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Understanding Risk Perception and Prevention Education in Primary Education

Álvaro-Francisco Morote [1,*], Jorge Olcina [2], Brenda Tévar [3] and Alberto Alfonso-Torreño [4]

[1] Department of Experimental and Social Sciences Education, Faculty of Teaching Training, University of Valencia, 46022 Valencia, Spain
[2] Department of Regional Geographical Analysis and Physical Geography, University of Alicante, 03080 Alicante, Spain; jorge.olcina@ua.es
[3] CEIP L'Albereda, 46023 Valencia, Spain; b.tevarlopez@edu.gva.es
[4] Department of Didactics of Social Sciences, Language and Literature, University of Extremadura, 06006 Badajoz, Spain; albertoalfonso@unex.es
* Correspondence: alvaro.morote@uv.es

Abstract

The aim of this study is to analyze the perceptions of students in Primary Education (5th and 6th grades; n = 260; Valencian Community, Spain) regarding natural hazards, based on their personal experiences, memories, school-based instruction and preventive measures. Methodologically, the study is based on the administration of a mixed-type questionnaire. The high proportion of students reporting strong awareness (68.5%) suggests that school-based instruction is already contributing to a foundational level of risk perception. Floods associated with torrential rainfall are the most frequently recalled hazard, influenced by the cut-off low event of 29 October 2024 (Valencia) (72.3%). Furthermore, no significant differences were found between students who experienced or remembered a flood and those who did not, in terms of preventive measures received, indicating a consistent and homogeneous instruction. In conclusion, this study highlights that students hold a strong awareness of natural hazards, particularly floods, with uniform school-based training. The cut-off low 2024 event in Valencia stood out among other disasters, reinforcing the educational importance of water-related hazards in high-risk regions and underscoring the need to strengthen hydrological awareness as a key component for enhancing socio-territorial risk perception.

Keywords: cut-off low; floods; primary education; perception; impacts; natural hazards

1. Introduction

The Mediterranean region, due to its geographical location, is recognized as a risk-prone area [1,2], facing large-scale natural disasters with significant destructive potential [3]. In recent years, there has been an observed increase in the frequency and intensity of extreme weather events, attributable to changes in atmospheric patterns, which supports the hypothesis of climate change effects in this region [4].

On the global scale, the Centre for Research on the Epidemiology of Disasters [5] reported a total of 399 disasters in the year 2023, exceeding the annual average of 369 recorded over the past two decades. Floods stand out as the most recurrent phenomenon, accounting for 41.0% of cases and causing 7763 deaths—well above the historical decadal average of 5518 fatalities. The human impact has been particularly severe in developing countries such as the Democratic Republic of Congo, India, and Nigeria, with 2970, 1529, and 275 victims

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respectively. At the European level (2024), between 1980 and 2022, floods have affected 5.5 million people, resulting in 5582 deaths and economic losses exceeding €170 billion [5].

In the Spanish context, according to the latest available data, a total of 1174 deaths caused by natural disasters were recorded between 2000 and 2023, of which 346 (25.5%) were attributed to heatwaves and 233 (19.9%) to flood events. These figures must be supplemented by the 238 victims (230 in southern municipalities of Valencia) resulting from the cut-off low (29 October 2024), which severely affected several areas along the Mediterranean coast. This disaster marked a turning point in risk perception in Spain, standing as the second most devastating event since the mid-20th century [6], surpassed only by the historic floods in the Vallés region (Catalonia) in September 1962, which officially claimed 617 lives—though some estimates suggest between 800 and 1000 fatalities.

This event (Valencia's cut-off low) was the result of multiple factors that significantly increased the level of risk. Notable among them were the rapid overflow of ravines in l'Horta Sud and the high vulnerability of the area, which is densely occupied by urban infrastructure [1]. The absence of early warning systems and limited education in risk prevention further exacerbated the situation. These shortcomings contributed to the high number of casualties, highlighting the urgent need to improve the population's geographic literacy in exposed areas along the Spanish Mediterranean coast [7].

In the Spanish context, in recent years, education has increasingly been considered a priority measure for reducing social vulnerability to natural hazards [8,9]. However, initiatives have emerged aimed at strengthening civic education regarding climate change and its associated risks [10]. At the international level, organizations such as the United Nations [11], through the 2030 Agenda and its Sustainable Development Goals (SDGs)—particularly Goal 13, 'Climate Action'—have highlighted the role of education in building more resilient societies. Similarly, the Sendai Framework for Disaster Risk Reduction (2015–2030) underscores the integration of educational approaches as a key element in risk management and climate change adaptation [12].

In the Spanish educational context, topics such as climate change, natural hazard prevention, and critical digital literacy are increasingly embedded within the Primary Education curriculum and in the training of future teachers. The LOMLOE explicitly promotes environmental awareness, sustainability, and risk-prevention competencies as cross-curricular elements, encouraging schools to address extreme events through inquiry-based and contextualized learning [10]. Likewise, university programs for prospective Primary Education teachers incorporate modules on scientific literacy, socio-environmental challenges, and the critical evaluation of information—skills that are essential for navigating post-truth dynamics and misinformation during extreme events. Integrating these curricular orientations into disaster-risk education strengthens the pedagogical framework of the present study and underscores the relevance of fostering informed, resilient, and critically aware young citizens in Mediterranean regions.

Education on natural disasters benefits from an interdisciplinary approach that integrates Geography with Geology, Meteorology, Sociology, and Civil Protection, enabling a more comprehensive understanding of hazards, their underlying processes, their social impacts, and the strategies required for effective crisis management.

These initiatives have sparked growing interest in the study of education related to natural hazards, particularly floods, both internationally and nationally. Numerous scientific studies have addressed this topic across different regions of the world: in North America [13], in Europe [14–23], in Asia [24,25], in Central and South America [26–28], and Africa [29–31]. The Asian experience is particularly noteworthy, where significant progress has been made in citizen preparedness for such risks through the implementation of innovative pedagogical strategies and adapted didactic proposals [24,32–34].

The location of schools—particularly in the Valencian Community (study area)—is often in zones exposed to natural hazards, with students being one of the most vulnerable groups [20]. Therefore, it is a priority to implement educational processes that promote awareness and assess school-based risk perception regarding these phenomena. Various studies emphasize that more rigorous training focused on prevention and awareness of natural hazards can reduce mortality and enhance resilience [22,25,35–38]. This approach has also been progressively incorporated into Spanish educational policy, as reflected in the LOMLOE (2020) (Organic Law 3/2020, of 29 December, which amends Organic Law 2/2006, of 3 May, on Education) [39]. Similarly, studies conducted in countries such as Romania [40], Nepal, and Turkey [36] have demonstrated that education in risk management has become an effective strategy for improving citizens' preparedness for extreme events.

Considering the perspective of Primary Education students from several schools in the Valencian Community, this study has the following General Objective (GO): to analyze the perceptions of students in Primary Education (5th and 6th grades; Valencian Community, Spain) regarding natural hazards, based on their personal experiences, memories, school-based instruction and preventive measures. This GO is specified through the following Specific Objectives (SO): (SO1) to examine the degree of knowledge and instruction students have received in their schools regarding natural hazards and associated prevention measures; and (SO2) to explore their experiences related to these events—whether lived or remembered—and their connection to the preventive education received.

In relation to the Specific Objectives (SO), the following hypotheses (H) have been formulated: (H1) the majority of participating students have received school-based instruction related to natural disasters and basic prevention measures; (H2) students' personal experiences related to natural hazards significantly influence their risk perception and their recollection of recent extreme events; and (H3) there are no statistically significant differences between having experienced a flood event and the level of preventive training received at school, indicating that preventive education is not adapted to the geographical reality and specific experiences of the students, as noted by [20].

Despite the growing body of literature on natural hazards and risk education, research focusing on Primary Education students' perceptions remains limited [37,38], particularly in regions with recurrent hydrometeorological events such as the Valencian Community [20]. Previous studies have predominantly examined curricular frameworks or teachers' perspectives, leaving a gap regarding how children themselves interpret hazards, recall past events, and value school-based instruction. This study addresses this gap by analyzing students' perceptions through a mixed-type questionnaire, offering novel insights into how personal experiences, memories, and preventive education interact in a high-risk Mediterranean context. The scope of this research is therefore twofold: to provide empirical evidence on students' understanding of natural hazards—especially floods—and to assess the consistency of preventive instruction received across schools. By doing so, the study contributes new knowledge to the field of disaster risk education and highlights the relevance of contextualized learning for strengthening socio-territorial risk perception [41].

2. Methodology

2.1. Research Design

This study is characterized as correlational and explanatory research without experimental intervention [42], in which a mixed-type questionnaire was used for data collection [43]. Regarding the temporal dimension, it is a cross-sectional study, as the information was gathered throughout the 2024–2025 academic year.

2.2. Context and Participants

Participants were selected through non-probability convenience sampling [42]. The study involved students from the 3rd cycle of Primary Education (5th and 6th grades; n = 260), with an average age of 10.7 years, enrolled in various schools across the Valencian Community (Spain). Regarding gender, the sample included both boys and girls, with girls representing 51.9% (n = 135). The participating schools include two located in the province of Alicante (69.6%; n = 181) and two in the province of Valencia (30.4%; n = 79). Due to the extent of the damage caused by the flood (school closures, provisional classrooms, etc.), it was decided not to include the schools most affected by the 2024 cut-off low. This remains a research challenge for future academic years.

2.3. Research Instrument

To collect data, a mixed-type questionnaire (quantitative and qualitative) proposed by Morote [44] was used. This instrument, titled "Natural Hazards: Education and Social Representation", consists of 17 questions and aims to explore students' social perception, level of training, and experiences related to natural hazards.

In this study, six items (including age, sex, and grade) from the broader questionnaire were selected for analysis, as they directly aligned with the research objectives. These items were chosen because: (1) they specifically address school-based instruction on natural hazards (Items 6 and 8) and students' personal experiences and memories of such events (Items 10 and 11) (see Table 1); and (2) they address the specific objectives of this study. These items specifically addressed students' perceptions of natural hazards, their memories and experiences related to water-related events, and the preventive instruction received at school. The remaining items in the instrument focused on dimensions unrelated to these constructs and were therefore excluded.

Table 1. Analyzed Questionnaire Items.

Items	Type of Response
- Item 6. At school, I have been taught what natural hazards are (1 means 'strongly disagree' and 5 means 'strongly agree'). Mark with an X.	- Standardized Likert-type response (1–5).
- Item 8. At school, I have been taught preventive measures to deal with... (1 means 'strongly disagree' and 5 means 'strongly agree'). Mark with an X.	- Standardized Likert-type response (1–5). - Note: Students were asked to mark the options for the following items: (1) Hailstorms; (2) Cold and heat waves; (3) Torrential rains causing floods; (4) Earthquakes; (5) Snowstorms; (6) Volcanoes; (7) Windstorms; (8) Droughts; (9) Wildfires.
- Item 10. What natural hazards have you experienced?	- Open-ended response.
- Item 11. What major natural hazards do you remember occurring in Spain?	- Open-ended response.

The remaining items, which examine broader dimensions such as social representations, curricular perceptions, or institutional responses, were excluded because they do not contribute to the explanatory framework of this study and would have expanded the scope beyond water-related risk perception and preventive education. Basic background variables, such as grade level and province, were also included to contextualize the sample, while other sociodemographic variables were not collected due to ethical constraints with minors. This targeted selection ensured conceptual coherence and allowed the analysis to focus on the variables most relevant to understanding students' awareness and educational experiences regarding water-related hazards.

To verify the reliability and internal consistency of the analyzed items, Cronbach's Alpha test was conducted. The result obtained was $\alpha = 0.817$, indicating that the instrument demonstrates an acceptable level of internal consistency, appropriate for the objectives of this study [45].

2.4. Procedure

Regarding the research procedure, the questionnaire was administered in paper format during February 2025, with an estimated completion time of 15 min. It is important to note that the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki issued by the World Medical Association, ensuring respect for human dignity, confidentiality, and data protection.

In addition, the study complied with current legal provisions regarding personal data protection, in accordance with the Spanish Law on Personal Data Protection and Guarantee of Digital Rights [46], which ensured both the anonymity of participants and the collection of informed consent. Prior to administering the questionnaire, an official communication was sent to families outlining the objectives and characteristics of the study. As for the students, they were provided with clear information about the purpose of the research and its relevance for strengthening social and territorial risk perception in the face of flood-related risks.

2.5. Data Analysis

To conduct the statistical analysis of the data, SPSS software (v. 29) was used, applying descriptive analyses (frequencies and percentages) and non-parametric inferential tests. To identify possible associations between nominal items (Items 10 and 11) and ordinal items (Items 6 and 8), the non-parametric Kruskal–Wallis H test was applied. The aim was to determine whether statistically significant differences exist between the preventive measures taught in schools and the students' experiences with natural hazards (see Section 3.3). Additionally, effect size was estimated using epsilon squared (ε^2) for the Kruskal–Wallis test to assess the magnitude of differences between groups. Negative ε^2 values, which may arise from correction formulas when the H statistic is very small, were interpreted as equivalent to zero.

In addition, a coding process was carried out for the open-ended responses (items 10 and 11) to perform a frequency analysis. This coding involved identifying recurring patterns in the content, classifying the collected information, and organizing it into meaningful categories, following the approach established by Bingham [47]. Keywords were counted, the frequency (f) of the most representative responses was calculated, and the relative percentages of the textual fragments corresponding to these items were recorded. Analytical rigor was reinforced through saturation criteria, transparent coding rules, and systematic categorization, supported using MAXQDA software (v. 24.5), which enabled systematic coding, categorization, and saturation-based qualitative analysis [48].

To enhance the qualitative depth of the analysis, several verbatim student responses were incorporated into the Results section. These excerpts illustrate how students describe their experiences with water-related events and provide concrete examples that complement the coding process (Item 10). For this purpose, literal quotations were included using the format "Student no. X" to exemplify individual perspectives. Item 11 was not accompanied by verbatim quotations because the responses consisted solely of naming the hazard (e.g., "cut-off low", "volcano", "earthquake"), without any descriptive or interpretative content. As these answers directly matched the predefined coding categories, including literal excerpts would not have added qualitative depth or analytical value beyond the existing classification.

3. Results

3.1. Analysis of School-Based Teaching on Natural Hazards and Their Prevention

This first section analyzes the results obtained from items 6 and 8. Regarding Item 6 ("At school, I have been taught what natural hazards are"), the results can be interpreted positively, as more than half of the participants selected responses at levels 4 and 5 on the Likert scale, accounting for 68.5% of total responses (n = 178) (Table 2).

Table 2. Item 6. "At school, I have been taught what natural hazards are".

	n	%
1	15	5.8
2	11	4.2
3	56	21.5
4	79	30.4
5	99	38.1
Total	260	100.0

Secondly, the results obtained from Item 8 ("At school, I have been taught preventive measures to deal with. . .") were examined. To this end, students responded using a standardized Likert scale ranging from 1 to 5 in relation to various phenomena (Figure 1). As shown in the figure, the preventive education received by students is mainly focused on certain risks. Specifically, those that exceed 30.0% of responses in levels 4 and 5 of prevention include droughts, wildfires, floods associated with torrential rains, and cold/heat waves. These data reflect greater awareness and preparedness regarding atmospheric hazards that have a high incidence in the Mediterranean environment. Educational attention to these events may be linked to their frequency and severity, which justifies their prioritized inclusion in school-based disaster prevention training. Likewise, it is noteworthy that students reported limited preparation for geological risks such as earthquakes, despite their frequent inclusion in emergency drills [20].

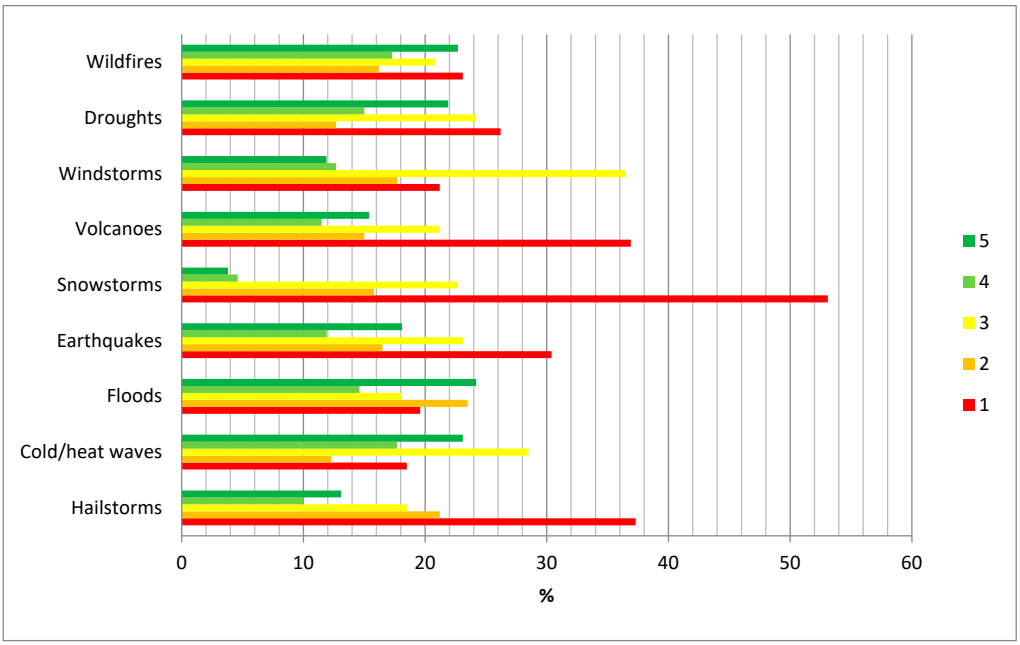

Figure 1. Item 8. "At school, I have been taught preventive measures to deal with. . .".

3.2. Students' Experiences and Recollections of Natural Hazards

In this section, students' experiences with natural hazards are analyzed. To this end, they were asked the question: "What natural hazards have you experienced?" (Item 10). The data collected from Primary Education students reveal that a considerable proportion has not had direct contact with such phenomena (39.2%; n = 102). For example, some of these responses are: "I have not experienced any" (Student n. 12); "None" (Student n. 20).

Among those who have, the most frequently mentioned event was flooding caused by heavy rainfall, cited by 24.2% (n = 63) (Figure 2). For example, some of these responses are: "What happened in Valencia, the flood" (Student n. 2); "The cut-off low of Valencia" (Students n. 42 and n. 197); "The cut-off low of Valencia, but I was safe" (Student n. 156)."

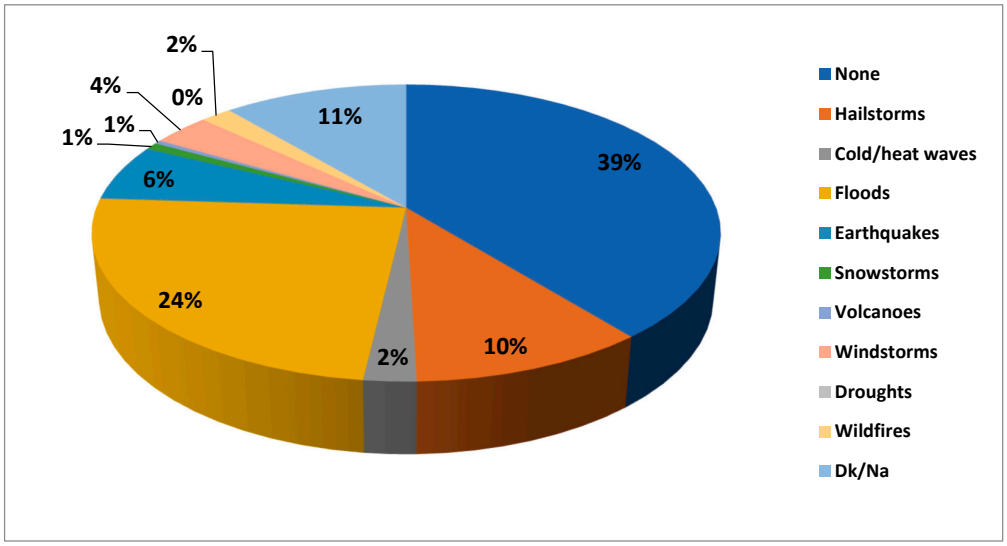

Figure 2. Item 10. "What natural hazards have you experienced?". Note: Dk/Na = Do not know/No answer.

The results show that, although a significant portion of students have not experienced such hazards, flooding stands out as the most recalled natural threat. This suggests a heightened awareness of this specific risk and provides a relevant foundation for reinforcing preventive education in school contexts exposed to such phenomena. It is also noteworthy that no student reported having directly experienced a drought sequence. This finding is striking and aligns with the perspective of several scholars in academic geography, who have described drought as a silent yet persistent hazard [1].

In the previous responses, flooding caused by torrential rainfall was identified as the main hazard, likely influenced by the recent cut-off low that occurred in Valencia in 2024. To support this claim, Item 11 was analyzed ("What major natural hazards do you remember occurring in Spain?"). The data show that the cut-off low in Valencia was the most frequently mentioned event by students (72.3%; n = 188) (Figure 3). In second place was the eruption of the Cumbre Vieja volcano in La Palma (2021), although it was cited by only 9.2% of respondents. This finding suggests that students' perceptions may have been shaped by the extensive media coverage of the event, particularly through television, which provided information and live broadcasts of the eruption's progression.

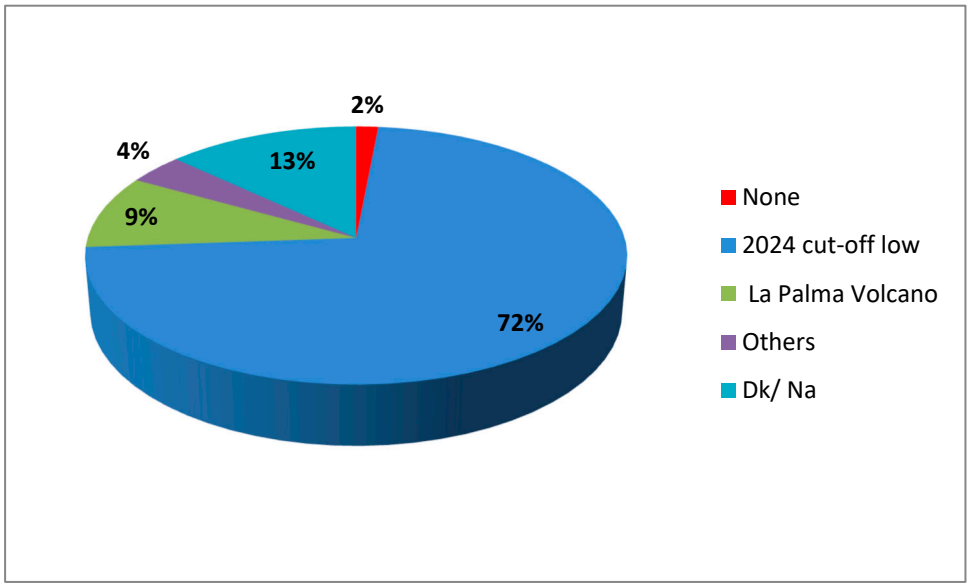

Figure 3. Item 11. "What major natural hazards do you remember occurring in Spain?".

Beyond the frequency patterns, the open-ended responses reveal meaningful nuances in how students construct and interpret their experiences with natural hazards. Several students describe flood events not only as isolated meteorological episodes but as emotionally charged situations linked to fear, disruption of daily routines, or concern for family members ("The cut-off low of Valencia, but I was safe", Student no. 156). These narratives show that children tend to frame hazards through personal and relational lenses, emphasizing safety, proximity, and the visibility of impacts.

Moreover, the recurrent references to the 2024 cut-off low suggest that highly mediatized events shape collective memory, even among those who did not experience them directly.

To avoid overinterpreting this result, we acknowledge that the strong recollection of the 2024 cut-off low event cannot be directly attributed to media exposure, as this variable was not measured in the questionnaire.

Further consideration relates to the ability of students, given their average age of 10.7 years, to clearly distinguish between direct personal experience, indirect exposure, and events remembered through media or other secondary sources. This distinction is relevant for interpreting H2, as potential overlap between these categories may influence how the relationship between personal experience, risk perception, and recollection of recent extreme events is understood.

3.3. Experience in Risk Instruction—The Case of Floods

Finally, this research has also focused on examining the relationship between the prevention measures received by schoolchildren in their educational centers (Item 8) and their personal experiences with natural hazards (items 10 and 11). Since floods caused by torrential rains are the most experienced and/or remembered phenomena by the students, this type of hazard has been specifically considered in the analysis (floods–Item 8.3).

Regarding the experienced phenomena, the Kruskal–Wallis H test was conducted. The results showed no statistically significant differences in the prevention measures received with respect to floods (Kruskal–Wallis H = 2.388; $p = 0.665$; $\varepsilon^2 = 0.000$, indicating a negligible effect size). This implies that both those who have experienced flooding events and those who have not undergone such an experience have received similar training.

When analyzing the response levels of those who reported having experienced these phenomena, a homogeneous distribution is observed across all values of the Likert scale

(Table 3). However, the scores at levels 3 (132.38) and 4 (130.22) stand out, suggesting a moderately positive perception regarding the preventive education received (Table 4). These findings indicate a moderately positive perception of the preventive education received, particularly among students who reported prior experiences with natural hazard events.

Table 3. Natural hazards experienced (Item 10) and prevention measures to address floods (Item 8.3).

Natural Hazards Experienced (Item 10)		Likert Scale (Floods) (Item 8.3)					
		1	**2**	**3**	**4**	**5**	**Total**
0	n	16	28	19	11	28	102
	%	15.7%	27.5%	18.6%	10.8%	27.5%	100.0%
1	n	5	3	5	7	7	27
	%	18.5%	11.1%	18.5%	25.9%	25.9%	100.0%
2	n	0	1	2	2	1	6
	%	0.0%	16.7%	33.3%	33.3%	16.7%	100.0%
3	n	15	12	7	14	15	63
	%	23.8%	19.0%	11.1%	22.2%	23.8%	100.0%
4	n	9	2	3	0	2	16
	%	56.3%	12.5%	18.8%	0.0%	12.5%	100.0%
5	n	0	0	0	0	2	2
	%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
6	n	0	1	0	0	0	1
	%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
7	n	0	3	4	0	2	9
	%	0.0%	33.3%	44.4%	0.0%	22.2%	100.0%
8	n	0	0	0		0	0
	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	n	0	3	0	1	1	5
	%	0.0%	60.0%	0.0%	20.0%	20.0%	100.0%
10	n	6	8	7	3	5	29
	%	20.7%	27.6%	24.1%	10.3%	17.2%	100.0%
Total	n	51	61	47	38	63	260
	%	19.6%	23.5%	18.1%	14.6%	24.2%	100.0%

Note: coding of responses for Item 10: 0 ("none"); 1 ("Hailstorms"); 2 ("Cold and heat waves"); 3 ("Torrential rains causing floods"); 4 ("Earthquakes"); 5 ("Snowstorms"); 6 ("Volcanoes"); 7 ("Windstorms"); 8 ("Droughts"); 9 ("Wildfires"); 10 ("Dk/Na"). Statistical results: Kruskal–Wallis H = 2.388; p = 0.665; ε^2 = 0.000 (negligible effect size).

Table 4. Ranks of natural hazards experienced (Item 10) and prevention measures to address floods (Item 8.3).

	Floods (Item 8.3)	n	Average Rank
Natural hazards experienced (Item 10)	1	51	142.03
	2	61	129.14
	3	47	132.38
	4	38	130.22
	5	63	121.25
	Total	260	

Secondly, regarding the natural hazards remembered as having occurred in Spain, the Kruskal–Wallis H test once again showed no statistically significant differences in the prevention measures received concerning floods (Kruskal–Wallis H = 5.637; $p = 0.228$; $\varepsilon^2 = 0.006$) (Table 5). Therefore, the results indicate that both the students who recall these episodes (mainly the cut-off low 2024 in Valencia) and those who do not have received a similar level of preventive training.

Table 5. Natural hazards remembered by students (Item 11) and prevention measures to address floods (Item 8.3).

Natural Hazards Remembered by Students (Item 11)		Likert Scale (Floods) (Item 8.3)					
		1	**2**	**3**	**4**	**5**	**Total**
None	n	0	2	1	0	1	4
	%	0.0%	50.0%	25.0%	0.0%	25.0%	100.0%
2024 cut-off low	n	41	40	30	30	47	188
	%	21.8%	21.3%	16.0%	16.0%	25.0%	100.0%
La Palma Volcano	n	4	10	5	0	5	24
	%	16.7%	41.7%	20.8%	0.0%	20.8%	100.0%
Others	n	0	2	0	4	4	10
	%	0.0%	20.0%	0.0%	40.0%	40.0%	100.0%
Dk/Na	n	6	7	11	4	6	34
	%	17.6%	20.6%	32.4%	11.8%	17.6%	100.0%
Total	n	51	61	47	38	63	260
	%	19.6%	23.5%	18.1%	14.6%	24.2%	100.0%

Note: Statistical results: Kruskal–Wallis H = 5.637; $p = 0.228$; $\varepsilon^2 = 0.006$.

When analyzing the response levels of those who reported remembering this phenomenon, a homogeneous distribution is observed across all values of the Likert scale (Table 5). However, there is a greater concentration of responses at level 4 (179.40) (Table 6). The analysis shows a generally homogeneous distribution of responses, although the higher concentration at level 4 indicates a moderately positive perception of the preventive education received among those who reported remembering this phenomenon.

Table 6. Ranks of natural hazards remembered by students in Spain (Item 11) and prevention measures to address floods (Item 8.3).

	Floods (Item 8.3)	n	Average Rank
Natural hazards remembered by students (Item 11)	1	4	132.25
	2	188	130.55
	3	24	114.54
	4	10	179.40
	5	34	126.88
	Total	260	

4. Discussion

The results obtained in this study allow a critical reflection on the role of school education in shaping students' perception and preparedness in the face of natural hazards, particularly floods, within a highly vulnerable context such as that of the Mediterranean region [49].

Firstly, according to the H1 ("the majority of participating students have received school-based instruction related to natural disasters and basic prevention measures"), most students reported having received instruction on these topics, particularly in relation to atmospheric phenomena common in the Mediterranean region, such as heatwaves, floods, and wildfires. However, in Eilam's [50] study, the author notes that only about half of Primary (54.0%) and Secondary (55.0%) students have received specific training on these issues. Similarly, at the university level, 56.0% of future teachers report not having been trained in climate change [51]. These findings highlight a systematic deficiency in the inclusion of content related to climate change and atmospheric hazards throughout the educational system, thereby affecting awareness and preparedness in the face of these challenges, in line with the observations made by Kolenatý et al. [52].

In this study, the strong presence of floods in students' memories and experiences confirms the centrality of water as a key driver of socio environmental vulnerability. The prominence of the 2024 cut-off low in Valencia further illustrates how hydrometeorological extremes shape children's perceptions and reinforce the need for targeted educational strategies that address water-related risks explicitly.

Regarding the second hypothesis (H2: "students' personal experiences related to natural hazards significantly influence their risk perception and their memory of recent extreme events"), the results confirm that personal experiences do indeed influence risk perception, as observed by Yildiz et al. [36]. Floods were the most frequently mentioned (24.2%), mainly associated with the cut-off low event in Valencia. Students recall this disaster as one of the most significant to have occurred in Spain in recent years, being the most prominent natural phenomenon in their memory due to its temporal proximity to the present moment. In general, society tends to quickly forget episodes with catastrophic effects [53]. This aligns with previous research showing that geographic and emotional proximity to a disaster increases risk awareness and reinforces the portrayal of climate change as a future threat in media and social discourse [14,54].

The findings show that students' awareness is strongly influenced by both direct and indirect exposure to water-related events. However, it is also plausible that factors such as media exposure, conversations within the family, school instruction, and the wider local environment contributed to shaping these recollections. Even though no significant differences were found between those who had experienced a flood and those who had not, the high levels of perceived preparedness suggest that school-based instruction may contribute to shaping a shared understanding of hydrological hazards. This homogeneity indicates that educational interventions can compensate for unequal personal experiences, ensuring that all students acquire a minimum level of knowledge and preventive competencies related to water-driven risks.

Increasing knowledge about these phenomena among students, families, and teachers is essential, as reflected in the 2024 cut-off low event [22]. However, previous research reveals insufficient training. Gómez-Trigueros and Morote [19] indicate that 62.6% of their sample (teachers) did not receive specific education on floods, while those who did recall content limited to basic drills. Regarding teaching strategies, watching documentaries and scientific videos was the most frequently mentioned (14.2%), highlighting the need to enrich current educational approaches. Additionally, the limited mention of certain relevant hazards, such as earthquakes or droughts, reinforces the notion that current training presents selective gaps. The case of droughts, for example—considered a "silent hazard" [55]—reveals a lack of visibility that hinders students' preparedness for phenomena with less dramatic but equally destructive long-term impacts. This finding also reflects broader challenges in how drought is perceived and taught in Primary Education. Previous analyses of school textbooks in Spain [9] show that drought tends to receive limited and

sometimes superficial treatment, which may reduce its visibility compared to more sudden and disruptive hazards such as floods. Moreover, drought remains an understudied phenomenon in school contexts, particularly regarding how it is explained, what pedagogical resources are employed, and how students develop an understanding of its impacts. These considerations highlight the need for further research on the educational treatment of slow-onset hazards and their role in shaping children's risk awareness.

Regarding the third hypothesis (H3: "there are no statistically significant differences between having experienced a flood event and the level of preventive education received at school, indicating that preventive teaching is not adapted to the geographical reality and specific experiences of students"), this hypothesis is confirmed. This means that both those who have experienced flood events and those who have not received similar training.

These findings should be interpreted with caution. Although the absence of statistically significant differences in self-reported preventive education may suggest a relatively homogeneous level of instruction across students, this result does not allow us to conclude that preventive education is insufficiently adapted to the territorial context. A more robust assessment would require examining the actual content and depth of instructional activities, the degree of local risk exposure, the presence and implementation of school emergency plans, and potential differences between schools located in areas with varying levels of flood hazard. By incorporating this nuance, the discussion acknowledges that the current evidence points to uniformity in students' perceptions of instruction, while also recognizing that further contextual and curricular analyses would be necessary to substantiate broader claims about territorial adaptation.

The lack of territorial adaptation in preventive content highlights a disconnect between the direct experience of risk and its treatment in schools, as previously noted by Velásquez and Alcántara [28] in a region particularly vulnerable to floods in Nicaragua. In the present study, greater awareness and preparedness were observed regarding frequent climate threats in the Mediterranean area, although there is limited attention to extraordinary region-specific events. In this regard, studies such as that of Ahn et al. [56] in South Korea show that more than 70.0% of students wish to receive flood education based on real-life experiences.

Various studies have addressed flood risk education and perception in school contexts. The "Venero Claro-Agua" project [57] proved effective in raising awareness among more than 3700 children and preadolescents in Spain between 2013 and 2019. Building on this, Díez-Herrero et al. [18] propose a risk management approach based on participation and emotional recovery after extreme events. In the United Kingdom, Williams and McEwen [23] show that children aged 7 to 9 understand flood risk through a systemic and conscious lens in relation to climate change. In Thailand, Intaramuean et al. [53] reveal that despite high exposure to floods, most primary school students lack specific training, showing low levels of preparedness.

According to Roca et al. [22], schools must serve as protective spaces that offer emotional support to children following extreme events. While the socio-emotional role of schools is acknowledged, Morote et al. [20] warns of the lack of concrete actions in response to floods. Although students recognize an increase in natural hazards, transforming that awareness into concrete actions can be challenging due to various obstacles, such as a perceived lack of influence, limited personal connection to the issue, or insufficient educational training [52,58,59]. To improve socio-territorial awareness and response capacity to such phenomena, it is essential to train teachers through ongoing programs that integrate geospatial technologies, Game-Based Learning (GBL) [12], resources like the video game "Stop Disasters" [24], local toponymy, or field trips [54]. Additionally, enhancing literacy in time and climate requires integrating practical and engaging applications of climate

concepts into the school curriculum, as well as providing teacher training to foster student motivation and enthusiasm [60,61].

The prominence of floods—particularly the 2024 cut-off low in Valencia—in students' experiences and memories reflects the strong territorial imprint of hydrometeorological hazards in Mediterranean environments. The combination of recurrent torrential rainfall, high urban exposure, and the emotional visibility of recent catastrophic events help explain why this hazard emerges as the most salient in the students' perceptions. The event's importance is based on how often students mentioned it and its temporal closeness. Media exposure may explain this perception, but since they were not measured, they remain hypotheses rather than confirmed findings. This pattern suggests that risk awareness in Primary Education is shaped not only by curricular instruction but also by the social amplification of extreme events through media coverage and community narratives. These findings underscore the need for disaster-risk education that is sensitive to local contexts, reinforcing hydrological awareness as a core component of risk perception -building in regions where water-related hazards are both frequent and socially disruptive. Strengthening this contextualized approach may enhance students' capacity to interpret risks, connect personal and collective experiences, and internalize preventive measures more effectively.

5. Conclusions

Understanding students' perceptions of natural hazards and extreme weather events linked to climate change is essential for designing teaching strategies that enable effective risk education. This is confirmed by the analysis conducted in the current study, which involved students from various educational centers in the Valencian Community (Spain), one of the regions currently experiencing the most significant effects of climate change.

The results confirm that participants show a favorable perception of teaching received regarding natural hazards, especially floods. A total of 68.5% of responses to the higher values of the Likert scale indicate significant awareness, forming an important educational foundation for building school risk perception. The 2024 cut-off low event in Valencia emerges as the most prominent phenomenon in collective memory. This result is directly derived from students' responses in the questionnaire and reflects its temporal proximity and perceived impact. Although many students have not directly experienced these events (39.2%), their recollection is clear and consistent, particularly in relation to floods (24.2%). Analysis reveals no significant differences between students with direct experience and those without, highlighting the consistency and reach of preventive education. Statistical analysis reinforces this trend, as no significant differences were found between those who experienced or remembered these events and the preventive education received. The homogeneity in responses and the prevalence of intermediate values suggest that, regardless of personal experience, there is a moderately positive perception of school instruction.

The results indicate high awareness and relatively homogeneous preventive instruction, but do not support conclusions on emotional preparedness, long-term knowledge retention, or territorial adaptation. Nevertheless, they suggest that contextualized and consistent school-based instruction may strengthen hydrological risk awareness in high-risk Mediterranean regions.

Beyond the empirical findings, this study highlights several practical implications for educational policy and teacher training. In Primary Education, curricular frameworks should explicitly integrate disaster-risk education through contextualized activities that address local hydrometeorological hazards, promote critical interpretation of environmental information, and strengthen students' capacity to respond to extreme events. Likewise, initial teacher-training programs should incorporate specific modules on climate change, natural hazard prevention, and critical digital literacy to ensure that future educators are

equipped to guide pupils in navigating misinformation and post-truth dynamics during crises. Embedding these competencies within both school curricula and teacher-education pathways would contribute to building more resilient and better-informed communities in Mediterranean regions.

Regarding the limitations of the study, the limited quantitative coverage of the instrument. Future research should include more items for a fuller assessment of students' risk perception and preparedness. In addition, longitudinal approaches would allow analysis of how awareness and preparedness over time, while comparative studies with other regions could help assess the degree to which preventive education is adapted to specific territorial contexts.

Future research would benefit from exploring several complementary areas to enrich the findings. For instance, it would be relevant to investigate, together with school administrators, the status of emergency drills and hazard response plans. It would also be valuable to examine what types of content are taught regarding natural hazards and how they are delivered in the classroom.

A future challenge for this line of research involves addressing the methodological implications of excluding the schools most affected by the 2024 cut-off low event. Because these students likely experienced the most direct impacts of the flooding, their absence from the sample limits the scope and generalizability of the findings, particularly regarding risk perception and preventive education.

Geographic understanding plays a central role in reducing disaster risk, as it helps students grasp how territories function and why certain responses are effective. Although recent disaster experiences can heighten risk awareness, this sensitivity often diminishes over time. Current preventive education still struggles to reflect local territorial realities or connect with students lived experiences, limiting its impact on community risk perception. Strengthening and continuously integrating risk education from the earliest school levels is therefore essential. Its long-term effectiveness depends on sustained collaboration among administrations, schools, families, and the scientific community. Embedding this content in the curriculum not only addresses the challenges posed by climate-driven alterations in water systems but also honors past victims of water-related disasters and contributes to preventing future tragedies.

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