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Negative Emotions in The Mathematics Classroom: Shame and Humiliation Amongst High School Students

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Emotions play a significant role in learning mathematics, but some school situations may lead students to experience negative emotions. The objectives of this study were to analyse the emotional experience of embarrassment and humiliation in high school students in mathematics classes, define the role of sex and academic grade in the experience of such emotions, and determine the classroom situations related to these emotions. A cross-sectional survey study examined 479 Colombian high school students aged between 12 and 15 years old. The emotions and associated classroom situations were evaluated through self-report questionnaires. Higher levels of shame and humiliation were found among girls in the eighth grade. Shame was associated with peer teasing, and humiliation with peer exclusion and repressive teacher behaviours. Clearly, the emotions of humiliation and shame may be present in mathematics classes in high schools, calling for a review of the role of educators and the management of emotional health in the classroom in the teaching of mathematics.

Keywords: Humiliation; Shame; Mathematics; Emotions; Learning.

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Introduction

Children and young people experience various emotions in their learning (Cerda et al., 2017), underlining the role of emotions in the learning process. In mathematics education, research has shown the value of emotional experience in learning mathematics, especially when positive emotions are experienced (Forsblom et al., 2022). However, reality shows that for many students, mathematics is a subject that is traditionally viewed

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unfavourably and represents a threat that arouses intense emotional reactions in the learners (Haase et al., 2019). Negative emotions, such as shame, may lead students to avoid academic content or underperform (Pekrun et al., 2019). Learners may also feel shame and humiliation due to inappropriate educator practises, such as employing coercive forms of assessment or a traditional instructional approach in which the teacher takes centre stage (Chronaki & Kollosche, 2019). In other cases, teachers employ fear as an educational strategy, either with the aim to discipline or, seemingly, to motivate students (Putwain & Symes, 2010).

While research tends to associate emotions with positive academic achievement in mathematics (Pekrun et al., 2017), there appears to be a dearth of research on the role of negative emotions in the teaching and learning of mathematics. Our study investigates the presence of embarrassment and humiliation in mathematics classes of high school students, and identify the situations linked to the classroom associated with the experience of such emotions.

Emotions in the classroom and mathematics learning

The socio-emotional development of students has become a key responsibility in education today (Elias, 2003). Several theories examine the role of emotions in the educational process, but one of the most common and recognised models on the emotions associated with academic success or failure is the control-value theory (Schutz & Pekrun, 2007). This model focuses on emotions in academic achievement and encompasses motivational, cognitive, and expressive/physiological manifestations (Bieleke et al., 2023; Putwain & Wood, 2023).

According to Pekrun (2006), achievement emotions can be positive or negative depending on various dimensions. The first dimension is valence (the distinction between pleasant and unpleasant emotions); the second is activation (activating emotions versus deactivating events), while the third dimension is object focus (activity-focused versus outcome-based emotions). In summary, achievement emotions involve pleasant and unpleasant experiences including anger, enjoyment, pride, boredom, hopelessness, and shame (Pekrun et al., 2007; Pekrun et al., 2011). In particular, negative emotions are of special concern, as they can hinder the learning process (Pelch, 2018).

In the classroom, it is also important to consider social emotions. Pekrun (2014) emphasises that social emotions are related to interactions with teachers and classmates, including feelings such as admiration, contempt, and envy. According to the control-value theory, achievement emotions and social emotions are interrelated, given that both can be derived from performance goals (being better than peers, avoiding doing worse than others) (Pekrun, 2014). However, their natures differ. Whereas achievement emotions are linked to academic success or failure, social emotions involve the interpersonal dimension of the school context, where factors such as teacher-student dynamics and peer relationships can affect the student's emotional experience (Bieleke et al., 2021).

This approach recognises that the experience of emotions, such as embarrassment and humiliation, in the classroom does not depend solely on personal success or failure, but also on social interactions. For instance, peer competition in high-performing classrooms may heighten emotional tension, increasing the

likelihood of experiencing negative emotions such as shame (Holm, 2020). Aggressive social behaviours among peers can also contribute to the development of negative social emotions (Pekrun, 2014). In conclusion, the achievement emotion model provides insight into how student learning and well-being can be affected by their own purposes and social interaction. In this context, shame and humiliation are emotions that arise from such interactions and can decrease student motivation, especially in areas perceived as challenging, such as mathematics (Pekrun, 2014; Bieleke et al., 2023).

Shame and humiliation: theoretical aspects and applications to the mathematics classroom.

According to Amidon et al. (2020), a mathematical problem should demonstrate a lack of knowledge and promote a learning challenge; hence, its resolution generates pride and satisfaction, while a lack of effectiveness may be associated with feelings of shame. If shame is used as a tool of influence, this plays a crucial role. Shaming has historically been a means of disciplinary control in schools, which for centuries was also accepted by parents. Painfully, this idea is still present in the representation of some teachers, with notions such as “smart students” and “dumb students” reflecting this ongoing permeation (Stearns & Stearns, 2016).

Shame is a painful emotion related to the self (Tangney & Dearing, 2011), which entails the perception of negative judgement that devalues the individual (Tangney et al., 2013). It lowers self-esteem and is often accompanied by the need to hide or deny the situation that provokes it (Amidon et al., 2020; Tangney et al., 2013). Nathanson (1992) described four ways of coping with shame: withdrawal, avoidance, self-attack, and attacking others. Although these responses seek to manage shame, their effects on students' school lives vary. As a highly intense emotion, shame rarely elicits corrective action; its intensity may paralyse the individual rather than enable him or her to cope (Tangney & Dearing, 2011). Students who feel embarrassed in mathematics often avoid exposure so as not to appear incompetent (Turner et al., 2002). In contrast, students whose teachers motivate them rather than highlight their errors tend to avoid mathematics less as opposed to those with error-focused teachers (Liew et al., 2014).

Humiliation, unlike shame, has been particularly addressed in socio-legal contexts, but significant work has been done to situate it within mathematics education as well. Wilson (2007) reports on the experiences of trainee teachers in Australian primary schools, who report having experienced humiliating situations during their years as school students, such as being deprived of breaks for not being able to answer questions about multiplication tables. Shame has also been shown to arise when students are afraid of their mathematics teacher, stemming from the teaching method, attitudes, or abuses of authority in the classroom (Syawal et al., 2019). In an interesting qualitative study, Bibby (2002) recounts an example of a student whose teacher demanded accurate answers and when she did not provide them, publicly exposed her, generating feelings of humiliation and avoidance. More recently, Chronaki and Kollosche (2019) described a student who reported feeling humiliated when her teacher demanded she solve exercises on the board without prior explanation.

Humiliation occurs when an individual feels degraded or belittled in a social interaction by another with more power (Kelin, 1991). Hartling and Luchetta (1999) situate humiliation within an interpersonal

framework, underlining that connections and disconnections experienced across the lifespan can be sources of psychological difficulties. These damaging relational experiences can have lasting negative consequences; thus, real or perceived experiences of humiliation can lead individuals to become secretive, isolated, or limit their opportunities for participation (Hartling & Luchetta, 1999).

Humiliation is a harmful experience for any person as it can lead the individual to develop feelings of worthlessness, despair, helplessness, and anger (Torres & Bergner 2010). In the context of mathematics education, it affects students' performance by fostering doubts about their knowledge or the belief that it may not be sufficient or reliable compared to others' knowledge. This results in a complex array of negative affective states that interfere with mathematics education (Bibby 2002). Humiliation and shame share common elements, but they are distinct emotional experiences. Both are self-conscious (Sadath, 2024), involve people interpreting events as shameful or humiliating, impact the whole self rather than just one aspect of the self, and generate similar responses such as isolation, anger, anxiety (Hartling & Luchetta, 1999). The key difference lies in the fact that shame stems from an internal evaluation process, whereas in humiliation, the individual is degraded by another from a position of power, making it an interpersonal event.

The study of these emotions demands recognition of students' subjective experience in mathematics, along with an examination of the factors influencing students' motivation and their experiences of unpleasant emotions such as shame and humiliation.

The present study

The trend in research has been to integrate cognitive psychology and mathematics education to study the role of emotions such as anxiety, leading to substantial understanding of their relationship with academic achievement (Zhang et al., 2019). However, other emotions, such as frustration, anger, and hopelessness still warrant further attention, particularly the experience of shame and humiliation. These emotions encompass not only the emotional experience but also the effects of various classroom-related situations, such as the exercise of power, the threat of public exposure, teacher evaluations, and peer reactions.

In this study, we examined the emotions of embarrassment and humiliation experienced in mathematics classes by a sample of high school students and sought to test whether these emotions varied as a function of student sex (H1) and academic grade (H2). Additionally, we examined a series of classroom-related situations through self-reports, focusing on teacher behaviours (teasing, public scolding, offensive treatment) and peer behaviours (teasing, exclusion of groups), and investigated whether these situations were related to the experience of shame and humiliation (H3).

Methodology

Participants

A survey research study with a cross-sectional design was developed, allowing the gathering of information at a single point in time by extracting one or more samples from the population to compare the behaviour of variables among them (Shaughnessy et al., 2012). The sample was obtained through non-probabilistic

accidental or, convenience sampling, whereby participants were selected based on accessibility and availability, following specific inclusion criteria (Neuman, 2014). The inclusion criteria stipulated that participants needed to have been students at official urban schools, aged between 12 and 15, and enrolled seventh to ninth grade, which correspond to the academic levels at which general mathematics is taught in Colombian secondary education. The selection process was independent of sex (male or female) and academic performance. Sixth-grade students were excluded to ensure a better understanding of the questionnaire content, and the last two grades were excluded due to their focus on specialised areas, such as trigonometry and calculus, which differ from the general mathematics curriculum.

A total of 479 Colombian students were selected from an urban school in the fourth-largest capital city in the country. The sample consisted of 203 girls (42.4%) and 276 boys (57.6%), with ages ranging from 13 to 15 years and a mean age of 13.57 years (SD = .96). The mean age for girls was 13.42 years (SD = .96) while for boys it was 13.6 years (SD = .95). In terms of grade level, 36.3% (n = 174) were ninth graders, another 36.6% (n = 174) were students in eighth grade, and 27.4% (n = 131) in seventh grade.

Measures

Demographic data and classroom situations. A form was designed to collect demographic data such as age, academic grade, and sex. It is important to specify that in this study sex is defined exclusively according to the biological characteristics of the participants, classified as "male" and "female", based on the school administrative record. This approach is not intended to exclude other gender identities but to focus on the analysis of biological sex differences relevant to the educational context in Colombia. Variables related to gender identity and sexual orientation have not been included.

The form also included five items presenting classroom situations, that were answered on a dichotomous scale. Students were asked to specify whether they had experienced the situations during the school year and the emotions they elicited. The situations evaluated included teacher-related scenarios such as teasing ("Teasing by the teacher for errors in performance or lack of subject knowledge"); offensive treatment ("Offensive treatment by the teacher, for example, for lack of knowledge in mathematics subjects"); and public scolding ("Public scolding by the teacher concerning performance in the subject"). They also evaluated situations related to classmates, including teasing ("Teasing from classmates, for example, laughter or mocking comments when not knowing a topic or not being able to solve an exercise on the blackboard"); and exclusion ("Exclusion from work groups, for example, classmates get together to do group work and do not want to include you or work with you"). For each item, students marked whether they had experienced the situation (Yes-No) and what emotions they had experienced as a consequence (embarrassment, humiliation, or both).

Achievement Emotions Questionnaire - Mathematics (AEQ-M). This is an adaptation of the AEQ developed by Bieleke et al. (2023) to assess achievement emotions specifically within the field of mathematics studies. The instrument consists of eight subscales, one of which focuses on evaluating shame. This subscale comprises eight five-point Likert-type items ranging from "total disagreement" to "total agreement", assessing the experience of shame in mathematics study situations such as class (e. g., "When I say something in my

math class, I feel like I am embarrassing myself"), studying content (e. g., "When I don't understand something in my math homework, I don't want to tell anybody"), and exams (e. g., "After taking a test in mathematics, I feel ashamed"). In this study, the shame subscale demonstrated excellent internal consistency scores (ω = .841, α = .835).

Humiliation Inventory (Hartling & Luchetta, 1999). It comprises 32 five-point Likert-type items ("total disagreement" / "total agreement") organised into two dimensions: cumulative humiliation (items 1-12) and fear of humiliation (items 13-32). In this study, we use the factor structure revised by Cardoso et al. (2019), with the participation of Linda Hartling, the author of the original version. This revised structure maintains the cumulative humiliation dimension (items 1-12; ω = .919, α = .918), understood as the humiliating experiences accumulated throughout life. The respondent reflects on times when he or she has felt hurt by being teased, mistreated, or denigrated. The remaining 20 items are divided into two dimensions labelled fear of humiliation (items 13-24; ω = .928, α = .927) and worry about humiliation (items 25-32; ω = .909, α = .909). The first refers to the anticipation of suffering humiliating situations in the future: participants were asked to mark whether, in math class they feared being ridiculed, excluded, and so on. Conversely, worry about humiliation assesses the discomfort at the possibility of being humiliated, regardless of whether there have been previous humiliating experiences. We asked participants to mark whether, in mathematics classes they worried about appearing incompetent, feeling insignificant, and being unfairly excluded, amongst others.

Procedure

Access to the sample was granted through negotiations with institutional authorities of a teacher training college that offers both a secondary academic training cycle (sixth to eleventh grades) and a complementary pedagogical training cycle (two additional — non-mandatory — years of training as primary level teachers). This study involved high school students. Following approval from the academic authorities, informed consent was obtained from the parents or legal guardians of the students, who then signed an informed consent form after being briefed about the study.

The study was developed in compliance with an ethical protocol based on the principles contemplated in the Declaration of Helsinki and on the Law 1090 of 2010, which defines the code of ethics for psychological practise and research involving human subjects in Colombia. This included institutional authorisation, along with access to the guardians (parents or responsible adults) to provide their consent for students' participation. In turn, the participants signed informed consent after learning about the aims of the present study and the guarantees of anonymity, confidentiality and privacy protection.

Data analysis

The normality of the data was assessed using the Kolmogorov-Smirnov test, which indicated that the variables failed to meet the normality assumption. Therefore, robust statistical methods were employed to evaluate the study's hypotheses. Robust statistics utilise techniques that accommodate violations of the assumptions required by traditional statistical methods, consequently ensuring reliable results. Their application is

appropriate for datasets with non-normal distributions (Erceg-Hurn et al., 2013), as observed in this study. Given that the first two hypotheses aimed to compare groups (according to sex and academic grade), t-test and ANOVA may yield misleading outcomes in the context of non-normality. Robust corrections of these tests provide more dependable results.

H1 was tested using Yuen's test. This method was chosen because it provides more reliable results even with skewed data and does not require equal sample sizes between groups (Delacre et al., 2017). Yuen's test automatically adjusts degrees of freedom for differences, offering more accurate estimates of data variability. In addition, an M-estimator was employed to calculate a specific t-value, which provides a robust estimate of the differences between the medians of boys and girls. Furthermore, the bootstrap method with 5000 samples was employed to obtain 95% confidence intervals for the differences between groups. This method allows for evaluating the stability of results and provides precise parameter estimates in the presence of non-normality (Wilcox, 2017). The effect size was calculated using the ξ (xi) statistic (small = .20, medium =.50, large = .80).

H2 was tested with Robust ANOVA, and post hoc analysis to identify specific differences between school grades was conducted using the Modified One-Step estimator, known for its robustness to outliers and parameter estimation (Wilcox, 2017). The analysis was complemented with 5000 bootstrap samples and projection distances, which measure how far individual observations deviate from the central estimate. The comparison of differences between groups utilised the psi-hat statistic ($\hat{\psi}$), which estimates the magnitude of the differences between pairs of groups without being influenced by outliers or deviations from normality (Wilcox, 2017). The calculation of the psi-hat statistic included p-values and 95% confidence intervals.

To test the third hypothesis, contingency tables were constructed based on reports of situations related to the roles of teachers and peers. Chi-square (χ^2) was used to examine the relationships between these situations and experiences of shame and humiliation. Post hoc analysis utilised corrected typed residuals (CTR). Effect sizes were calculated with the w-index (small = .10, medium = .30, large = .50). Hypothesis tests were conducted using jamovi 2.3, and chi-square effect sizes were calculated with G*Power 3.1.

Results

Data pertaining to the presence of feelings of shame and humiliation among students are presented in Table I. The normality test yielded associated p-values less than .05, indicating non-compliance with this assumption. The means of the variables are accompanied by very high standard deviations, reflecting substantial variability within the sample. Therefore, employing the median is deemed a more appropriate alternative for data analysis, justifying the application of robust methods.

Table I.

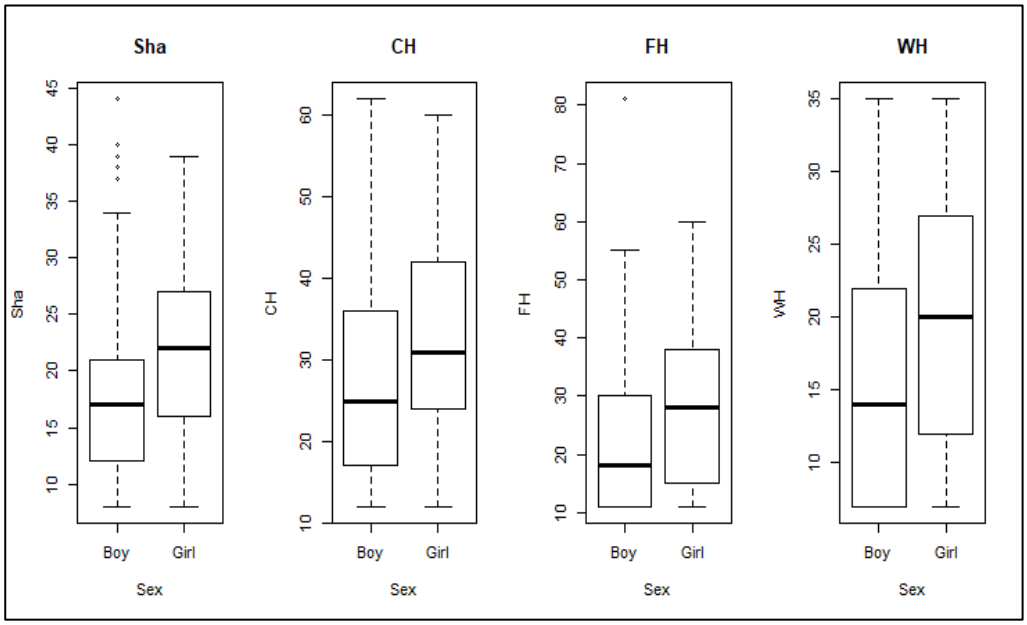
Descriptive data and normality test of the variables shame and humiliation.

Variables	*Me*	*M*	*CI95%*	*SD*	*CI95%*	*Z*[a]
Shame	18	19.28	(18.62, 19.94)	7.39	(6.92, 7.81)	1.78**
Cumulative humiliation	28	29.29	(28.14, 30.45)	12.88	(12.18, 13.54)	1.96***
Fear of humiliation	22	24.95	(23.75, 26.14)	13.31	(12.45, 14.1)	3.22***
Worry about humiliation	16	17.41	(16.61, 18.20)	8.87	(8.47, 9.22)	2.63***
** $p < .01$, *** $p < .001$, [a]Kolmogorov-Smirnov test.						

Figure 1 presents grouped box plots comparing the distribution of the variables according to students' sex. The diagrams illustrate distinct distributions of variables between boys and girls, with higher medians among girls for all variables, along with some outliers. Overall, worry about humiliation is the most frequently reported emotion in both groups; this result suggests that students experience constant anxiety at the possibility of suffering humiliation, although not as a function of specific events, but as a latent worry that permeates their thoughts. Concurrently, fear of being humiliated is the least frequently reported emotion, indicative of lower levels of fear regarding future humiliating situations. This combination of results may reflect elevated social vigilance (worry) without an immediate avoidance reaction (fear).

Figure 1.

Comparison of the scores of the variables shame and humiliation according to sex.



Note: From now on: Sha = shame, CH = cumulative humiliation, FH = fear of humiliation, WH = worry about humiliation.

In order to test for differences in these values, Yuen**'s** instrument was conducted, which corrects for the effects of outliers and violations of normality. The results indicate that in all cases, the calculated differences have low p-values (< .001), and the difference in medians falls within the confidence interval (Table II). Specifically, the difference shows higher values among girls with a small effect size ($\xi > .20 < .50$). These results indicate a greater tendency for girls to express negative emotions such as shame and various forms of humiliation, corroborating the initial findings observed in the clustered box plot (Figure 1). However, given the small effect sizes, it is likely that these differences are not of notable magnitude in practical contexts. This finding may suggest differential emotional sensitivity but requires caution in generalising due to the small effect of these differences.

Table II.

Robust test of comparison of medians between two groups defined by the students' sex.

					CI95%			CI ξ 95%	
		t	**gl**	**Difference**	**Low**	**Upp.**	**ξ**	**Low**	**Upp.**
Sha	Yuen's test	7.034***	228.847	5.180	3.729	6.631	.468	.330	.587
	Bootstrap	6.993***							
	M-estimator	5.534***							
CH	Yuen's test	4.877***	257.449	6.538	3.898	9.177	.304	.183	.440
	Bootstrap	4.851***							
	M-estimator	6.147***							
FH	Yuen's test	5.211***	234.140	7.821	1.778	4.864	.348	.224	.479
	Bootstrap	5.181***							
	M-estimator	9.024***							
WH	Yuen's test	5.109***	261.397	5.394	3.315	7.473	.315	.179	.438
	Bootstrap	5.083***							
	M-estimator	3.621***							
*** p < .001									

An analogous analysis was implemented with students' academic grades as an independent variable. In this case, Robust ANOVA was employed, which indicated no differences between academic grades for cumulative humiliation (F = .560, p = .575) and fear of humiliation (F = 2,683, p = .069). However, differences were identified in the case of shame (F = 4.877, p = .011 < .05) and worry about humiliation in math class (F = 6.251, p = .003 < .01). The post hoc analysis for these variables (Table III) reveals that eighth-grade students exhibit higher levels of shame and worry about humiliation compared to their seventh-grade peers, with no additional differences observed between groups. Specifically, for shame, there is a difference of 2.924 points in eighth grade compared to seventh grade. The difference is even more pronounced for worry about

humiliation, with values 4.741 points higher in eighth grade than in seventh grade. In both cases, the differences are contained within the confidence interval.

Table III.

Post hoc comparisons for the Robust ANOVA.

Shame				**CI95%**	
		psi-hat	**p**	**Low.**	**Upp.**
Ninth	Eighth	-1.443	.111	-3.557	.698
	Seventh	1.481	.159	-.875	3.667
Eighth	Seventh	2.924	< .001	.670	5.013
Worry about humiliation				**CI95%**	
		psi-hat	**p**	**Low.**	**Upp.**
Ninth	Eighth	-2.019	.105	-4.849	.972
	Seventh	2.722	.073	-.795	5.922
Eighth	Seventh	4.741	< .001	1.248	7.632

Finally, we examined whether there was a relationship between different classroom-related situations and the experience of shame and humiliation. Chi-squared (χ^2) yielded small p-values in all cases (Table IV). In the case of shame, only teasing by peers passed the post hoc test for effect size (w) and statistical power ($1-\beta$), indicating that feeling embarrassed is dependent on the relationship with peer actions such as laughing or making teasing comments when they fail to solve mathematical activities. Humiliation was associated with scenarios such as being excluded from study groups and receiving offensive treatment or public scolding from the teacher.

Table IV.

Proof of independence between humiliation, shame and situations related to the classroom.

	Shame				**Humiliation**			
	x²	***CTR***	***w***	***1-β***	***x²***	***CTR***	***w***	***1-β***
Teasing of peers	41.871^{***}	6.47	$.29^{p}$	.99	13.922^{***}	3.73	.17	.72
Exclusion of groups	13.374^{***}	3.65	.17	.72	17.315^{***}	4.16	$.19^{s}$	.83
Teasing of the teacher	14.536^{***}	3.81	.18	.78	10.602^{**}	3.25	.15	.50
Offensive treatment of the teacher	16.641^{**}	3.26	.15	.79	18.655^{***}	4.31	$.20^{s}$	.87
Public scolding	13.733^{***}	3.70	.17	.71	22.313^{***}	4.72	$.22^{s}$	.95
CTR = typified residues corrected for category crossing Yes, ^{s} = small. $^{**}p$ <.01, $^{***}p$ <.001.								

Discussion

In this study, we investigated emotional expressions of shame and humiliation in high school students, evaluating possible differences based on gender and academic grade. We also assessed classroom situations related to both emotional experiences. Our findings partially support the initial hypotheses. Regarding H1, we initially highlighted the identification of emotions such as shame and humiliation that suggest that students have negative experiences related to their classroom environment. Although shame scores are not particularly high, in the case of humiliation the results show higher levels of worry than fear, suggesting a constant anxiety about the possibility of being humiliated in the classroom, without translating into an avoidance reaction to specific situations (Hartling & Luchetta, 1999). This constant worry may reflect elevated social vigilance, as well as sensitivity to the judgement of others, which may affect self-image and interactions (Cardoso et al., 2019) in the mathematics classroom. However, we believe that low levels of fear of humiliation may indicate that experienced worry does not necessarily lead to avoidance behaviours typically associated with intense fear.

The sex-based comparison revealed differences in the experience of embarrassment and all forms of humiliation, with higher medians for girls. Although practical evidence suggests that mathematical performance is not significantly influenced by sex, control-value theory has shown that the tendency to negative emotions in girls is related to low confidence in their abilities and reduced interest in mathematics, despite their assumption of it as an important area (John et al., 2022). Among girls, it is more common to find a negative mathematical self-concept, leading to greater doubts about their mathematical ability even if they have better results than boys (John et al., 2022). Other forms of analysis address the effects of role assignment and expectations on the performance of boys and girls, giving rise to stereotypical preconceptions that generally disadvantage females. The literature highlights a lower perception of mathematical skills in girls (Alan et al., 2018), and the belief that mathematics is a more "masculine" field (Makarova et al., 2019), among other ideas that contribute to a gender gap commonly reinforced by teachers themselves (Carlana, 2019).

The sex differences we observed however, were accompanied by a small effect size, suggesting that, although girls report higher levels of negative emotions, in practical terms, the sex difference may not be contextually relevant. This result encourages us to consider the impact of other contextual or individual factors (e.g., prior mathematical experience, cultural gender expectations, teaching characteristics), that may influence the emotional experiences of mathematics amongst boys and girls.

The results partially support the second hypothesis, revealing differences in embarrassment and worry about humiliation in eighth-grade students compared to seventh grade. We consider these variations a function of students' developmental stage, given that the transition that characterises eighth grade (where students move from childhood to early adolescence), is a stage where self-consciousness and vulnerability to self-conscious emotions (Steinberg, 2014) such as shame are intensified. In early adolescence, the perception of control tends to decrease due to increased academic challenges, whereas the value of achievement may be particularly affected if the content seems more challenging and less relevant (Sakaki et al., 2023). Moreover, according to Pekrun (2019), embarrassment is more likely to occur when students feel observed in moments of error or

failure, triggering negative self-evaluation. In this context, the observed differences in levels of shame could be explained by the increased adolescent sensitivity to evaluation and social comparisons. In eighth grade, students may start to compare themselves with their peers in a more rigorous manner, increasing the likelihood of feeling shame in a competitive environment (Cunha et al., 2021).

We can apply a similar logic to understand the heightened worry about humiliation in this group of students, given that in early adolescence interpersonal relationships and valuing others become increasingly important, and school serves a primary setting where adolescents find that their sense of competence and worth is under constant scrutiny, whether from peers or authority figures (Klein, 1991). The power dynamics in the classroom influenced by the teacher (Syawal et al., 2019), the evaluative emphasis focused on failures (Liew et al., 2014), as well as the impact of fellow peer behaviours (Pekrun, 2014), may exacerbate this feeling, heightening eighth-grade students' anxiety as they become more aware of their social and academic standing.

Finally, our H3 results indicate that interactions with teachers and peers are related to the experience of shame and humiliation. Participants' embarrassment is associated with peer teasing, reinforcing our earlier discussion on the effects of social comparison in adolescence. The influence of peer treatment can trigger negative emotional responses (Pekrun, 2014). Moreover, shame is experienced more intensely when a student is perceived as responsible for their own failure (Pekrun, 2006). Our data suggest that achievement emotions and social affect interact to shape the experience of shame. When a student fails to achieve and faces ridicule that undermines their self-image, they are exposed to social judgement, which generates feelings of inferiority (Tangney & Dearing, 2011; Tangney et al., 2013).

Similarly, our data indicates that students' exposure to social situations where peers marginalise them from work groups contributes to the experience of humiliation, reiterating the importance of the treatment given among group members (Pekrun, 2014). Additionally, the use of offensive treatment by mathematics teachers or public scolding when failing to solve mathematical activities, contributes to the students' sense of humiliation. Our findings align with existing literature that suggests how the abuse of authority by some teachers (Syawal et al., 2019), the position of dominance to exert control in the classroom, and relationships focused on discipline through ridicule, may lead to students feeling humiliated (Bibby, 2002; Chronaki & Kollosche, 2019), and consequently impact the process of teaching and learning mathematics (Pelch, 2018).

Limitations

Some limitations of the study pertain to the generalisability of the results, a common concern in research (Holm et al., 2020). Future work can increase the sample size and include students from public and private schools to broaden the scope. Hierarchical models may also be useful for achieving multilevel comparisons in regularly nested groups, as is the case with students. Although we identified higher levels of embarrassment and humiliation in girls, given that this is a self-report survey study, there is the possibility of emotional underreporting by boys, who may choose to appear stronger or may not acknowledge their negative emotions (Chaplin, 2014). While we focused the comparisons on sex, subsequent studies could expand the perspective

to include gender, furthermore, the literature suggests that studies focused on the field of mathematics education should address gender from an inclusive view (Forgasz, 2021).

While the identification of differences between two academic grades appears to support the initial hypothesis, we underscore that these differences are associated with a small effect size. This suggests a modest practical impact, indicating that any intervention or pedagogical measure based on these findings should be nuanced and carefully tailored. It is essential to consider other individual and contextual factors that may influence the variability of the phenomenon.

Conclusion

Our findings highlight how a mathematics class can become an emotionally damaging experience for students (Bibby, 2002; Wilson, 2007) as a result of the teacher's and/ or peer group's behaviour (Torres & Bergner, 2010). The social aspects in the mathematics classroom significantly influence students' emotional experience. Perceived teacher and peer criticism of mathematics failures can generate negative achievement and social emotions that affect the student's relationship with the subject. This highlights the importance of teachers managing authority and social interactions appropriately to promote students' emotional well-being. Teachers are expected to consider the needs of their students when creating a learning context that ensures meaningful learning and fosters lasting social-emotional learning (Elias, 2003). This implies a focus on the potential of each student instead of publicly pointing out their mistakes.

Disclosure

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