strategies			Mastery goals (AG) (rho=.179, p=.018)
			Performance goals (Approach) (AG) (rho=.126, p=.097)
			Classroom Performance goals (CG) (rho=.130, p=.087)
		Self-efficacy (rho=.187, p=.087)	Self-efficacy (rho=.297, p= <.001)
			Self-handicapping (rho=-.246, p=.001)

Source. Own work.
Note. C: cognitive; RM: resource management; AG: academic goals; CG: classroom goals
Significant positive relation $p<.05$
Marginally significant positive relation $p<.1$
Significant negative relation $p<.01$

Based on statistically significant correlations, a multiple linear regression analysis was performed. The Durbin-Watson statistic was calculated, showing the independence of the residuals, as well as the tolerance and the variance inflation factor (VIF), showing the absence of multiple collinearity (Table IV).

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Table IV. Regression coefficients.

MODEL		β	t	DW	TOLERANCE	VIF	F	R^2
MEDIUM PERFORMANCE (n=85)								
Learning strategies	Metacognition	.008 (p=.947)	.067	1.933	.725	1.379	5.889 (p=.004)	.126
	Peer help	.350 (p=.005)	2.887					
Motivation strategies	Self-efficacy	.199 (p=.067)	1.853	1.841	1.00	1.00	3.433 (p=.067)	.040
HIGH PERFORMANCE (n=174)								
Learning strategies	Elaboration	.140 (p=.158)	1.502	2.157	.578	1.729	6.264 (p=<.001)	.157
	Critical thinking	.145 (p=.100)	1.616		.626	1.597		
	Perseverance (volitional)	-.103 (p=.222)	-1.226		.710	1.408		
	Effort (volitional)	.322 (p=<.001)	4.019**		.780	1.282		
	Teacher help	.017 (p=.826)	.220		.846	1.182		
Motivation strategies	Mastery goals	-.038 (p=777)	-.283	2.036	.284	3.526	4.546 (p=<.001)	.119
	Performance goals (Approach)	.112 (p=.165)	1.394		.814	1.228		
	Classroom Mastery goals	-.103 (p=.437)	-.779		.302	3.308		
	Self-efficacy	.293 (p=.001)	3.240**		.60	1.563		
	Self-handicapping	-.163 (p=.047)	-2.003		.790	1.265		

Source. Own work.
$^{a}p<0.1$; $^{*}p<0.05$; $^{**}p<0.01$

Table V presents the regression model including only the significant variables detected in the model in Table IV.

Table V. Regression coefficients.

MODELO		β	t	DW	TOLERANCE	VIF	F	R2
RENDIMIENTO MEDIO (n=85)								
Learning strategies	Peer help	.354 (p=<.001)	3.452	1.935	1.00	1.00	11.916 (p=<.001)	.126
Motivation strategies	Self-efficacy	.199 (p=.067)	1.853	1.841	1.00	1.00	3.433 (p=.067)	.040
RENDIMIENTO ALTO (n=174)								
Learning strategies	Critical thinking	.191 (p=.008)	2.688	2.146	1.00	1.00	13.768 (p=<.001)	.139
	Effort (volitional)	.322 (p=<.001)	4.532		1.00	1.00		
Motivation strategies	Self-efficacy	.255 (p=.001)	3.294	2.,027	.879	1.137	9.236 (p=<.001)	.097
	Self-handicapping	-.112 (p=.105)	-1.446		.879	1.137		

For medium performance, the learning strategies model was significant (p<.001), explaining 12.6% of the variance in performance, where only the variable peer support contributed significantly and positively to academic performance in mathematics. The motivation strategies model was marginally significant (p<.067) with a marginally significant contribution from the self-efficacy variable.

In the case of high performance, the learning strategies model was significant (p<.001), explaining 13.9% of the variance in performance, with the variables effort and critical thinking contributing positively and significantly to academic performance in mathematics. The motivation strategies model was also significant (p<.001), explaining 9.7% of the variance in performance, with positive self-efficacy and negative self-handicapping strategies marginally explaining performance.

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Discussion and conclusions

The objectives of this study were to analyse the use of learning and motivation strategies by secondary school students according to their level of mathematical performance and to explore the contribution of these strategies at different performance levels.

The results obtained are consistent with previous studies (Paz-Baruch & Hazema, 2023; Torrano & Soria, 2016). Students use all learning and motivation strategies regardless of their level of mathematical performance. However, it appears that not all learning strategies are used to a greater extent by high-performing students, as claimed by Paz-Baruch & Hazema (2023). In the current study, resource management is not used more by high-performing students compared to low- and medium-performing students. In the case of motivational strategies, higher-performing students report greater use of all strategies except self-efficacy, self-handicapping, and avoidance-type class goals. This partially confirms hypotheses H1a and H2a.

It seems reasonable to assume that simply using these strategies does not guarantee that they will have a significant impact on performance. In fact, only in cases of average and high performance a relationship between self-regulation strategies and mathematical achievement is found.

Given this situation, it is worth asking what happens with low/medium performers if they also seem to use these strategies, and some even to the same extent as higher performers. A joint analysis of the types of strategies can help us understand these relationships and their contribution to performance beyond the individual contributions already known and reported by previous research (e.g. Abín et al., 2020; Alyani & Ramadhina, 2022; Duru & Obasi, 2023 or Wang et al., 2021). First it is offered an analysis of what the data suggest from this individual impact and then an analysis of them together to see their real contribution.

In terms of learning strategies, correlation analysis reveals that there is a relationship between the strategies used by students and high performance. They use elaboration, critical thinking and repetition as their main cognitive strategies, and effort, perseverance and even help from the teacher seem to be key resources in their management of the environment when successfully tackling mathematical tasks. Interestingly, although they report similar use of metacognitive strategies, these strategies only correlate positively, marginally, with the medium performance group. To achieve an average result, it seems that students must be particularly strategic at the metacognitive level (planning, monitoring, evaluating) and rely on the help of their peers. However, if we are talking about an excellent result, the strategies that must be deployed are greater and many of them are complex.

When analysed together, the data on the type of strategy that actually contributes to different types of achievement modify this initial perception. In the case of medium performance, peer support is the only strategy that seems to explain the results achieved by this group of students. In the case of high-performing students, however, it is effort and critical thinking. At this point, it is worth remembering that effort is understood as a volitional strategy: it is not simply a matter of taking action and working hard, but of doing so strategically around a specific goal, with students taking on constant work that ultimately explains this type of result. As for critical thinking, it is important to note that not only does it appear as a frequently used strategy in the high-achieving group compared to the other groups, unlike the data from Paz-Baruch & Hazema (2023), but it also partly explains the achievement of these results.

These analyses allow for the identification of certain elements that had not been identified previously: 1) metacognitive strategy does not explain medium or high mathematical performance; 2) high performance is explained by the use of certain cognitive strategies (critical thinking) and resource management strategies (effort); 3) the only learning strategy that contributes to medium mathematical performance seems to be peer support, a resource management strategy that, given this result, should be valued. This confirms hypothesis H1b.

To complete the overview of the regulation of these students, it is necessary to look at the results obtained in the case of motivational strategies. When analysed individually, it can be seen how academic goals, especially those related to learning or mastery, have a significant positive correlation with high mathematical performance, confirming the study by Sorić et al. (2017). The other motivational strategy that seems to have a stronger positive relationship with high mathematical performance is self-efficacy, corroborating the data from Sun et al. (2018). Furthermore, this strategy seems to be common for the group of students with medium and high performance, with no significant relationship found in the case of low-performing students. High performance is related to the pursuit of mastery, marginally to the pursuit of performance, the perception of a learning-oriented classroom approach or mastery, and self-efficacy. Meanwhile, medium performance is related only to the latter. With regard to self-handicapping, for which a negative relationship was predicted (Schwinger et al., 2014), this was only found in the high-achieving group. However, when analysing all the variables together, not all those identified end up having an impact, as had been anticipated (H2b). In a more realistic view, in which students have numerous strategies at their disposal and use them all to a greater or lesser extent, it seems that self-efficacy is a key variable for both medium and high performance. Mastery and performance goals are diluted and do not end up having a significant impact. Self-handicapping strategies also remain, marginally explaining negative performance only in high-performing students. Given its repeated appearance in all analyses, self-efficacy emerges as a key motivational strategy that must be addressed in order to help students. Interestingly, the data on self-handicapping strategies brings us back to the previous discussion, as it is the only strategy that seems to have a negative impact on the high-achieving mathematics group, despite being the one they use least frequently. This is a paradox with significant educational implications. Previous studies (Valle et al., 2009) have demonstrated the relationship between learning or mastery orientation and the reduction of this type of strategy, so it is feasible to assume that within this group of high-achieving students, only those with a different orientation (e.g., performance approach) are likely to activate this type of defensive strategy more frequently. This is an interesting question to explore.

In conclusion, to understand performance in complex subjects such as mathematics, what matters is not the greater or lesser use of different learning and motivation strategies, but rather how they are used when students are faced with the content and have all of them at their disposal. In this sense, peer support and self-efficacy seem to be key to average performance, while effort, self-efficacy, critical thinking, and self-handicapping (in a negative sense) seem to be key to high performance.

This is one of the few studies of its kind in Spain that has relevant educational implications:

- If we want to help lower-performing students improve, peer support and self-efficacy strategies seem to be key.
- If we want high-performing groups, it is not enough for students to be intelligent, well organised (metacognitively speaking) or interested in what they are studying; they must also deploy volitional effort strategies that help them protect their goals from other possible ones. Teachers must also insist that their students feel capable of achieving the goals set for them, since the perception of self-efficacy is what explains both average and high performance.
- Finally, we must be aware of the type of goal orientation, because if it is defined primarily by demonstrating one's personal worth to others, the activation of self-protective strategies that negatively affect what is being pursued will be very likely. Insisting at every step on the importance of one's own learning rather than constant comparison, valuing effort even when mistakes are made, understanding them as part of the learning process (De Sixte et al., 2020), seems to be the key to everything. Only in this way will all students be helped.

Our data reinforce some of the most recent recommendations (Méndez-Giménez et al., 2017) that call on secondary school teachers to help their students pursue goals focused on the task ('doing it well') or on their own progress ('doing better than before'). Helping them feel effective in this process ('believing they can') and teaching them to ask their peers for help seem to be the other key factors at the educational level.

Limitations and prospects

This study has several limitations. First, the performance measure used in this work is the same as that commonly used in previous studies (e.g. Satrústegui et al., 2024; Torrano and Soria, 2016). However, it would have been more useful to control the teacher variable in some way, since the way it has been measured assumes educational homogeneity in all classrooms due to the obligation to follow educational regulations. It would be interesting to consider this in future studies.

Secondly, the use of self-reports means that the data may be biased by the social desirability of those being assessed. However, it is a common tool in this area of research as it is indispensable for assessing self-regulated learning (Pintrich, 2004) and it would be interesting to complement it with other methods that allow for a person-centred analysis (Pekrun, 2020) of mathematics content. This type of analysis would allow for an examination of the relationship between what is said to be done and what actually occurs when students are faced with learning a complete set of content. Thirdly, this is a cross-sectional study, which provides a static view of the use and impact of self-regulated learning strategies on performance. Future research with longitudinal designs would allow for a dynamic view of this in compulsory secondary education, as well as an overview of the strategies deployed in each of the courses in this stage. Fourthly, the sample means that the data cannot be generalised, so it would be interesting for future studies to increase the number of students in order to contrast the findings of this work, as well as to carry out a gender-based analysis.

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Appendix I. Correlations between learning and motivation strategies and performance groups

	PERFORMANCE			
	Low (n=33)	Medium (n=85)	High (n=174)	Total (n=292)
	M (SD)	M (SD)	M (SD)	M (SD)
LEARNING STRATEGIES	**.103**	**.157**	**.208**	**.24**
Cognitive Strategies	**.123**	**.134**	**.160**	**.08**
Repetition	.067	.152	.044	-.05
Elaboration	.133	.175	.267	.17
Organization	.131	.073	.041	.03
Critical thinking	-.028	.146	.185	.11
Metacognitive Strategies	**.046**	**.187**	**.058**	**.16**
Resource Management Strategies	**.125**	**.144**	**.267**	**.42**
Perseverance (volitional)	.195	.084	.128	.32
Effort (volitional)	.202	-.008	.347	.48
Study environment	.164	.050	.025	.15
Peer help	-.059	.339	.086	.09
Teacher help	.053	.143	.144	.30
MOTIVATION STRATEGIES	**-.015**	**.081**	**.124**	**.12**
Academic Goal Orientation	**.079**	**.023**	**.131**	**.14**
Mastery goals	.022	.158	.179*	.30
Performance goals (Approach)	.096	-110	.126	.06
Performance goals (Avoidance)	.022	-002	.074	.04
Perception of classroom goals	**-.070**	**.053**	**.091**	**.12**
Mastery goals	-.237	.024	.130	.22
Performance goals (Approach)	.060	.118	.086	.11
Performance goals (Avoidance)	.113	-.011	.023	.02
Academic Self-Efficacy	**.032**	**.187**	**.297**	**.34**
Self-Handicapping	**-.077**	**.015**	**-.246**	**-.34**

Source: Own work.

Note: The totals for each of the two types of strategies analysed are highlighted in bold.

Significant positive relation $p<.05$

Marginally significant positive relation $p<.1$

Significant negative relation $p<.01$