



32
December 2025

- Gaetano Domenici*
Editoriale / *Editorial*
Istruzione, educazione, cultura come antidoto alle nascenti Oclocratie 11
(Education and Culture as an Antidote to Emerging Ochlocracies)

STUDI E CONTRIBUTI DI RICERCA

STUDIES AND RESEARCH CONTRIBUTIONS

- Shuaib Abolakale Muhammed - Magaret Funke Omidire*
Silent Struggles: Exploring Social Anxiety and Its Impact 23
on Nigerian Adolescents
(Lotte silenziose: esplorare l'ansia sociale e il suo impatto sugli adolescenti nigeriani)
- Manuel Ángel Río Ruiz - María Ortega Gómez*
Policies of Early Childhood Education and Care (ECEC) 39
in Andalusia (Spain): Development, Trends and Privatization Effects
(Politiche di educazione e cura della prima infanzia – ECEC – in Andalusia – Spagna: sviluppo, tendenze ed effetti della privatizzazione)

- Ludovica Fanni - Livia Petti*
Exploring Research and Strategies for Preventing School Dropout: 59
An Umbrella Review
(*Esplorazione della ricerca e delle strategie per la prevenzione dell'abbandono scolastico: una umbrella review*)
- Wahyudi - Beti Indah Sari - Maya Mustika Kartika Sari*
Iman Pasu Marganda H.P. - Warsono - Rahmanu Wijaya
Budi Santosa - Itok Dwi Kurniawan - Edy Suprianto
Sukma Ayu Putri Ariningtyas
Civic Education and Bullying: Strengthening the Civic 77
Disposition in Preventing Bullying in Junior High Schools
(*Educazione civica e bullismo: potenziare le disposizioni civiche per prevenire il bullismo nelle scuole medie inferiori*)
- Loto Montana - Antonio Calvani - Andrea Peru*
Sviluppare abilità logiche e di problem solving nella scuola 93
primaria: una sintesi delle evidenze
(*Developing Logical Reasoning and Problem Solving Skills in Primary School: a Synthesis of the Evidence*)
- Stefano Scippo - Diego Fabiani - Maria Ranieri*
Developing and Validating a Knowledge Test on Flood Risk 117
for Primary Teachers
(*Costruzione e validazione di un test sulle conoscenze del rischio idraulico per futuri insegnanti di scuola primaria*)
- Galuh Nur Rohmah - Ulil Fitriyah - Lina Hanifiyah*
Interculturality in EFL Education as a Gateway to Religious 137
Moderation: Voices from Religion-Based School Teachers
(*L'interculturalità nell'educazione EFL come via verso la moderazione religiosa: le voci degli insegnanti di scuole confessionali*)
- Elena Zizioli - Chiara Meta - Lisa Stillo - Rita Marzoli*
Giulia Franchi - Elisabetta Colla
Incarcerated Motherhood and the Right to Education: 155
A Pedagogical Scoping Review
(*La maternità in carcere e il diritto all'educazione: una scoping review in prospettiva pedagogica*)

*Émiliane Rubat du Mérac - Giulia Halina Nilo - Astrid Favella
Pietro Lucisano*
The Transition to Work of Education and Pedagogy Graduates: 189
A Mixed-Methods Longitudinal Study from Sapienza University
(2008-2018)
*(La transizione al lavoro dei laureati in Scienze dell'Educatione e Pedagogia:
uno studio longitudinale mixed-methods presso la Sapienza Università
di Roma, 2008-2018)*

Francesca Alby - Matteo Alpini
«Come alberi senza radici»: le sfide dell'accoglienza ai giovani 207
migranti nelle narrazioni degli operatori
*(«Like trees without roots»: The Challenges of Supporting Young Migrants
in Practitioners' Narratives)*

Maria Giulia Ballatore - Anita Tabacco
CIAO! Online Escape Room: Assessment of Basic Mathematical 223
Skills for Incoming Engineering Students
*(Ciao! Online escape room: verifica delle competenze matematiche di base
per le matricole di Ingegneria)*

NOTE DI RICERCA

RESEARCH NOTES

Leslie Burton - Amanda Tatnall - Aedan Frumento
Meditation App Use May Decrease State Anxiety 243
(L'uso di un'app di meditazione può ridurre lo stato d'ansia)

COMMENTI, RIFLESSIONI, PRESENTAZIONI,
RESOCONTI, DIBATTITI, INTERVISTE

COMMENTS, REFLECTIONS, PRESENTATIONS,
REPORTS, DEBATES, INTERVIEWS

Raffaele Pozzi
About the Emergence of an Environmental and Ecological 253
Perspective in 20th Century Music: Some Reflections
on Gustav Mahler and Olivier Messiaen
*(Sull'emergere di una prospettiva ambientale e ecologica nella musica
del XX secolo: alcune riflessioni su Gustav Mahler e Olivier Messiaen)*

Author Guidelines 263

Developing and Validating a Knowledge Test on Flood Risk for Primary Teachers*

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COSTRUZIONE E VALIDAZIONE DI UN TEST SULLE CONOSCENZE DEL RISCHIO IDRAULICO PER FUTURI INSEGNANTI DI SCUOLA PRIMARIA

ABSTRACT

This article presents the development and psychometric analysis of a test designed to assess knowledge about flood risk among pre-service primary school teachers. The test was developed within the framework of the Return project and administered to 149 final-year students enrolled in a Primary Education degree program. Following the initial construction of 14 items, item difficulty, discrimination, and reliability were evaluated using Classical Test Theory. After removing underperforming items, a final version of the test was obtained, consisting of 10 items with acceptable levels of difficulty, good discriminative power, and a satisfactory KR20 reliability index. The resulting test represents a valid tool for measuring knowledge levels about flood risk. Future directions include test standardization and the adaptation of the instrument for use with children and in different linguistic and cultural contexts.

* The contribution reflects the joint effort of all authors; however, S. Scippo authored the paragraphs 1, 2.1, 4 and 5; D. Fabiani wrote the paragraphs 2.2, 2.3 and 3; M. Ranieri authored the paragraph 6.

Keywords: Environmental education; Learning assessment; Risk education; Teacher education; Test construction.

1. INTRODUCTION

Over the past two decades, several studies have shown that flood risk is increasing in various parts of the world. For example, Ceola *et al.* (2014) and Najibi & Devineni (2018) report a significant rise in Africa, Asia, and tropical regions. The most immediate explanation is undoubtedly climate change, although its impact varies regionally (Blöschl *et al.*, 2015). Climate change has certainly led to a greater atmospheric water-holding capacity and more intense precipitation in many areas (Kundzewicz, 2022). There are also socio-economic drivers, such as urbanisation, deforestation, and population growth in flood-prone areas (Ceola *et al.*, 2014; Kundzewicz, 2022).

In Italy too, various studies indicate a growing trend in hydraulic risk, largely attributable to climate change. For instance, Esposito *et al.* (2018) conducted an in-depth study in the volcanic area of the Campi Flegrei, documenting an increase in flash flood frequency between 1970 and 2014, likely due to changes in rainfall patterns. The role of extreme precipitation is also examined in the work of Ojeda *et al.* (2022), which predicts a general increase in flood risk across Italy. In particular, river peak levels could rise by 30% in the near future and by over 100% in the more distant future, especially in the Po basin and along the eastern coasts. Unsurprisingly, Castellarin *et al.* (2024) observed a rise in record-breaking floods in central and north-eastern Italy over the past 50 years, particularly in drier climates and at higher altitudes.

Nonetheless, socio-economic factors still play a significant role: Sofia *et al.* (2017) found that both climate change and land use changes contributed to the increase in short-duration floods in north-eastern Italy between 1900 and 2010. For these reasons, there is a growing need in Italy for new risk management policies and improved communication strategies capable of addressing the evolving nature of flood-related threats (Galizzi *et al.*, 2020).

It is clear that long-term results can only be achieved by fostering greater awareness of the issue among younger generations. To this end, since the 1990s a specific educational approach focused on preparedness for natural disasters has developed, known as Disaster Risk Reduction Education (DRRE) (UN General Assembly, 2015; Canlas & Karpudewan, 2023). For DRRE to be effective, it must adopt *interactive, experiential, and participatory* teaching approaches (Kagawa & Selby, 2012) and, to this

end, it may benefit from the use of extended-reality technologies (Scippo *et al.*, 2024).

The establishment of this approach necessarily requires teacher training and the development of their professional competence, and thus a process that requires equipping teachers to deliver educational pathways on flood risk reduction. The need to train teachers is highlighted, for example, by a study conducted in Spain by Morote Seguido and Souto González (2020), who found that future primary school teachers have limited knowledge of flood hazards and a poor understanding of vulnerability factors. In Italy, various initiatives have been undertaken and documented to raise students' awareness of natural risks and hazards, including flooding (Morelli *et al.*, 2018; Occhipinti, 2019; Piangiamore & Maramai, 2024). This training on flood risk reduction must be framed within the process of continuous professional development of teachers, essential for addressing the increasing complexity of contemporary society (Ulivieri *et al.*, 2010). In this perspective, teacher professionalism is not limited to disciplinary knowledge, but requires the acquisition of complex competences – going beyond declarative and procedural knowledge – and a constant capacity for reflection on action in uncertain contexts (Birbes, 2018; Spadafora, 2022). However, teacher training on flood risk reduction is rarely addressed directly (Bancocchi *et al.*, 2017). It therefore seems necessary to expand educational programmes on flood risk reduction specifically targeted at teachers.

If teacher training is necessary, it is equally important to develop valid and reliable tools for measuring the knowledge acquired and the related dimensions of teacher professionalism (Spadafora, 2022). Such instruments are not conceived solely for summative assessment, but serve as essential diagnostic and formative support, crucial for teachers as reflective practitioners (Schön, 1983) capable of monitoring and reorienting their educational practices.

In this regard, the study by Putra *et al.* (2021) appears of particular interest. The authors conducted research in Indonesia to measure the knowledge and involvement of geography teachers in flood risk reduction. Questionnaires and in-depth interviews were used to collect data on participants' knowledge of disasters, risk, vulnerability, and capacity. However, the sample consisted of only 12 subjects, and the study does not report any psychometric analysis of the items, nor validity or internal consistency measures.

This article presents the process of developing and analysing a test designed to measure knowledge of flood risk among future teachers, specifically students in the final year of a Primary Education degree programme – the official qualification required to teach at primary school level in Italy.

2. METHOD

2.1. Test development

The test was developed as part of the research activities carried out under the Return project, a three-year initiative funded by the European Union through the NextGenerationEU scheme (National Recovery and Resilience Plan – PNRR, Mission 4 Component 2, Investment 1.3 – D.D. 1243, 2 August 2022, PE0000005). Return (*Multi-risk science for resilient communities under a changing climate*) brings together 26 partners, including universities, research institutions, businesses, and the Italian Civil Protection Department. Its goal is to strengthen research on environmental, natural, and anthropogenic risks at national level, and to promote participation in European and global strategic value chains. Within this framework, the Laboratory of Educational Technologies (LTE) at the University of Florence was tasked with designing and validating educational strategies and tools for flood risk reduction. To this end, a didactic intervention was designed for fifth-year students enrolled in the Primary Education degree course, with the aim of enhancing their knowledge of flood risk and improving their risk perception.

To measure participants' knowledge before and after the educational intervention, a 14-item test was developed in four phases.

In the first phase, the content domain to be assessed was defined. To this end, LTE collaborated with hydraulic engineers from the University of Florence involved in the Return project. The domain was organised into three thematic areas (A, B, and C), each covering specific facts, concepts, and procedures deemed essential:

- A. Causes and dynamics of flooding (frequency of extreme events, flood effects, soil permeability, maintenance of riverbanks).
- B. Land mapping and flood control (EU Directive 2007/60/EC, culverts, flood control strategies, Civil Protection Plan).
- C. Weather alerts and recommended behaviours (yellow, orange, and red alerts, appropriate actions before and during a flood).

At this stage, Bloom's taxonomy, as revised by Anderson and Krathwohl (2001), was employed to define the cognitive objectives to be measured.

In the third phase, with the support of subject-matter experts, one or more questions were developed for each identified objective. These questions were designed to assess the attainment of the first five levels of the taxonomy (from «remember» to «evaluate») across all types of knowledge: factual, conceptual, procedural, and metacognitive, as represented in *Table 1*.

Table 1. – Test matrix.

THE KNOWLEDGE DIMENSIONS	THE COGNITIVE PROCESS DIMENSIONS				
	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate
A. Factual Knowledge	1, 2				
B. Conceptual Knowledge	5, 8	3	6		7
C. Procedural Knowledge	4, 9		10, 11, 13	14	7, 12
D. Metacognitive Knowledge					12

In the fourth phase, the face validity of the drafted questions was evaluated with the help of a PhD holder in Psychology of Social, Developmental and Educational Processes. Although not a domain expert, she is experienced in the construction of educational assessment tools. She suggested revisions to the formulation of several items in order to ensure alignment with established item-writing guidelines from the literature (Corbetta, 2014). Specifically, redundant elements were removed from the question stems, and some distractors were reworded to eliminate ambiguity or vagueness in their original formulations.

For example, the stem of Item 1 was simplified. In its original version, it read: «To assess the flood risk of a given area, the average frequency with which an extreme event (flood or river overflow) reoccurs in that area is calculated. What is the name of this frequency measure?». This formulation was unnecessarily long, so the question was revised as follows: «What is the average frequency measure of an extreme event (such as a flood or river overflow)?».

In other cases, both the question stem and one or more distractors were revised. For instance, the original version of Item 4 was: «Which element is considered crucial for preventing the collapse of riverbanks?». The word *considered* could prompt the respondent to wonder *by whom* the element is considered crucial, potentially diverting attention from the task itself. Therefore, the question was rephrased as: «Which element is crucial for preventing the collapse of riverbanks?».

Moreover, distractor (*d*) contained redundant information. The original version was: «Census and control of river fauna through targeted hunting». As this was an incorrect alternative and significantly longer than the other options, it was shortened to: «Controlling river fauna through targeted hunting».

Tables 2-4 present the finalised questions, each categorised by the corresponding thematic area.

Table 2. – Items related to Area A – Causes and dynamics of flooding.

ITEM NO.	ITEM	ANSWER OPTIONS	CORRECT ANSWER
1	What is the average frequency measure of an extreme event (such as a flood or river overflow)?	a) Hydraulic risk coefficient. b) Return period or recurrence interval. c) Average alert time between extreme events. d) Territorial vulnerability index.	b
2	What beneficial effect can a flood produce?	a) Improvement in air quality. b) Reduction of environmental pollution. c) Soil fertilisation. d) Increase in biodiversity.	c
3	Regarding soil permeability, which of the following statements is true?	a) Heat prevents floods by drying the soil and making it more permeable. b) Roads, buildings, and car parks increase soil impermeability. c) Parks, gardens, and wetlands reduce soil permeability. d) Healthy trees and plants increase water runoff over the soil.	b
4	Which element is crucial for preventing the collapse of riverbanks?	a) Regular maintenance through restoration work. b) Building new embankments to replace existing ones. c) Regular pruning of plants growing along the river. d) Controlling river fauna through targeted hunting.	a

Table 3. – Items related to Area B – Land mapping and flood control.

ITEM NO.	ITEM	ANSWER OPTIONS	CORRECT ANSWER
5	What is a Flood Risk Management Plan (PGRA)?	<ul style="list-style-type: none"> a) A document prepared by Italian municipalities at hydrogeological risk to define risk reduction actions. b) A plan that implements an EU directive to manage hydraulic risk in Italy, identifying river basin districts. c) A regional programme that establishes emergency measures to protect flood-prone areas. d) A national mapping of areas where construction is prohibited due to hydraulic risk. 	b
6	Where am I most at risk during a flood near a culverted stream?	<ul style="list-style-type: none"> a) Near the upper part of a culverted stream. b) Near an open manhole in the middle of the street. c) Along a road that runs over the culvert. d) Near the mouth of a stream that has been culverted upstream. 	a
7	Which of the following is the most effective method to reduce flood risk?	<ul style="list-style-type: none"> a) Building embankments as high as possible to contain the water. b) Creating runoff basins and floodplains. c) Blocking the water with walls and barriers to stop the flow. d) Diverting water into drains and city sewers. 	b
8	What is the main purpose of the local civil protection plan regarding flood risk?	<ul style="list-style-type: none"> a) To provide emergency numbers to call in case of flooding. b) To offer risk maps and information on how it is managed. c) To organise training courses for civil protection volunteers. d) To distribute tools and materials for emergency management. 	b

Table 4. – Items related to Area C – Weather alerts and appropriate behaviours.

ITEM NO.	ITEM	ANSWER OPTIONS	CORRECT ANSWER
9	From which alert level is information about the weather event communicated to the public?	a) Green. b) Yellow. c) Orange. d) Red.	c
10	If you live in a building located in a flood-prone area, what should you do?	a) Stock up on drinking water for a few days. b) Install filters directly on the tap to purify tap water. c) Buy a steel jug to filter tap water. d) Use glass bottles for drinking water instead of plastic ones.	a
11	If you live in a building in a flood-prone area, what should be included in an emergency kit?	a) Documents, first aid kit, torch, battery-powered radio. b) First aid kit, torch, battery-powered radio, face masks. c) Documents, face masks, first aid kit. d) Battery-powered radio, torch, documents, and face masks.	a
12	Imagine you live on the ground floor in a flood-prone area, heavy rain is falling and a red alert has been issued. What should you avoid doing?	a) Protecting doors and windows (e.g., with sandbags). b) Evaluating escape routes and avoiding flood zones. c) Going into the basement to check for water leaks. d) Sharing information and guidance with others.	c
13	Imagine you're on the ground floor of a building. A flood is occurring, and water is entering through doors and windows. What should you do?	a) Seal doors and windows as best as possible. b) Go to help loved ones who may be in need. c) Move your car to higher ground. d) Go upstairs using the stairs.	d
14	Imagine you live on the ground floor in a flood-prone area, heavy rain is falling and a red alert has been issued. Which of the following actions is NOT urgent?	a) Turning off the gas and electricity from the internal panel. b) Moving valuables and hazardous liquids to higher levels. c) Staying as informed as possible using available media. d) Covering furniture with plastic sheets to protect from water.	d

2.2. Participants and data collection

The questionnaire was administered between 10 and 16 May 2025, to a total of 149 students ($M = 4$, mean age = 27, $SD = 4.08$; $F = 145$, mean age = 27.4, $SD = 5.06$), all enrolled in the final year of the Primary Education degree programme at the University of Florence. The administration was conducted via a Google Form during the first session of the two editions of the Educational Technologies laboratory course, serving as the pre-test (baseline measure), prior to any instructional intervention. This was a convenience sample (Johnson & Christensen, 2019), comprising individuals who voluntarily consented to participate in the study. As such, it does not statistically represent the entire population of future primary school teachers. Nonetheless, the sample is sufficiently large to permit statistical analyses for selecting the most valid items in the test.

Before proceeding with the analyses, responses to two attention-check items – placed midway and near the end of the questionnaire – were examined.

- «This is an attention-check question: please select ‘Disagree’».
- «Please indicate your level of agreement with these statements (0 = strongly disagree, 6 = strongly agree). This is an attention-check question: please select 4».

No students failed both attention checks.

Next, responses were recoded dichotomously, assigning a score of 1 to correct answers and 0 to incorrect ones. Total scores were calculated for each participant, and the full sample was then ranked based on performance. Following this, the sample was divided into three groups:

- the upper layer (27% of students with the highest scores);
- the intermediate layer (46% with mid-range scores);
- and the lower layer (27% with the lowest scores) (Brown, 2013).

2.3. Data analysis

The data analysis was conducted in three phases.

In the first phase, item difficulty was assessed using the Item Difficulty Index (p), which is based on the probability of the correct response being selected over its distractors. This value ranges from 0 to 1, and items with a probability between .20 and .90 are considered acceptable. Items with values below .20 are regarded as too difficult, while those above .90 are considered excessively easy. Items with values around .60 are deemed excellent (Thorndike *et al.*, 1991).

In the second phase, item discrimination was measured using two indices. The first is the Item Discrimination Index (D), which compares the proportion of correct responses between the upper and lower scoring groups in relation to group size. Values above .20 are considered acceptable (Ebel & Frisbie, 1991). The second index is the Point-Biserial Correlation (r), which uses the Pearson product-moment correlation between each item and the total test score as an estimator of discrimination (Crocker & Algina, 1986). The commonly accepted cut-off for this index is .30 (Cohen, 1992).

Both indices range from -1 to 1. Negative values indicate that higher-scoring students are more likely to answer the item incorrectly than lower-scoring students. The closer the value is to 1, the better the item's discrimination.

In the third and final phase, test reliability was assessed using the Kuder-Richardson Formula 20 (KR20). This test was selected because it is optimised for multiple-choice items with nominal responses scored dichotomously, in contrast to Cronbach's alpha, which is more suited to ordinal or continuous response formats. Given the mathematical similarity among reliability indices, similar cut-off values are often adopted in the literature; however, some authors argue that, to mitigate potential distortions from administering the test to a single class group, KR20 values of .50 or above should be considered acceptable in educational assessment contexts (Rudner & Schafer, 2002).

All analyses were conducted using STATA 19.5 SE.

3. RESULTS

The results of the item difficulty analysis are reported in *Table 5*, showing the Item Difficulty Index (p) for each of the 14 items in the test.

As shown in *Table 6*, only one item (Item 6) was found to be too difficult ($p < .20$), and only one item (Item 14) was excessively easy ($p > .90$). As a result, it was recommended that these two items be removed from the test, retaining the 12 items that demonstrated moderate difficulty.

For item discrimination, both the Item Discrimination Index (D) and the Point-Biserial Correlation (r) were used. The values for each item are reported in *Table 7*.

Table 5. – Item difficulty.

ITEM	ITEM DIFFICULTY	ITEM	ITEM DIFFICULTY
1	0,22**	8	0,57**
2	0,56**	9	0,34**
3	0,46**	10	0,43**
4	0,83**	11	0,72**
5	0,26**	12	0,62**
6	0,14*	13	0,85**
7	0,85**	14	0,91***

Note: Level of difficulty = *too difficult; **appropriate; ***too easy.

Table 6. – Distribution of items by difficulty level.

ITEM DIFFICULTY INDEX (p)	TOTAL ITEMS
Easy (above 0.90)	1
Moderate (0.20 – 0.90)	12
Difficult (below 0.20)	1

Table 7. – Discrimination indices (D and r) for each item.

ITEM	ITEM DISCRIMINATION INDEX (D)	POINT-BISERIAL CORRELATION (r)
1	0.23*	0.25
2	0.43***	0.38*
3	0.55***	0.47**
4	0.33**	0.39*
5	0.30**	0.30*
6	0.10	0.10
7	0.40***	0.46**
8	0.55***	0.45**
9	0.13	0.12
10	0.53***	0.38*
11	0.53***	0.39*
12	0.43***	0.37*
13	0.38**	0.41*
14	0.10	0.15

Note: Discrimination levels = *acceptable; **good; ***strong.

According to the Item Discrimination Index (D), three items (6, 9, and 14) were not sufficiently discriminative, as they scored below the .20 threshold. According to the Point-Biserial Correlation (r), the same three items, plus Item 1, failed to meet the .30 cut-off.

Based on these findings, the test was reduced from 14 to 10 items, by removing:

- Item 1, due to the very low score, although generally above the thresholds, it fails the biserial correlation test.
- Item 6, due to being too easy and not sufficiently discriminative.
- Item 9, due to poor discrimination.
- Item 14, due to being too difficult and poorly discriminative.

As discrimination indices are highly influenced by the total test score, the values were recalculated after the removal of these four items (*Tab. 8*).

Table 8. – Discrimination indices (D and r) for the 10-item test.

ITEM	ITEM DISCRIMINATION INDEX (D)	POINT-BISERIAL CORRELATION (r)
2	0.40***	0.37*
3	0.68***	0.50**
4	0.40***	0.38*
5	0.40***	0.33*
7	0.40***	0.49**
8	0.68***	0.54***
10	0.55***	0.48**
11	0.38**	0.39*
12	0.40***	0.39*
13	0.35**	0.42**

Note: Discrimination levels = *acceptable; **good; ***strong.

At this stage, the reliability of the final 10-item test was calculated using the KR20, yielding a score of .504. According to Rudner and Schafer (2002), this value is acceptable for knowledge assessment tools used in educational contexts.

The overall average score on the test was 6.107 (SD = 1.921) out of 10, with a range from 1 to 10 points.

4. DISCUSSION

This article has presented the development and analysis of a test aimed at assessing knowledge of flood risk among future primary school teachers – an essential step in preparing younger generations to face the increasing challenges posed by flooding in Italy. Item analysis was conducted to evaluate the effectiveness and overall quality of the test, following well-established approaches in psychometric literature.

Regarding item difficulty, the initial analysis of the 14-item version revealed that most items (12 out of 14) fell within the acceptable difficulty range of 0.20 to 0.90 (Thorndike *et al.*, 1991). This is a positive outcome, indicating that the test was suitably challenging without being overly difficult or too easy for the 149 prospective teachers who participated. However, one item (Item 6) was found to be excessively difficult ($p = 0.14$), while another (Item 14) was too easy ($p = 0.91$). Overly difficult items may suggest ambiguity in wording or inappropriate content, whereas overly easy items may serve as warm-up questions but fail to discriminate effectively between different levels of knowledge. Consequently, these two items were removed to improve the test's validity.

Item discrimination analysis was used to ensure the test could differentiate between students with high and low levels of knowledge. Using the Item Discrimination Index (D) and the Point-Biserial Correlation (r), four items (1, 6, 9, and 14) were identified as having low discriminative power, as they did not meet the accepted thresholds (Ebel & Frisbie, 1991; Cohen, 1992). Notably, these included the two items that also fell outside acceptable difficulty parameters. Based on these findings, the test was reduced from 14 to 10 items, and discrimination measures were recalculated for the revised version. The remaining 10 items demonstrated satisfactory discriminative properties.

After removing the four items that failed to meet the acceptable thresholds for both difficulty and discrimination, the reliability of the final 10-item version was calculated using the KR20 formula, yielding a score of 0.504. Although not particularly high, it is necessary to remember that this value is strongly influenced by the composition of the sample. According to Rudner and Schafer (2002), it must be taken into account that the sample is represented by a single class group, even if large, this presents a lower variance in the results due to the extremely similar background of the students, which drastically reduces the coefficient. In these cases, the authors suggest that even KR20 values starting from .50 should be considered acceptable for evaluating reliability in educational settings.

In conclusion, the psychometric analysis allowed for a refinement of the initial test, resulting in a 10-item version that demonstrates sound properties in terms of difficulty, discrimination, and reliability – positioning it as a promising tool for assessing knowledge of flood risk.

5. LIMITATIONS

Although the test developed in this study demonstrates good psychometric properties, several limitations should be acknowledged. First, the sample used for validation was selected through convenience sampling (Johnson & Christensen, 2019) and is not statistically representative of the broader population of pre-service primary school teachers. This has important implications for the standardisation of the instrument: the current results do not allow for the establishment of general reference norms or valid national benchmarks. Future studies should therefore administer the test to probabilistic samples, stratified by geographical area, gender, and other relevant variables, in order to initiate a more robust standardisation process. Additionally, the sample was heavily gender-skewed, with a clear predominance of female participants (145 out of 149). While this reflects the typical composition of Primary Education degree courses in Italy, such imbalance may have indirect effects on score distributions and external validity. Finally, the test was administered in a single context and at a single point in time. Although the content areas of the test were defined through a solid theoretical background, the sample size did not allow for analysis to verify the actual factorial structure of the test. Further analyses of test stability (e.g., test-retest reliability) and additional validation in different educational settings would be beneficial in strengthening the instrument's reliability and long-term applicability.

6. CONCLUSIONS AND RESEARCH PERSPECTIVES

This article has provided a detailed account of the development and analysis of a test aimed at measuring knowledge of flood risk among future primary school teachers. The significance of such a tool lies in the growing need to prepare new generations to face the challenges posed by the increasing frequency of flood events in Italy and worldwide (Ceola *et al.*, 2014; Najibi & Devineni, 2018; Castellarin *et al.*, 2024). Item analysis,

conducted in accordance with well-established psychometric frameworks (Crocker & Algina, 1986; Ebel & Frisbie, 1991; Thorndike *et al.*, 1991; Cohen, 1992; Brown, 2013), made it possible to identify and refine the test items. The final version, consisting of 10 questions with satisfactory indices of difficulty and discrimination, represents a robust instrument capable of accurately distinguishing between varying levels of knowledge. As such, the test can be used in educational contexts to verify whether teachers have achieved learning objectives related to the acquisition of flood risk knowledge – a topic on which they may have limited prior understanding (Morote Seguido & Souto González, 2020). Its usefulness, however, extends beyond the mere measurement of specific knowledge of hydraulic risk, if this test is understood as a tool for assessing the cognitive prerequisites of complex teacher professionalism (Spadafora, 2022) in relation to an issue such as disaster risk reduction. This professionalism is defined by the capacity to act in indeterminate contexts, requiring reflective (Schön, 1983) and strategic competences, which are essential for mobilising resources in critical situations (Birbes, 2018). In particular, the test supports the assessment of the organisational dimension of teacher competence, which is crucial for managing safety and risk prevention. Better-prepared teachers would, in turn, be able to educate future citizens, equipping them to face emerging challenges associated with rising flood risk in different parts of the world, including Italy. The test, therefore, is not only a summative assessment tool, but constitutes a fundamental diagnostic instrument supporting continuous professional development (Ulivieri, 2010; Muñoz, 2020; Richit, 2021), because it can be used to identify gaps in teachers' knowledge not only regarding hydraulic risk, but also concerning the governance procedures required for an effective territorial response. Moreover, the use of this test may trigger in teachers that process of reflexivity on practice (*reflection on action*) which is necessary for their professional growth. In other words, the test can support teachers, understood as reflective practitioners (Schön, 1983), in monitoring and reorganising their knowledge and in strengthening the schemes of intentional mobilisation of resources that are essential for lifelong learning (Ulivieri, 2010; Muñoz, 2020).

The study presented here opens several avenues for future research. First, the test could be standardised. Although it was validated on a relatively large sample of 149 students, the sample was non-probabilistic. Administering the test to a probabilistic sample – statistically representative of future teachers or those already in service – would allow for the development of stronger norms, enhance the generalisability of findings, and support the definition of national benchmarks for flood risk knowledge. This, in turn, could inform teacher education policy and practice.

Secondly, the test could be incorporated into a broader assessment of teachers' organisational-relational and governance competences (Spadafora, 2022), complementing the evaluation of all the action variables that characterise the professional role in complex educational settings (Birbes, 2018).

Thirdly, given the global rise in flood events and the pressing need to raise risk awareness, the test could be translated and culturally adapted into other languages, and validated in geographical contexts similar to the Italian one. This would support the creation of multiple versions of the tool, facilitating comparative studies and fostering international collaboration in flood risk education research.

Finally, considering that the test was developed for future primary school teachers, a further research direction involves adapting the language and complexity of the items to assess flood risk knowledge directly in primary school children. This would enable the monitoring of educational intervention effectiveness from an early age and provide valuable data to improve school-based learning pathways, ultimately contributing to greater awareness of flood-related risks among younger generations.

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RIASSUNTO

In questo articolo si presenta la costruzione e l'analisi psicometrica di un test per misurare le conoscenze sul rischio idraulico da parte di futuri insegnanti di scuola primaria. Il test è stato sviluppato nell'ambito del progetto Return e somministrato a 149 studenti dell'ultimo anno del corso di laurea in Scienze della Formazione Primaria. Dopo la costruzione iniziale di 14 item, sono state effettuate analisi di difficoltà, discriminatività e affidabilità secondo la teoria classica dei test. In seguito all'eliminazione degli item non soddisfacenti, è stato ottenuto un test finale composto da 10 item, con buoni valori di difficoltà, capacità discriminativa e un indice di affidabilità KR20 accettabile. Il test rappresenta uno strumento valido per misurare i livelli di conoscenza sul rischio idraulico. Si suggeriscono prospettive di standardizzazione e adattamento del test a bambini e ad altri contesti linguistico-culturali.

Parole chiave: Costruzione di test; Educazione al rischio; Educazione ambientale; Formazione degli insegnanti; Valutazione dell'apprendimento.

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