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Training and Didactic Proposals for Teaching Floods: A Study Based on the Experience of Trainee Social Science Teachers

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Abstract: This study examines the training and didactic proposals used to teach flood-related topics in Primary (5–12 years old) and Secondary Education (13–18 years old). This research employs a survey methodology, gathering responses from 726 trainee teachers across two Spanish universities (582 in Primary Education and 144 in Secondary Education). The findings highlight a significant gap in training, as more than half of the participants reported having received no instruction on floods, either during their school years or university studies. However, Secondary Education trainee teachers demonstrated a higher level of preparedness compared to their Primary Education counterparts. Regarding didactic proposals, two approaches stood out: activities based on real experiences (32.6%) and drills/talks led by experts (21.5%). Notably, Primary Education trainee teachers preferred expert-led sessions (24.7%), suggesting a lack of confidence in teaching these topics independently. This study underscores the crucial role of educators in risk reduction. Given their ethical responsibility to equip students with critical thinking skills, proper training is essential to fostering informed citizens capable of making sound decisions in the face of climate-related challenges.

Keywords: climate action; disasters; floods; proposals

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Academic Editors: Robert Mark Silverman and Mirjam Braßler

Received: 15 January 2025
Revised: 30 April 2025
Accepted: 13 June 2025
Published: 16 June 2025

Citation: Morote, Á.-F.; Olcina, J.; Gómez-Trigueros, I.-M. Training and Didactic Proposals for Teaching Floods: A Study Based on the Experience of Trainee Social Science Teachers. *Societies* **2025**, *15*, 166. https://doi.org/10.3390/soc15060166

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1. Introduction

Natural disasters are events that, due to their destructive potential and magnitude, put human lives at risk and cause economic damage. Their prediction is highly complex. In the Mediterranean area, extreme events related to atmospheric behavior have been occurring with greater frequency and intensity in recent years [1]. This phenomenon is manifested in the proven effect of global warming on global atmospheric circulation and its occasional occurrence in certain regions such as the Mediterranean [2]. Furthermore, according to the Intergovernmental Panel on Climate Change (IPCC) [3], future climate change scenarios predict more frequent and intense extreme atmospheric events.

According to the latest available data on a global scale, in 2023, the Centre for Research on the Epidemiology of Disasters [4] recorded a total of 399 catastrophic events: a considerably higher figure than the average of 369 for the period 2003–2023. Regarding floods, these phenomena account for 41% (n = 164) of the total. In 2023, a total of 7763 people died in floods across the world. This figure exceeds the average number of fatalities from floods in the world for the period 2003–2023 (n = 5518). Particularly noteworthy are the Democratic

Republic of the Congo (2970 deaths), India (1529 deaths), and Nigeria (275 deaths) for the highest number of deaths.

With respect to economic damage, floods in 2023 resulted in total losses of USD 20.4 billion (10% of the total), with Italy experiencing the highest financial impact (USD 9.8 billion). Therefore, underdeveloped and developing countries are most vulnerable to fatalities, while developed countries are more prone to significant financial losses.

With respect to teaching, as indicated by Morote and Olcina [5], education is a first-order action for reducing social vulnerability to natural hazards and, therefore, achieving greater territorial resilience to climate change [6].

The floods that have occurred in many countries over the last few decades and their effects, given the increase in social responsibility, have led to a new approach: the management of flood risk through raising awareness and encouraging societal participation, as these factors can play a crucial role in preventing the loss of human lives [7]. However, in developed countries, education has not been a key element in the design of policies aimed at preventing the effects of climate change [8]. Moreover, different authors [5] have found that the explanation of floods in textbooks is often poorly structured, with an overuse of excessively catastrophic messaging.

Teaching climate change and the associated atmospheric hazards was emphasized in the Fifth Climate Change Report of the IPCC [9]. Furthermore, the United Nations [10] with the Sustainable Development Goals (SDGs)—Agenda 2030, specifically with Objective 13 "Climate Action", places a central role on the teaching of climate change as a fundamental action toward achieving greater territorial resilience. Additionally, the Sendai Framework for Disaster Risk Reduction (2015–2030) highlights the education factor as one of the priority actions for reducing social vulnerability to floods [11].

For the Spanish case, the Climate Change Law (Law 7/2021 of May 20 on Climate Change and Energy Transition) includes several references to the importance of educating about this phenomenon, specifically Title VIII ("Education, Research, and Innovation in the Fight Against Climate Change and Energy Transition") (Article 35, "Education and Training on Climate Change") [12].

Therefore, in recent years, the importance of climate-related phenomena and their education has gained regulatory and institutional support, indicating a growing interest in this line of research. This interest is reflected in the publication of academic studies in the field of education. Different studies have been carried out for different territorial contexts, including. North America [13], Europe [7,14–16], Asia [17–21], South America [22], Oceania [23], and Africa [24]. In the case of Spain, teaching about floods has traditionally been integrated into Natural Science [25,26], and the studies conducted from the perspective of Social Sciences (the focus of this study) are relatively recent [27–30].

There are several reasons for the relevance of this study:

1. Flood risk is the most significant natural hazard affecting the Mediterranean region (where the study area, Spain, is located).
2. There is a scarcity of research on the didactics of flood risk in Spain from a geographical (Social Sciences) perspective.
3. Education plays a crucial role in mitigating the effects of floods by raising awareness and training society.
4. Floods are a topic that should be taught in Geography classes in schools, as established by current Spanish education legislation: Primary Education (Royal Decree 157/2022) and Secondary Education (Royal Decree 217/2022) [31,32].
5. According to future climate change scenarios, these phenomena are expected to become increasingly frequent and intense [3].

All of this has been highlighted in Spain with the DANA, commonly referred to as a "cut-off low", which struck the province of Valencia (Eastern Spain) on 29 October 2024, causing widespread devastation and resulting in 227 deaths. This event has underscored, among other concerns, the critical need to prioritize education and training in flood risk management.

The objective of this study is to analyze the training and didactic proposals for teaching floods in the school stage (Primary and Secondary Education). Furthermore, these issues will be analyzed based on teacher groups (Primary and Secondary Education) to determine whether there are any differences.

With respect to the starting hypothesis, it should be noted that the majority of trainee social science teachers have not received training on these topics during their school or university education, as it is a traditionally "neglected" subject in school and university (teacher training) classrooms [33]. The exception is those studying Geography in the Secondary Education Master's Degree, as this content is typically taught in this program.

Regarding the proposals, particularly noteworthy are activities related to the local environment of the students, hands-on experiences, and those based on drills and/or expert-led talks. These latter proposals are expected to be more relevant for Primary Education teachers, as they tend to feel less prepared due to a lack of training in geography.

2. Materials and Methods

2.1. Design of the Research

This research is a correlational and explanatory study (non-experimental) [34], based on the use of a mixed-type questionnaire as an instrument for data collection [35].

With respect to the temporal dimension, the design is cross-sectional, as the information obtained was collected at different time points (between the academic years 2018–2019 and 2023–2024), organizing the data according to the trainee teacher groups that participated (Degree in Primary Education and Master's Degree in Secondary Education).

2.2. Context and Participants

The selection of participants was carried out through non-probabilistic convenience sampling [36]. The trainee teachers in Primary and Secondary Education from two Spanish universities ([university names removed for peer review]) participated in the study.

The sample consists of 726 trainee teachers out of a total of 1233 enrolled students and is distributed as follows: Degree in Primary Education (n = 582); Master's Degree in Secondary Education—Specialization in Geography and History (n = 144). This figure (n = 726) achieves a confidence level of 99% with a margin of error of 5%. Therefore, it is considered representative of the total sample studied (Table 1).

Regarding the educational context of teacher training in Spain, Primary Education includes years 1 to 6 (ages 6–12), while Secondary Education covers years 7 to 10 (ESO) and years 1 and 2 of Baccalaureate (ages 13–18).

The overall average age of the sample is 22, and in terms of gender distribution, the majority are women (68.3%; n = 426) (Table 1).

Furthermore, within the postgraduate group, it is important to highlight their academic training in their chosen disciplines: Degree in History (60.4%; n = 87), Degree in Art History (21.5%; n = 31), Degree in Geography (13.9%; n = 20), and Other fields (Humanities, Tourism, Law, etc.) (4.2%; n = 6).

Table 1. Trainee teachers who participated in the research.

	Registered (n)	Participants (n)	Average Age	Gender	
				M	F
Primary Education trainee teachers	955	582	21.0	25.3% (n = 147)	74.7% (n = 434)
Secondary Education trainee teachers	278	144	26.1	57.6% (n = 83)	42.4% (n = 61)
Total	1233	726	22	31.7% (n = 230)	68.3% (n = 496)

Source: own elaboration.

2.3. Research Instrument

For the data collection process, a previously designed and validated questionnaire used in prior studies was administered [removed for peer review]. This mixed-type questionnaire (quantitative and qualitative) contains 28 items divided into different blocks: (1) Socio-educational characteristics; (2) Flood risk in the participant's municipality; (3) Flood episodes in the participant's school; (4) Training on flood risk during the school years; (5) Perception of flood risk; (6)Teacher training and digital competence related to flood risk (see Appendix A).

For this study, considering the defined objectives, specific items from block 4 (items 15 and 16) and block 6 (items 26, 27, and 28) were analyzed. The questions include both closed-ended and open-ended formats (see Table 2).

Table 2. Items of the questionnaire analyzed.

Item (n.)	Type of Response
-Item 15. During your school years, did you receive any type of information about the risks of flooding?	-Item 15. Closed response: Yes/No/Do not know/No answer
-Item 16. Could you indicate the information that you received?	-Item 16. Open answer.
-Item 26. Have you received any previous training on these contents at university (during your degree)?	-Item 26. Closed response: Yes/No/Do not know/No answer
-Item 27. Have you received any previous training on these contents at university (during your Master's degree in Secondary Education)?	-Item 27. Closed response: Yes/No/Do not know/No answer
-Item 28. As a future teacher, what activities, resources, information, etc. would you use with your students to increase their knowledge of flood risk?	-Item 28. Open answer.

Source: own elaboration. Note: Item 27 has only been asked to the students of the Master's Degree in Secondary Education.

In relation to the research instrument, to evaluate the validity of the construct, a statistical analysis was first conducted on the ordinal variables. It was found that these variables exhibited an acceptable standard deviation (SD > 1).

After this verification, the construct (items analyzed in this study) underwent a Kaiser–Meyer–Olkin (KMO) validity test to determine whether the factorial analysis of the instrument was appropriate. This test yielded a positive value of 0.500, which, according to previous factor reliability studies, is considered an acceptable level [37].

Furthermore, as this is a mixed-type questionnaire, and following recommended procedures, the Friedman Chi-squared test (Friedman's x^2) was conducted. It produced a positive value of $p = 0.043$ (<0.05), indicating that there is no discrepancy between the variables and that they are interdependent [38,39]. This confirms the reliability and validity of the research, aligning with findings from other studies in the field of educational research [40], particularly Social Science Didactics [35].

2.4. Procedure

With respect to the research procedure, the questionnaire was administered during a session, with a response time of 20 min, in the first semester of each academic year.

The study was conducted in compliance with the directives of the Helsinki Declaration (World Medical Association Declaration), guaranteeing an ethical and philosophical commitment, as well as unwavering respect for human dignity, privacy, physical and moral integrity, and the protection of personal data in the use of the survey throughout the research.

Privacy regulations were adhered to, in alignment with the personal data protection code (Organic Law 3/2018), as well as the principles of anonymity and informed consent [41]. The objectives of the study were clearly stated, along with their significance for the training processes of trainee teachers.

2.5. Data Analysis

With regard to the data analysis procedure, the SPSS v.28 software was used to conduct a statistical-inferential analysis (non-parametric testing) of frequencies and percentages.

To analyze the nominal items (non-dichotomous) and teacher groups (Degree in Primary Education and Master's Degree in Secondary Education), the Chi-squared test (x^2) was applied to detect a linear relationship between these items, following methodologies used in previous studies [42].

As the data consists of quantitative elements (standardized Likert scale items) and qualitative elements (open-ended response items), a combined analysis has been conducted, integrating both quantitative and qualitative results. This approach allows for the confirmation of some of the findings obtained in this research. Likewise, presenting combined quantitative and qualitative results eliminates the traditional method of data analysis, shifting toward a holistic and comprehensive view of the values obtained through the mixed-type instrument that has been designed and validated.

Furthermore, it should be noted that the responses to the open-ended questions (items 16 and 28) were coded, generating a frequency analysis, as shown in Figures 1 and 2. This coding was performed by identifying content patterns and categorizing the available information.

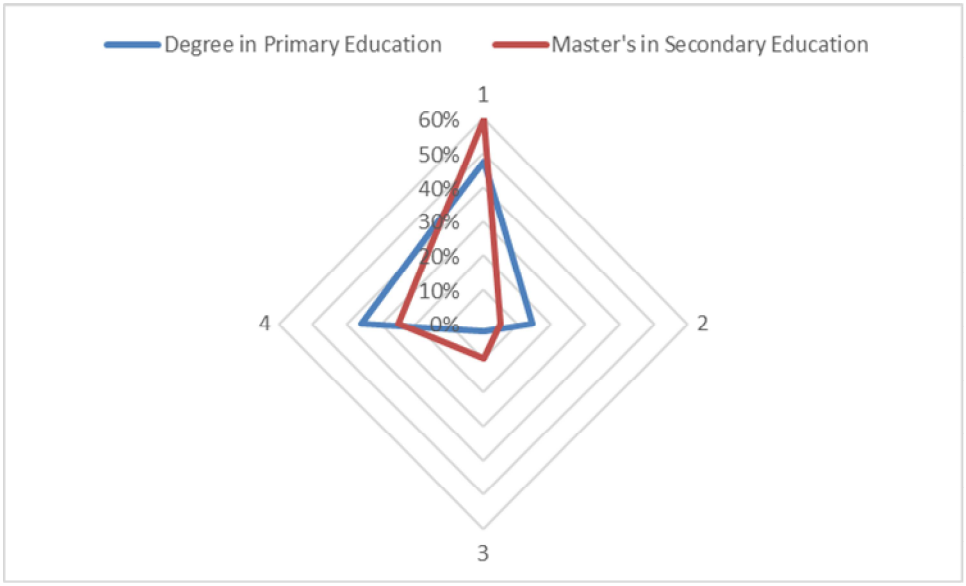


Figure 1. Contents received during the school stage on floods (Item 16). Source: questionnaire results. Coding of the answers to Item 16: "prevention measures" (1); "characteristics of the student's environment" (2); "explanation of the cold drop" (3); "contents of the textbook" (4). Own elaboration.

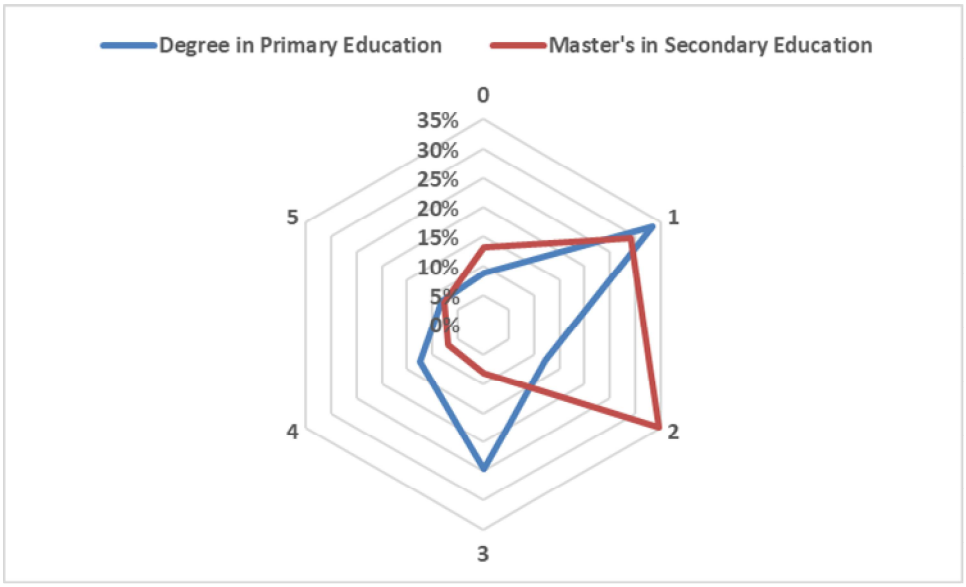


Figure 2. "As a future teacher, what activities, resources, information, etc. would you use with your students to increase their knowledge of flood risk?" (Item 28). Source: questionnaire results. Coding of the answers to Item 28: "Do not know/No answer" (0) "real experiences" (1); "work with sources, news/videos" (2); "drills/talks" (3); "field trips" (4); "self-created didactic units" (5). Own elaboration.

To achieve this, keywords were counted, the frequency (f) of the most recurrent responses for items 16 and 28 was recorded, and the percentages of textual fragments related to the concomitant items were documented (R%). The software MAXQDA (v.2020) was used for analysis due to its capabilities in coding, classification, and data saturation.

This qualitative study yields results that align with those obtained from the quantitative analysis of the administered questionnaire, as indicated above. Finally, regarding the open responses, the text includes examples, using the references "P.E.E." for students in the Degree in Primary Education and "S.E.E." for those in the Master's Degree in Secondary Education.

3. Results

3.1. School Education on Floods

This section examines the items related to the school education received by trainee teachers regarding flood content (items 15 and 16). Considering the data as a whole, more than half (57.6%; n = 418) reported that they did not receive any training on this topic (Table 3).

Table 3. Item 15. "During your school years, did you receive any type of information about the risks of flooding?".

		Degree in Primary Education	Master's Degree in Secondary Education	Total	Value	
					x^2	p
No	n	343	75	418	4.813	0.090
	%	58.9%	52.1%	57.6%		
Yes	n	146	35	181		
	%	25.1%	24.3%	24.9%		
Do not know/No answer	n	93	34	127		
	%	16.0%	23.6%	17.5%		
Total	**n**	**582**	**144**	**726**		
	%	**100.0%**	**100.0%**	**100.0%**		

Source: questionnaire results. Own elaboration. x^2 = Chi-squared; p = asymptotic significance (bilateral).

When analyzing these data by teacher group (Primary Education and Secondary Education), no significant differences were observed. To verify this, the Chi-squared test was performed, which indicated that the association between these two variables (school training and teacher group) was not significant (Pearson's Chi-squared = 4.813; p = 0.090).

Thus, they are not significantly associated ($p > 0.05$), and the two variables are independent of one another. In other words, the school education received on floods was not influenced by the trainee teacher group (Primary Education or Secondary Education).

Second, the taught contents were analyzed (Item 16, Figure 1) for those who responded positively to Item 15 (24.9%; total of 193 responses). Respondents reported receiving training primarily on "prevention measures" (50.3%; n = 97) and, secondly, through teacher-explained content based on the "textbook" (33.7%; n = 65). Some responses related to prevention measures include:

- "Do not go near rivers and gullies when it rains" (P.E.E. n. 2).
- "Evacuation methods, advice to remain calm, what to do if the classrooms flood, etc." (S.E.E. n. 175; Master's Degree in Secondary Education).

Responses regarding textbook-based teaching include:

- "Only what was included in the Baccalaureate textbook—the topic on catastrophes such as floods—but I was not given advice..." (P.E.E. n. 101).
- "I received scarce information from the textbook, and I cannot even remember it" (P.E.E. n. 136).
- "In Geography class, we learned about risks in general in all cities with rivers or nearby seas, based on the textbook" (S.E.E. n. 543).

When analyzing the responses by trainee teacher group, certain differences emerge. For example, the postgraduate group responded more frequently to "prevention measures" (60.0%; n = 24), while the Degree in Primary Education group referred more to "textbook contents" (35.9%; n = 55).

To determine whether these differences are statistically significant, the Chi-squared test was conducted again. The results indicate that the association between these two variables (contents received and teacher group) is significant (Pearson's Chi-squared = 9.975; $p = 0.019$). Thus, they exhibit a statistically significant association ($p < 0.05$) and should be considered dependent variables

3.2. University Education on Floods

In this second section, the results on university training are analyzed, covering both undergraduate (Item 26) and postgraduate education (Item 27, specifically the Master's Degree in Secondary Education).

Regarding undergraduate training, the data show that the instruction received is similar to that obtained during school education. However, responses indicating "no training" account for 62.7% ($n = 364$) of the Primary Education group compared to 48.6% ($n = 70$) of the Secondary Education trainee teachers (Table 4). This suggests that discipline-specific training during university has an impact. Among the Secondary Education group, 45.8% ($n = 66$) responded affirmatively, in contrast to only 7.7% of the Primary Education trainee teachers (Table 4).

Table 4. "Have you received any previous training on these contents at university (during your degree)?" (Item 26).

		Degree in Primary Education	Master's Degree in Secondary Education	Total	Value	
					x^2	p
No	n	364	70	434	140.024	0.001
	%	62.7%	48.6%	59.9%		
Yes	n	45	66	111		
	%	7.7%	45.8%	15.3%		
Do not know/No answer	n	172	8	180		
	%	29.6%	5.6%	24.8%		
Total	**n**	**581**	**144**	**725**		
	%	**100.0%**	**100.0%**	**100.0%**		

Source: questionnaire results. Own elaboration. x^2 = Chi-squared; p = asymptotic significance (bilateral).

Moreover, within the postgraduate group, it is important to determine whether there are differences based on their discipline (graduates in Geography, History, Art History, and Other fields). The results indicate that Geography students (100.0%; $n = 20$) received the most training during their university education (Table 5). Secondly, except for History graduates (50.6%; $n = 44$), the remaining groups (Art History, Other fields) received little to no training. When interpreting these data, it should be noted that these teachers will be qualified to teach Geography.

To determine whether these differences are statistically significant, the Chi-squared test was performed. The results show that the association between these two variables (university training and degree discipline) is significant (Pearson's Chi-squared = 56.632; $p < 0.001$).

Finally, regarding the participants' university education, the results obtained for Item 27 were analyzed, focusing exclusively on training related to floods during the postgraduate degree. It should be noted that, to avoid influencing responses, the questionnaire was administered before the sessions on natural risks. As a result, the majority (59.0%; $n = 85$) reported that they had not received training on these topics during their postgraduate studies.

Table 5. "Have you received any previous training on these contents at university (during your degree)?" (Item 26) (Secondary Master's students in Secondary Education).

		Geography	History	Art. Hist.	Others	Total	Value	
							x^2	p
No	n	0	36	29	5	70	56.632	0.001
	%	0.0%	41.4%	93.5%	83.3%	48.6%		
Yes	n	20	44	2	0	66		
	%	100.0%	50.6%	6.5%	0.0%	45.8%		
Do not know/No answer	n	0	7	0	1	8		
	%	0.0%	8.0%	0.0%	16.7%	5.6%		
Total	**n**	**20**	**87**	**31**	**6**	**144**		
	%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**		

Source: questionnaire results. Own elaboration. x^2 = Chi-squared; p = asymptotic significance (bilateral).

3.3. Didactic Proposals to Train and Raise Awareness Among School Children on Floods

In this section, after analyzing the results on school and university training, we will examine the didactic proposals of the trainee teachers to improve the training and awareness of the rise in floods of school children (Item 28). In general, three main proposals stand out: "real experiences" (32.6%; n = 237); "drills/talks" (21.5%; n= 156); "work with sources, news/videos" (16.7%; n = 121) (Figure 2).

Some of the responses related to "real experiences" include the following:

- "Use a rainy day to introduce the topic, incorporating information on historical floods or firsthand experiences" (P.E.E. n. 1).
- "Many families have likely experienced major floods in Alzira. Students could conduct interviews to gather testimonies about these events" (S.E.E. n. 658).

For the case of "drills/talks," some responses include the following:

- "Above all, a set of action guidelines and drill exercises." (P.E.E. n. 182).
- "Drills and expert-led talks." (S.E.E. n. 692).

Regarding "working with sources, news, and videos", respondents suggested:

- "I would use recent news reports from various media outlets, analyzing the situation to reach a possible conclusion. Then, I would try to identify solutions to prevent it from happening again" (P.E.E. n. 183).
- "Work based on documentaries and the analysis of journalistic information" (P.E.E. n. 688).

It should be noted that, as shown in Figure 2, the postgraduate group responded more frequently to the proposal of "working with sources, news, and videos" (34.7%; n = 50). Conversely, the Primary Education group showed greater preference for "drills/talks" (24.7%; n = 144), suggesting that they feel less prepared to teach these contents. Furthermore, it is notable that few responses referred to field trips, even among Geography graduates.

To verify whether these differences are statistically significant, the Chi-squared test was performed. The results indicate that the association between these two variables (proposals and teacher group) is significant (Pearson's Chi-squared = 55.471; $p < 0.001$).

An analysis of these data (focusing exclusively on the postgraduate group by degree discipline) reveals that Geography graduates prioritize "real experiences" more than other disciplines (50.0%; n = 10) (Figure 3). The Chi-squared test results indicate that the association between these two variables (proposals and degree discipline within the postgraduate group) is statistically significant (Pearson's Chi-squared = 74.373; $p < 0.001$). Thus, they

exhibit a statistically significant relationship ($p < 0.05$), confirming that the two variables are interdependent.

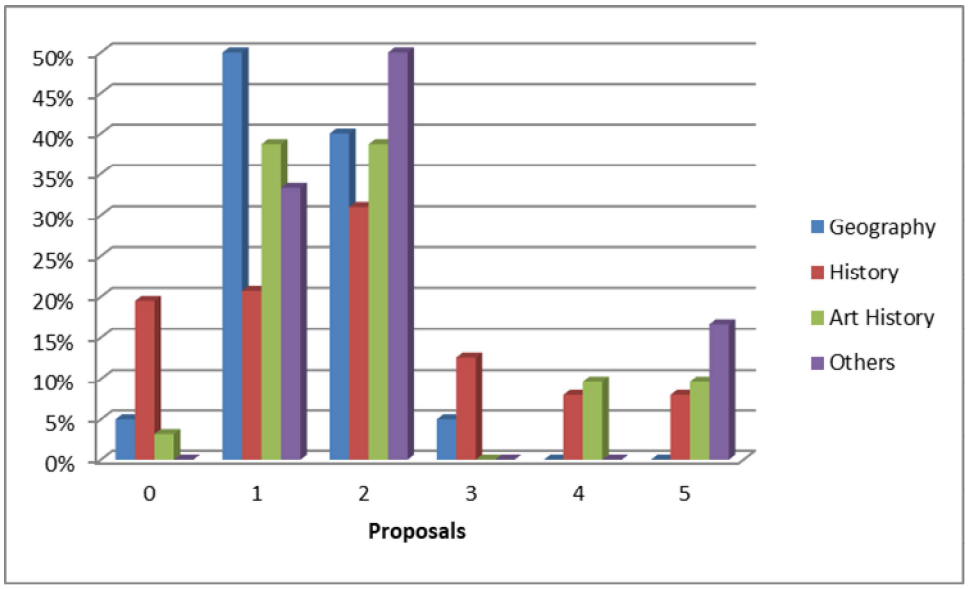


Figure 3. "As a future teacher, what activities, resources, information, etc. would you use with your students to increase their knowledge of flood risk?" (Item 28) (responses of postgraduate group). Source: questionnaire results. Coding of the answers to item 28: "Do not know/No answer" (0); "real experiences" (1); "work with sources, news/videos" (2); "drills/talks" (3); "field trips" (4); "self-created didactic units" (5). Own elaboration.

4. Discussion

This research enhances knowledge on teacher training in relation to one of the natural risks with an increasing socio-economic impact, driven by the proven effects of climate change (greater frequency and intensity of torrential rainfall). Additionally, the influence of human activities has further exacerbated this risk, particularly evident in the Mediterranean region [2].

With respect to the starting hypotheses, the first establishes that "the majority of trainee teachers have not received training on these contents in their school or university stages, as it is a traditionally "forgotten" topic in school and university (teacher training) classrooms, except for those studying Geography (Secondary Education Master's Degree) as this content is usually taught in this degree program". This hypothesis is partly fulfilled. It has been shown that more than half of the participants (57.6%) reported that they had not received training on this topic, with no significant differences between the two trainee teacher groups during their school years. Regarding the content received, two aspects stand out: "prevention measures" (33.7%) and teacher-explained content based on the "textbook" (33.7%). However, differences were observed between the groups. The postgraduate group was more likely to report training in "prevention measures" (60.0%), while the Degree in Primary Education group more frequently cited "textbook-based content" (35.9%).

The percentage of surveyed participants who received flood-related training during their school years was approximately 40.0%. However, this percentage increased significantly in university education, particularly among the postgraduate group (52.0%). Thus, the academic discipline in which participants were trained plays a crucial role when comparing the different trainee teacher groups. For example, 100.0% of Geography graduates received training on floods during their university studies.

Other studies conducted in the Mediterranean region on Primary Education teachers have yielded similar results. For example, Morote and Hernández [43] found that only 21.3% had received information on these topics during their school years.

Meanwhile, Morote and Souto [33] confirmed that Primary Education teachers possess very little prior knowledge of natural risks and have a limited perception of the importance of the vulnerability factor in mitigating the consequences of these natural catastrophes. Similarly, they reported a low level of training received during school years (12.1%).

On an international level, particularly across the Asian continent, risk education has a well-established tradition with demonstrated positive effects on training and awareness-raising among younger generations. For example, in South Korea, Ahn et al. [44] examined the needs and effective approaches for school safety training in relation to flood disasters. Based on a survey of Secondary Education teachers and students, they found that more than 70.0% of respondents expected to receive flood disaster safety education based on firsthand experience and wished to be taught about this once a year, for at least one hour, by a specialist.

Regarding educational content, participants expressed a preference for evacuation drills. In other words, their responses align with the experiences documented in this study, although only 40.0% recalled having received such training.

Therefore, training in natural disaster prevention is essential and should begin at an early age. This has been confirmed in Malaysia by Azmi et al. [17], who conducted a study involving 337 Primary Education students in the Klang Valley. Using children's games and implementing a control and experimental group, the authors found that both groups demonstrated a significant improvement in their knowledge of disasters after participating in multiple sessions focused on risk education and play-based learning. Azmi et al. [17] concluded that students became more engaged and interested in learning

In Mexico, Cajigal and Maldonado [45] state that populations with higher levels of education possess more information and a greater understanding and awareness of disasters. According to these authors, risk education at compulsory education levels (up to age 15 in Mexico) serves as an indicator of social vulnerability, which must be considered in local-scale risk assessments. In this regard, González and Maldonado [46] emphasize that evaluating risk perception and community vulnerability, particularly in areas frequently impacted by extreme hydro-meteorological phenomena such as floods, is essential for developing educational programs aimed at strengthening community resilience

The importance of teaching about these phenomena in schools is critical, as it not only raises awareness among families but also in society as a whole [7].

With respect to the second hypothesis, it is confirmed, as the findings show that the two primary approaches to teaching consist of activities based on "real experiences" (32.6%) and "drills/talks" led by experts (21.5%). Furthermore, it should be noted that the Primary Education group expressed a greater preference for the latter (24.7%), suggesting that they feel less confident in teaching these topics and prefer to delegate instruction to subject-matter experts.

Undoubtedly, to effectively teach about floods in schools while keeping students engaged, it is essential to incorporate local and everyday territorial components, such as real experiences, oral sources, testimonials, and historical floods that have occurred in their environment.

In recent years, various studies have emphasized the importance of the environment, the familiarity of these phenomena, and the integration of digital tools in classroom learning. For instance:

- Guo et al. [18] analyze a teaching approach based on conceptual graphs to organize and visually structure knowledge about flood disasters.

- Olcina and Morote [29] propose using web viewers to display flood-prone areas affecting students' communities, enabling them to assess social and economic vulnerability (e.g., inhabitants, affected homes, etc.).
- Zaragoza and Morote [30] advocate for teaching historical floods through local toponymy, supplemented by oral sources and testimonials from individuals who have experienced these disasters firsthand.
- Mendoza [47], in a study on flood risk prevention programs at the Baccalaureate level in José Cardel (Veracruz, Mexico), recommends a range of educational activities, including documentary screenings, the creation of informative posters, and the development of student forums and social networks for risk-related discussions.

5. Limitations of the Study

This study, based on a questionnaire as the primary data collection instrument, presents several limitations that must be acknowledged to ensure transparency in its findings. Below, we discuss four key constraints affecting the reliability and generalizability of the results.

1. Self-report bias. A major limitation of questionnaire-based research is its reliance on self-reported data, which introduces biases such as social desirability, where participants provide answers they deem more acceptable, and memory recall issues, particularly when asked about past experiences.
2. Sample representativity. The ability to generalize results depends on the sample size and diversity. If participants belong to a specific university, city, or professional group, the findings may not be applicable to broader populations. For instance, a study focusing solely on trainee teachers from a single institution may not capture variations in educational practices elsewhere. A larger, more diverse sample would enhance the external validity of the research, ensuring a more comprehensive representation of different contexts.
3. Questionnaire design limitations. The structure and formulation of questionnaire items significantly influence responses. Ambiguous or leading questions may distort participants' answers, affecting the validity of the data. While closed-ended questions provide quantifiable insights, they often restrict detailed explanations, whereas open-ended responses, though valuable, pose challenges in systematic analysis.
4. DANA 2024. One important limitation of this study is its timing, as the data collection occurred before the devastating floods in Valencia in October 2024. Given the severity and impact of this disaster, it is likely that public awareness and perceptions regarding flood risks and climate change have significantly evolved since then. Had the study been conducted after the 2024 floods, responses might have reflected greater concern, heightened awareness, and a stronger demand for flood-related education. Individuals who previously underestimated the risks may now recognize the urgency of preparedness measures. Additionally, policy changes, educational initiatives, and media coverage following the disaster could have influenced participants' perspectives.

6. Conclusions

Educating society on key global issues, such as climate change and its associated atmospheric extremes, is essential for fostering critical awareness and decision-making capabilities. To achieve this, it is crucial that the training of teachers responsible for conveying this material to schoolchildren be rigorous, well-structured, and tailored to each educational level [48,49]. The findings of this study indicate that the initial training received by trainee teachers is neither extensive nor sufficiently adequate. Much of it relies on textbook-based information that tends to emphasize the catastrophic aspects, rather than

providing a rational explanation of the processes that create risk and can lead to disasters [5]. However, the study also highlights the strong interest among trainee teachers in enhancing their training and delivering meaningful instruction to students on risks, environmental issues, and climate change, incorporating real-world experiences and considering students' local environments.

This study addresses future challenges in improving both the study method and the results obtained. These include conducting surveys among active teachers and classroom assistants to assess the actual transmission of content on natural hazards and climate change in the classroom. Similarly, interviews with students could help determine their level of understanding of the facts and processes explained by teachers, as well as their preferences regarding the organization of instruction on these topics.

A society well-educated in natural hazards and environmental changes is less vulnerable. Within the current climate change context, teaching these topics is crucial, as the increased frequency of extreme natural events heightens risk. A tragic example of this was the 2024 DANA in Valencia (Spain), which resulted in devastating floods, causing significant loss of life (227 deaths) and infrastructure damage.

Teachers play a key role in risk reduction and climate change mitigation, given their ethical responsibility to equip students with the knowledge needed to become critical thinkers and decision-makers, ultimately contributing to safer societies.

Author Contributions: Conceptualization, methodology, formal review, and investigation were done by Á.-F.M., J.O. and I.-M.G.-T. All authors have read and agreed to the published version of the manuscript.

Funding: This research presents results from several research and educational innovation projects: (1) the R&D&I project "INCLUCOM—Curricular Models and Historical-Geographical Competencies of Teachers for the Construction of Inclusive Identities" (PID2021-122519OB-I00), funded by MCIN/AEI/10.13039/501100011033/ and by "FEDER: A Way to Make Europe"; (2) "Project Geographical knowledge about Spain, Europe, and the World among secondary school students" (COGESO), Project PID2021-124390OB-I00 funded by MICIU/AEI /10.13039/501100011033 and by FEDER, EU; and (3) the Educational Innovation Project "Ciencias y Letras. Crisis" (UV-SFPIE_PIEC-3330000), was approved by the University of Valencia on 29 July 2024.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. Regarding the ethics committee, in our institution (University of Valencia), if an opinion survey is going to be carried out on some topic or issue, professional situation, satisfaction with certain issues, etc., as long as psychological or health information is not included, authorization from the Ethics Committee is not required (https://www.uv.es/comision-etica-investigacion-experimental/es/etica-investigacion-humanos/comite/presentacion.html#:~:text=El%20Comit%C3%A9%20El%20Comit%C3%A9%20de%20%C3%89tica%20de%20Investigaci%C3%B3n,humanos.%20Utilizaci%C3%B3n%20de%20muestras%20biol%C3%B3gicas%20de%20origen%20humano, accessed on 15 January 2025).

Informed Consent Statement: Not applicable.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Questionnaire used in this research.

Block 1. Socio-Educational Characteristics	
Item (n.)	**Type of Response**
-Item 1. Gender. -Item 2. Sex. -Item 3. What degree or bachelor's program have you studied?	-Item 1. Open response. -Item 2. Closed response: Men (1); Women (2); Other (3); I prefer not to say (4). -Item 3. Open response.
Block 2. Flood risk in the participant's municipality	
Item (n.)	**Type of response**
-Item 4. Locality where the secondary school you attended is located -Item 5. Is this locality affected by flood risk? -Item 6. If the previous answer was "Yes," please specify which areas are usually affected by flooding -Item 7. Write the names of some ravines and/or rivers that flow through this municipality.	-Item 4. Open response. -Item 5. Closed response: No (0); Yes (1); Do not know/No answer (2). -Item 6. Open response. -Item 7. Open response.
Block 3. Flood episodes in the participant's school	
Item (n.)	**Type of response**
-Item 8. Name of the school. -Item 9. Was the school located in a risk area? (For example, in a dry riverbed, marshland, etc.). -Item 10. Did your route from home to school pass through areas at risk of flooding? -Item 11. If the previous answer was affirmative, were there any signs or preventive measures in place? -Item 12. If the previous answer was "Yes," could you specify what preventive measures were in place? -Item 13. Did you experience a severe flooding incident at your school? -Item 14. If the previous answer was "Yes," can you briefly describe what happened and how the situation was handled?	-Item 8. Open response. -Item 9. Closed response: No (0); Yes (1); Do not know/No answer (2). -Item 10. Closed response: No (0); Yes (1); Do not know/No answer (2). -Item 11. Closed response: No (0); Yes (1); Do not know/No answer (2). -Item 12. Open response. -Item 13. Closed response: No (0); Yes (1); Do not know/No answer (2). -Item 14. Open response.

Table A1. *Cont.*

Block 4. Training on flood risk during the school years	
Item (n.)	**Type of response**
-Item 15. During your school years, did you receive any type of information about the risks of flooding?	-Item 15. Closed response: Yes/No/Do not know/No answer
-Item 16. Could you indicate the information that you received?	-Item 16. Open answer.
-Item 17. At which educational stages do you recall receiving this content?	-Item 17. Open answer.
Block 5. Perception of flood risk	
Item (n.)	**Type of response**
-Item 18. Are there more flooding incidents now than when you were in school?	-Item 18. Closed response: Yes/No/Do not know/No answer
-Item 19. Why?	-Item 19. Open answer.
-Item 20. Regarding the following factors that influence flood risk, how important do you think they are in determining the level of risk? (rate each item, with 1 being the least important and 5 being the most important).	-Item 20. Likert scale response (1 to 5): Land use planning/Lack of societal understanding of territorial dynamics/Climate change/Prevention and emergency measures/Education and awareness/"Zero risk perception".
-Item 21. Has the pattern of rainfall changed over the last two decades?	-Item 21. Open answer.
Block 6. Teacher training and digital competence related to flood risk	
Item (n.)	**Type of response**
-Item 22. Do you feel prepared as a future teacher to teach these topics? Rate your opinion from 1 to 5, with 5 being the highest level of preparedness.	-Item 22. Likert scale response (1 to 5).
-Item 23. Could you explain the reason for your previous answer?	-Item 23. Open answer.
-Item 24. Is it worthwhile to address these topics in classrooms? Rate your opinion from 1 to 5, with 5 being the highest rating.	-Item 24. Likert scale response (1 to 5).
-Item 25. Could you explain the reason for your previous answer?	-Item 25. Open answer.
-Item 26. Have you received any previous training on these contents at university (during your degree)?	-Item 26. Closed response: Yes/No/Do not know/No answer
-Item 27. Have you received any previous training on these contents at university (during your Master's degree in Secondary Education)?	-Item 27. Closed response: Yes/No/Do not know/No answer
-Item 28. As a future teacher, what activities, resources, information, etc. would you use with your students to increase their knowledge of flood risk?	-Item 28. Open answer.

Source: own elaboration Note: Item 27 has only been asked to the students of the Master's Degree in Secondary Education.

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