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The interaction between bullying, socioeconomic background and attitudes on educational achievements: Evidence from the Balkan countries with TIMSS 2019 data

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Abstract

Despite substantial evidence about the negative impact of bullying on academic achievement, there is relatively scarce literature on the issue of bullying in the Balkan countries, which is an area that is prone to violence also in schools. In this study, we use data gathered from the 2019 TIMSS assessment of 4th grade students in eight Balkan countries, and implement mixed models of achievements in mathematics and science as well as student- and school-level explanatory variables to determine the interactions between these variables and bullying. The results indicate that students who are more frequently targets of bullying experience a stronger positive impact of confidence and socioeconomic background, while there is no significant impact of the school's emphasis on success and lower shortages of resources. Nonetheless, while student-level indicators generally have a lower impact on achievements than school-level ones, student-level confidence has a stronger effect than the average confidence at the school level. Our results provide evidence on possible interventions against bullying for policymakers in the region.

Keywords: **Bullying, Balkan countries, TIMSS 2019, achievements.**

Zależności między prześladowaniem, pochodzeniem społeczno-ekonomicznym i postawami wobec osiągnięć edukacyjnych: Dowody z badania TIMSS 2019 z krajów bałkańskich

Streszczenie

Pomimo wielu dowodów na negatywny wpływ przemocy rówieśniczej na wyniki w nauce, istnieje stosunkowo niewielka literatura dotycząca tego zjawiska w krajach bałkańskich, które są obszarem podatnym na przemoc również w środowisku szkolnym. W niniejszej pracy wykorzystujemy dane zebrane w międzynarodowym badaniu osiągnięć TIMSS 2019 przeprowadzonym wśród uczniów klasy czwartej w ośmiu krajach bałkańskich. W analizach wykorzystujemy modele wielopoziomowe, w których zmiennymi wyjaśnianymi są osiągnięcia uczniów w matematyce i naukach przyrodniczych, a zmiennymi objaśniającymi są czynniki na poziomie ucznia i szkoły. Badamy interakcje między tymi zmiennymi a zjawiskiem przemocy rówieśniczej. Wyniki wskazują, że im częściej doświadczają jej uczniowie, tym silniej odczuwają pozytywny wpływ pewności siebie oraz statusu społeczno-ekonomicznego. Nie zaobserwowano istotnego wpływu nacisku szkoły na sukces i mniejszych niedoborów zasobów. Mimo iż wskaźniki na poziomie ucznia mają zwykle mniejszy wpływ na osiągnięcia niż wskaźniki na poziomie szkoły, indywidualna pewność siebie ucznia ma silniejszy efekt niż średnia pewność siebie w szkole. Nasze wyniki dostarczają dowodów wskazujących możliwe obszary interwencji przeciw przemocy rówieśniczej dla decydentów w regionie.

Słowa kluczowe: **Przemoc rówieśnicza, dręczenie szkolne, kraje bałkańskie, TIMSS 2019, osiągnięcia edukacyjne.**

1. INTRODUCTION

Bullying in schools is a pervasive issue that has garnered significant attention from researchers and policymakers alike (Smith, Ananiadou & Cowie, 2003). It is well-established that bullying can have long-lasting negative effects on the psychosocial health of both victims and perpetrators. Victims and perpetrators of bullying often experience a decline in mental health, which can persist into adulthood, manifesting in lower psychosocial health, as well as affluence (Wolke, Copeland, Angold, & Costello, 2013; Flaspohler, Elfstrom, Vanderzee, Sink, & Birchmeier, 2009). The negative impact of bullying on educational achievement has been consistently documented across various countries and academic domains. For instance, studies by Murillo and Román (2011), Ponzo (2013), Van der Werf (2014), as well as Al-Raqqad, Al-Bourini, Al Talahin, and Aranki (2017) provide robust evidence that bullying correlates with lower academic performance. The psychological stress caused by bullying can lead to a negative perception of the educational environment, and this impacts learning and therefore achievements.

Despite the large amount of literature on bullying globally, there is a relative scarcity of studies focused on the Balkan countries. The limited evidence available, such as the work by Kovačević (2019), suggests that schools in this region are particularly susceptible to violence, including bullying. This susceptibility is likely influenced by broader societal issues, including political instability, economic hardship, and cultural attitudes towards violence. Nikolaidis et al. (2018) and Kovačević (2019) indicate that the prevalence of bullying in Balkan schools is substantially high, further emphasizing the need for effective interventions. The high incidence rates in this region may reflect underlying societal norms that may not be able to limit and prevent aggressive behaviour, making it more challenging to implement anti-bullying policies that are effective in other contexts.

This paper investigates the relationship between student bullying, socioeconomic background, and student attitudes in influencing educational outcomes. Specifically, it explores how bullying influences the relationship between a student's socioeconomic status, their confidence, and their academic achievement. The analysis uses data from the 2019 Trends in International Mathematics and Science Study (TIMSS) assessment of 4th grade students (Mullis et al., 2020), with a focus on the Balkan countries that took part in the assessment. By focusing on this geographic region, the study aims to contribute to the growing body of research that examines how factors such as bullying can impact academic performance in underrepresented contexts in educational research.

2. LITERATURE REVIEW

Emerging research has begun to explore the relationship between bullying and socioeconomic background, revealing that students from more affluent backgrounds may be more likely to engage in bullying behaviour, targeting their less affluent peers (Silva et al., 2024). This dynamic can be understood through the lens of social dominance theory, which posits that individuals or groups with more resources or power may assert their dominance over those with fewer resources. Jansen et al. (2012) also observed that disadvantaged students are more frequently targeted by bullies, although this pattern does not seem to be significantly influenced by the overall socioeconomic profile of the school. This finding suggests that individual socioeconomic status may play a critical role in bullying dynamics.

However, Tippett and Wolke's (2014) meta-analysis highlights that the relationship between socioeconomic status and bullying is complex and non-linear, suggesting that all students, regardless of their socioeconomic background, are at risk of being involved in bullying, either as victims or perpetrators. This complexity underscores the need for interventions designed on evidence that address bullying across all socioeconomic strata. Furthermore, it is also important to consider gender gaps in bullying, which usually sees boys as being the victims and perpetrators more often (see for instance Cosma et al., 2022). Yet, this could also affect achievement gaps. For instance, the results from the 2019 edition of TIMSS indicate that boys tend to outperform girls in mathematics, while the opposite is observed in science (Mullis et al., 2020). It is therefore important to assess if and how gaps in bullying can influence gaps in achievements, considering the role of gender influencing both aspects.

Socioeconomic status is not only a factor in bullying but also moderates the broader school climate, influencing the incidence of bullying and violence in schools (Deniz, 2015; Jain et al., 2018). A positive school climate can reduce the adverse effects of a low socioeconomic background on student achievement (Berkowitz et al., 2017). This could be due to more supportive relationships and sense of community, as well as a safe physical environment; for this reason, we investigate to what extent the school climate (measured through bullying) can interact with socioeconomic background and school in influencing achievements.

Furthermore, the role of student attitudes and motivations has been found to be a significant predictor of academic success, independent of socioeconomic status (Bellibaş, 2016). Among them, student confidence is one of the factors that are associated with increased academic achievements (Stankov, 2012), including in the TIMSS assessment itself (Mullis et al., 2020). However, findings suggest that the relationship may be reversed, with achievements being the drivers of a higher confidence in a given domain (Tripathy & Srivastava, 2012). We include this aspect by adding indicators relating to attitudes (such as student confidence or school emphasis on academic success) in our investigation. Another important aspect relates to the urban location of the school, which is usually associated with higher achievements as a result of increased socioeconomic background compared to rural areas (Betancur et al., 2024).

In addition to achievement and social relationships, bullying can also negatively affect the attitudes that students have toward school (Demanet & Van Houtte, 2012; Najam & Kashif, 2018). The social isolation and stigmatization that often accompany bullying can exacerbate feelings of disengagement from the school community, making it even more difficult for victims to succeed academically. However, research also suggests that interventions aimed at supporting student confidence can be effective in reducing bullying and its negative consequences (Beran & Shapiro, 2005). Therefore, it is important to evaluate to what extent bullying and student attitudes—such as confidence—can interact in their effect on academic achievements.

School-based policies that involve teacher interventions have been shown to mitigate the impact of bullying, though the effectiveness of these interventions often depends on the teacher's confidence and willingness to address the issue (Novick & Isaacs, 2010; Maynes & Mottonen, 2017). Moreover, Veenstra et al. (2014) emphasize the role of the classroom environment, suggesting that teachers can play a crucial role in preventing bullying. Overall, in our analysis we include variables relating to school-level policies and attitudes that relate to the availability of resources and climate, namely shortages and emphasis on academic success. The aim is to check whether they influence achievements both directly and through interaction with student bullying.

An aspect that could influence the emergence of bullying is the creation of within-school hierarchies. In this respect, social dominance theory (Sidanius & Pratto, 1999) could be used to investigate bullying dynamics in schools. Previous research has shown that bullying behaviours are associated with individual orientations towards social dominance (Reijntjes et al., 2013; Goodboy et al., 2016; Volk et al., 2021). This can also have an impact on school environment more generally, as well as on relationships between peers in school (Kiefer & Ryan, 2008; Hawley, 2015). Therefore, it is important to investigate if and how bullying can influence educational achievements, both directly and as an influencer of other variables.

3. DATA AND METHODOLOGY

This study uses data gathered from the 2019 edition of the TIMSS assessment, in particular from the student questionnaire, which includes a survey of competencies in mathematics and science, as well as inquiries surveying the attitudes of students themselves. Furthermore, we include indicators gathered from the principal's questionnaire, allowing us to add school-related indicators to our analysis. We included the data gathered for 4th grade students in the Balkan countries that took part in the assessment, namely Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Kosovo, Montenegro, North Macedonia, and Serbia.

The TIMSS survey administers a large number of items to participants, covering a broad range of topics, which are later used to build scales that are indicative of such topics. In our analysis, we used some of these scales to investigate how they interact with bullying in their association with academic achievements. Table A1 in the Appendix presents the measures included in our analysis, together with the associated items administered to students in the TIMSS questionnaires. It should be noted that these variables are based on reports by students and school principals, which could decrease their reliability, since they are not based on objective indicators or measurements. Moreover, the measure of bullying is based entirely on items relating to being a victim of bullying, which does not allow the perpetrators of bullying to be considered as well. This, in principle, could have an impact on the reliability of the findings, since the results could be biased due to the selection of the sample or the subjective beliefs or attitudes of the participants. While the sample selection bias is reduced through the use of sample weights (see below), it is important to stress that the results should be read bearing in mind the lack of the absolute objectivity of the measures.

In our analysis, we implemented mixed models and used educational achievements as the dependent variable, adding a number of indicators as independent variables. In particular, we included the scales of student bullying, availability of home resources, and student confidence in mathematics or science (separately for the two domains) as measured by the TIMSS assessment. As an additional control variable, we also included student gender in our models. From the principal's questionnaire, we included shortages in mathematics or science lessons (separately for the two domains), and emphasis on academic success. We also added school location as an additional control variable, coded as "Urban" for schools that are in densely populated areas, suburban, or medium-sized cities.

All the indicators have been standardized and centred on students, except for the dummy variables of gender and school location. The standardization of the dependent variables also allows us to compare the magnitude of the impact of each of the variables within and between educational domains. Moreover, the choice of the explanatory variables allows us to have two indicators of attitudes, namely student confidence and the school's emphasis on academic success, and two indicators of affluence, namely student availability of home resources and the school's resource shortages.

The data pooling is based on the assumption of the general homogeneity in the Balkan countries, due to regional characteristics, as well as on the aim of the research, which focuses on general regional trends. However, this also comes with the limitation that some sensitivity is lost at the country-level, as heterogeneity between countries still exists. To reduce the potential impact of this bias, we included country-fixed effects in the mixed models, thus acquiring results that are broadly representative of the regional trends, but that also take into account the possible differences found between the countries in the region. Moreover, it should also be stressed that the analysis is based on cross-sectional data, which in practice does not allow for definitive causal inferences, but only to infer associations between variables. While this still provides important

results to inform policy recommendations, the impossibility to infer causal relationships should be highlighted as the findings may not reflect direct effects but rather just correlations among indicators.

To analyse the data, we employed linear mixed-effects models (LMMs) to account for both fixed and random effects. The fixed effects included the student- and school-level indicators, while the random effects captured the variability among schools. The general form of the model is given by:

yij= 0+ k=1pkxijk+ ui+ ij

where yij represents the response variable for observation j in group i, 0 is the fixed intercept, k are the fixed-effect coefficients associated with the predictor variables xijk, ui is the random effect for group i assumed to follow a normal distribution with mean 0 and variance u2, and ij is the residual error term with variance u2. Model fitting was performed using Stata software, and the significance of the fixed effects was assessed through likelihood ratio tests.

We implemented six mixed model specifications, including the survey weights of the TIMSS assessment, to obtain a measurement that is representative of the entire student population of the countries surveyed, which we considered a single pooled dataset but including country-fixed effects. In the mixed models, student-level weights (computed as the product of the student weight factor WGTFAC3 and the student weight adjustment factor WGTADJ3) are included as level-one weights in order to give the same weight to all participants regardless of the country, while school-level weights (computed as the product of the student weight factor WGTFAC1 and the student weight adjustment factor WGTADJ1) are included as level-two weights—school-level weights are rescaled to sum up to the school size in the specification of the mixed model.

To account for the impact of school- and student-level variables, we computed school averages of the variables measured at the student level (i.e., bullying, availability of home resources, and confidence), and included them among the school-level indicators. Furthermore, we computed within-school measures of these indicators as the gap between the individual level and the school average, and included them among the student-level indicators. The interactions included in the mixed models are computed using within-school bullying, and within-school variables when available (i.e., in the case of home resources and student confidence).

In all the mixed models, the dependent variable is student achievements (in mathematics or science), which are measured through plausible values in the TIMSS assessment. We ran the models using only the first plausible value, as this allows the analysis to be simplified. Although the imputation measurement error is not accounted for, it is usually negligible, so we can treat the results as statistically reliable (Jerrim et al., 2017). In model specification 1, we only include the indicators specified above. In each of model specifications 2–5, we include the interaction terms of the student-level indicator of bullying and the four variables that measure attitudes and affluence (namely student confidence, availability of home resources, school's emphasis on academic success, and resource shortages). In model specification 6, we include all the interaction terms together. We compute variability at the school level, given that it is the environment in which bullying may take place in the most impactful way.

4. RESULTS

This section presents the results of our mixed models. Table 1 shows the results for 4th grade students in mathematics, while Table 2 shows the results for 4th grade students in science. The results are consistent overall when comparing mathematics and science, indicating that the domain of learning does not appear to have a substantial influence over the significance of the relationships between the main variables. This suggests that the underlying factors affecting student achievement are relatively stable across different subject areas, reinforcing the idea that broader educational and environmental influences may play a more dominant role than domain-specific factors.

As could be predicted, student- and school-level indicators are associated with achievements in the most intuitive way: in particular, lower bullying, higher availability of home learning resources, and higher confidence are all associated with higher student achievements, both when considered at the school- and at the student-level. This confirms previous literature suggesting that a supportive and resource-rich environment fosters better academic performance. It also highlights the need for schools to implement anti-bullying programs and ensure adequate learning materials at both the school and home environments. Nonetheless, shortages do not present any significant coefficient, while emphasis on academic success is positively associated only with achievements in science.

It is also worth noting that female students achieve significantly lower scores in mathematics, but not in science. This finding aligns with previous research on gender disparities in STEM subjects, suggesting that societal or educational factors may contribute to these differences in mathematics performance. Further investigation into classroom dynamics, teacher expectations, and cultural influences may be needed to fully understand these patterns.

Interestingly, it can also be seen how being in an urban school is not associated with mathematics achievements, and is negatively associated with science scores. This result is somewhat unexpected, as urban schools could be assumed to provide better educational resources. One possible explanation is that urban environments introduce additional variables that may counterbalance any advantages in infrastructure or teaching quality. These results are particularly interesting, since it could instead be expected that significant gaps would emerge between students in urban and rural schools based on resource

shortages; however, the inclusion of further control variables and especially country-fixed effects could explain why these variables are not significant. This suggests that educational inequalities may be more nuanced than traditionally assumed, and that country-level policies or socio-economic factors might be influencing the patterns observed in student achievements.

Crucially, among the interactions, only student confidence retains significance both for mathematics and science and among model specifications. This finding underscores the importance of psychological and emotional factors in academic success. Confidence appears to be a stable and strong predictor of achievement, suggesting that interventions aimed at boosting student self-efficacy could have lasting positive effects across different learning domains. In mathematics, the availability of home learning resources and confidence present negative interactions with bullying—the first two variables are the only ones that are statistically significant and retain their significance when all the interactions are accounted for at the same time (model specification 6). In science, as noted, only caonfidence presents a significant interaction with bullying and maintains it when all the interactions are accounted for at the same time (model specification 6). This reinforces the idea that confidence is not only a direct predictor of achievement but also plays a buffering role against negative experiences such as bullying. Students with higher confidence may be more resilient to peer victimization, allowing them to maintain their academic performance despite challenges.

Table 1 ***Mixed models of mathematics achievements***

	(1)	(2)	(3)	(4)	(5)	(6)
School-level variables						
Lower bullying	20.7***	20.7***	20.4***	20.6***	20.7***	20.4***
Home resources	43.1***	43.1***	43.1***	43.1***	43.1***	43.1***
Confidence in mathematics	11.4*	11.5*	11.6*	11.4*	11.4*	11.7*
Lower resource shortages	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Emphasis on success	3.8	3.8	3.8	3.9	3.8	3.8
Urban school	-6.3	-6.3	-6.3	-6.3	-6.3	-6.3
Student-level variables						
Lower bullying	2.4***	2.3**	2.0**	2.4***	2.3***	1.9**
Home resources	21.8***	21.9***	21.8***	21.8***	21.8***	21.9***
Confidence in mathematics	28.8***	28.8***	28.9***	28.8***	28.8***	28.9***
Gender (female)	-4.9***	-4.9***	-4.9***	-5.0***	-4.9***	-4.9***
Interactions of student-level bullying						
Student-level home resources		-2.9**				-2.0*
Student-level confidence in mathematics			-3.4***			-3.0***
Emphasis on success				-0.9		-0.8
Lower resource shortages					-1.1	-0.8
Constant	528.1***	528.1***	528.8***	528.1***	528.1***	528.6***
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
School-level variance	1027.5	1026.5	1028.2	1027.2	1027.3	1027.1
Student-level variance	3592.7	3589.6	3585.0	3592.1	3591.8	3582.5
No. of observations	31 799	31 799	31 799	31 799	31 799	31 799

Source: TIMSS 2019. *indicates p<0.05, **indicates p<0.01, ***indicates p<0.001

Table 2 ***Mixed models of science achievements***

	(1)	(2)	(3)	(4)	(5)	(6)
School-level variables						
Lower bullying	17.9**	17.9**	17.7**	17.8**	17.9**	17.7**
Home resources	52.4***	52.4***	52.4***	52.4***	52.4***	52.4***
Confidence in science	10.0*	10.0*	10.1*	10.0*	10.0*	10.1*
Lower resource shortages	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Emphasis on success	4.8*	4.8*	4.7*	4.8*	4.8*	4.7*
Urban school	-9.3*	-9.3*	-9.3*	-9.3*	-9.3*	-9.3*
Student-level variables						
Lower bullying	4.3***	4.2***	4.0***	4.2***	4.2***	3.9***
Home resources	24.7***	24.8***	24.7***	24.7***	24.7***	24.8***
Confidence in science	19.0***	19.0***	19.0***	18.9***	18.9***	18.9***
Gender (female)	0.0	0.0	0.1	0.0	0.0	0.1
Interactions of student-level bullying						
Student-level home resources		-1.3				-0.8
Student-level confidence in science			-2.1**			-1.9*
Emphasis on success				-1.1		-1.0
Lower resource shortages					-1.1	-0.9
Constant	531.7***	531.7***	532.0***	531.7***	531.7***	532.0***
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
School-level variance	1087.0	1086.3	1084.6	1086.9	1086.9	1084.1
Student-level variance	4157.2	4156.7	4154.8	4156.4	4156.4	4153.3
No. of observations	31 641	31 641	31 641	31 641	31 641	31 641

Source: TIMSS 2019. *indicates p<0.05, **indicates p<0.01, ***indicates p<0.001

The comparison of school- and student-level variances also show how most of the variance is found between students, i.e., within schools, as opposed to between schools. Yet, variance between schools accounts for around 20% of the total variance, thus still showing somewhat large disparities between schools, which could be attributed to different teaching methods, classroom environments, or school resources. This indicates that while student-level differences are the primary drivers of achievement gaps, school-level factors still play a meaningful role. Policymakers should consider strategies that address both individual student needs and broader school-wide improvements to maximize educational equity.

Moreover, it can be seen that indicators such as bullying and home resources show larger coefficients when considered at the school-level, rather than the student-level. However, confidence shows the opposite trend, highlighting the importance of student self-efficacy within the school—something that is also confirmed by the results of the interactions with bullying. This suggests that while material resources are more influential at the institutional level, personal psychological attributes, like confidence, are more impactful at the individual level. Schools should, therefore, adopt a dual approach that enhances both tangible resources and student psychological well-being.

The finding that the interaction terms of student variables are negative and statistically significant indicates how, everything else being equal, students who are more subjected to bullying from their peers (and who therefore have a lower bullying scale) receive a stronger benefit from increased availability of home learning resources and confidence in the domain of mathematics, and confidence in the domain of science, but not necessarily from an increased emphasis on academic success and lower shortages of resources. Interestingly, while all the interactions are negative in magnitude, only confidence maintains its

significance when all the terms are considered together. This suggests that confidence serves as the most robust protective factor against the negative effects of bullying. Unlike external factors that may provide indirect benefits, confidence appears to have a direct and significant impact on students' ability to withstand negative school climate experiences.

This suggests that while the overall environment of academic emphasis may play a role in mitigating the negative effects of bullying, the most crucial factors are those that directly influence the individual student's experience and self-perception. Specifically, the significant interaction between bullying and confidence in the domain of learning implies that students who face bullying but maintain higher confidence levels are better equipped to cope with its adverse effects. This could be due to their ability to internalize the value of education and maintain motivation despite peer victimization. Moreover, the availability of home learning resources appears to be a critical buffer for these students, providing them with the necessary tools to succeed academically, even when school becomes a hostile environment. This reinforces the need for targeted interventions that specifically support at-risk students. Programs that foster self-confidence and provide additional learning resources at home could be particularly effective in protecting vulnerable students from the negative impact of bullying.

On the other hand, the diminished significance of interactions relating to broader contextual factors, such as the overall emphasis on academic success and resource shortages, when controlling for student-level factors, highlights the less impacting nature of these influences. It may be that these broader school-level factors are important, but not as directly impactful as the student's immediate environment and personal resources. This distinction is crucial for educators and policymakers, as it suggests that while system-wide reforms are valuable, student-centred strategies may yield more immediate and tangible benefits. Investing in personalized support mechanisms, such as mentorship programs and home-based educational resources, could prove to be highly effective in closing achievement gaps. This finding underscores the importance of targeted interventions that enhance individual students' confidence and access to resources at home, especially for those who are most vulnerable to the negative effects of bullying. Such targeted efforts could be more effective in improving educational outcomes than broader, less individualized strategies.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

We investigated the relationship between student bullying and the socioeconomic background and attitudes in their association with educational achievements in mathematics and science, on a sample of the eight Balkan countries that took part in the 4th grade assessments of the 2019 edition of TIMSS. In particular, we implemented mixed models that aimed at investigating in which way school climate—i.e., bullying—could interact with economic measures of affluence, namely the availability of home learning resources and school resource shortages, and with measures of attitudes, namely student confidence and the school's emphasis on academic success. Our analysis aimed at providing large-scale evidence on the relationship between achievements, bullying and economic and psychological factors, as well as on whether the interaction between bullying, affluence and motivations can differ between mathematics and science also in light of the additional independent variables.

Our analysis provides evidence that the interaction between bullying and student confidence plays a significant role in student achievement. Specifically, students who are more subjected to bullying, i.e., those with lower scores on the bullying scale, derive a stronger benefit from increased availability of home learning resources and higher confidence in mathematics, and from higher confidence in science. These student-level factors are crucial in mitigating the negative impacts of bullying, while broader contextual factors, such as the school's emphasis on academic success and the availability of resources, play a less direct role. This highlights the importance of targeted interventions directly addressing the needs and experiences of bullied students.

Our results suggest several policy recommendations. Foremost is the need to reduce bullying across all grades, as this reduction is strongly associated with improved educational achievements. The coefficients of the mixed models indicate that the average bullying at the school level has a stronger impact on achievements than within-school bullying, which suggests that the phenomenon should be tackled organically at the school level, and not just by improving the relative condition of individual students. Given that bullying can also significantly affect students' well-being and confidence, addressing this issue could have a broad positive impact on other educational indicators as well. To this aim, it is important for school authorities to establish monitoring, as well as to provide opportunities for students to report instances of bullying.

Additionally, enhancing students' confidence in their academic abilities and ensuring their access to sufficient home learning resources can further improve their performance in mathematics and science. These targeted interventions are particularly effective for students who are more vulnerable to bullying, emphasizing the need for personalized support strategies. To this aim, teaching programs and curricula could be better targeted in order to allow students to be confident and self-effective in learning; moreover, additional support courses and programs can help the most struggling students in gaining confidence, which is something that has been found to also mitigate the impact of bullying on achievements. Importantly, the results show that the within-school effect of confidence on achievements is stronger than the school-level one, which indicates that interventions should focus on helping individual students in their self-efficacy and confidence, rather than implement measures for the school as a whole.

The current study also opens avenues for future research. Some relationships observed in our analysis, such as the differential impact of resource availability depending on the bullying context, warrant further investigation. It could be valuable to explore how specific aspects of home learning resources or student confidence contribute to the observed outcomes. Additionally, while our study emphasizes the importance of student-level factors, further research could investigate the broader school environment's role in moderating the effects of bullying. Understanding these dynamics in greater detail could help refine intervention strategies and better support all students, particularly those who are most at risk.

In particular, our results suggest that student confidence could be the most important factor that can help mitigate the negative impact of bullying on academic achievements. This claim is based on the finding that confidence retains a significant coefficient in its interaction with bullying on achievements both in mathematics and science, and that confidence as such has a stronger association with achievements in its level found within schools, rather than between schools. Nonetheless, the dynamics by which confidence in mathematics or science could benefit students who more often report bullying are not explained by our models. Future investigations could be aimed at clarifying this relationship.

Third, as this study relies upon data gathered before the outbreak of the COVID-19 pandemic, it is also crucial to assess if and to what extent the relationship between bullying, attitudes, affluence, and educational achievements has changed as a result of school closures. This is because the most economically disadvantaged students may have found more difficulties in keeping their learning consistent when studying remotely, and this may also have impacted how their attitudes are associated with their achievements. Additional research could be directed at investigating how the pandemic has influenced the relationship between bullying and achievements, as well as how other variables interact with bullying in influencing achievements. To this aim, data from TIMSS 2023 could be used, allowing for a comparison between samples of students of the same countries. This could also help overcome the limitation relating to the use of cross-sectional data, given that analysing data coming from multiple editions of TIMSS would allow a temporal factor to also be included in the data analyses.

DECLARATION OF INTERESTS STATEMENT

The author declares that there are no competing interests to declare.

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SUPPLEMENTARY MATERIAL

Supplementary data for this article can be found online.

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