

# The imaginary eruption - Volcanic activity through kids' eyes

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## Abstract

Strategies of risk mitigation become effective when citizens facing hazardous phenomena adopt rational behaviours that contribute to lower the risk. This is more likely to occur when endangered communities share a widespread understanding of natural phenomena and their impacts. To reach this goal, educational and outreach materials are often organized around the descriptions of the natural process and its effects. Unfortunately, however, receiving correct information does not automatically grant the adoption of safe behaviours. Our teaching efforts may fail because of pre-existing biases, beliefs and misconceptions. The identification of these biases is important to plan effective educational campaigns, capable of providing the concepts that are needed to actually inform citizens' choices about natural hazards.

In this work, we present the results of an unconventional workshop on volcanic risk that we proposed to primary and secondary schools (ages 6-13), in Italy. The workshop is meant to explore the mental models that kids and youngsters have about volcanic eruptions and it takes the form of a creative exercise. We asked the students to draw and write a story in four frames, describing the onset and outcome of an imaginary eruption. All stories were then presented to the class, and always provided useful hints to spark discussion about volcanic processes and hazards. As a whole, the collected stories provide a multifaceted description of volcanic eruptions and their potential impacts, as imagined by the kids. A careful analysis of this material provided several insights useful to improve future outreach material and educational plans. The workshop is simple to reproduce, even remotely, and could be easily extended to different types of hazards.

While very simple to organize, this approach grants the secure engagement of most participants and offers a very different perspective on pupils' understanding of natural phenomena.

## 1 Introduction

The mitigation of natural risk commonly involves educational campaigns aimed at disseminating correct scientific information among the exposed communities (Cardona, 1997; Borges de Amorim and Chaffe, 2021; Mohadjer et al., 2021). A clear understanding of how natural phenomena may unfold and eventually impact our lives is expected to favour the adoption of mitigation measures and cautious behaviour (Camassi et al., 2016; Meyer, 2009). However, the simple availability of correct information may be insufficient (Cook and Melo Zurita, 2019; Mohadjer et al., 2021). Mental models, personal experience and emotional belief play an important role in shaping people's response to hazards (Meyer, 2009). Research conducted to explore the commitment to mitigation measures against hurricanes showed how bad habits (like leaving the windows open during a tornado) can be perpetuated by a poor understanding of the physical phenomenon - in this case, the wrong assumption that building destruction is caused by the pressure difference inside and outside the house (Meyer, 2009). Mental models and beliefs constitute the magnifying glass through which laypeople will access and interpret any information regarding natural hazards (Chester, 2005; Gibson et al., 2016). Personal experience and emotions also contribute to form risk perception. Risk communication efforts should therefore take into account pre-existing knowledge and the current understanding of natural

40 hazards, in order to target the specific needs of the communities involved (Gregg et al., 2004; Lacchia et al., 2020). The  
41 comparison between expert's and laypeople's mental models highlights missing information, possible gaps and  
42 misconceptions on both sides and, most importantly, it grants a correct identification of people's needs and expectations.  
43 This work focuses on volcanic eruptions and their perception and targets kids and youngsters living in the Neapolitan urban  
44 area. The town is surrounded by three active volcanoes: Vesuvius, Ischia, and Campi Flegrei. The most recent eruptive activity  
45 in the area took place at Vesuvius, in 1944, when a lava plug obstructed the volcanic conduit (Sbrana et al., 2020 and refs.  
46 therein). Since then, the volcano has been in a quiescent state. Ischia is also quiescent, after its most recent eruption in 1302  
47 (Iovine et al., 2017). Campi Flegrei last erupted in 1538 (Di Vito et al., 1987), but this wide caldera has been giving signs of  
48 unrest since the 1950's, with periods of remarkable seismicity and ground uplift in 1969-72 and 1982-84 (Del Gaudio et al.,  
49 2010). Then, after 20 years of continuous subsidence, a new and slower uplift phase began in 2005 and continues to the time  
50 of writing. Ground deformation is accompanied by minor and shallow seismicity and by changes in the composition of  
51 fumarolic gases. Observed changes led the civil protection authorities to shift the emergency level from green (background)  
52 to yellow (scientific attention on the phenomenon) in 2012 (Tamburello et al., 2019).

53 A dormancy lasting for centuries followed by decades of unrest without eruption is a common evolution for a caldera (Acocella  
54 et al., 2015). Unlike the case of stratovolcanoes, such as Vesuvius, even remarkable unrest phenomena may not constitute  
55 short-term precursors of an impending eruption. However, with more than 3 millions people living in the municipality of  
56 Napoli and a volcanic risk among the highest on the planet, this kind of volcanic pattern easily becomes a real communication  
57 nightmare. Living memories from last Vesuvius' eruption further confuse the picture, bringing in vivid images from a very  
58 different volcanic setting.

59 Given the relevance of the problem, volcanic risk perception in the Neapolitan area was first tested in 2006 focusing on  
60 Vesuvius (Barberi et al., 2008). Results obtained for the Campi Flegrei caldera (Ricci et al., 2013) showed that volcanic hazards  
61 were not listed among the principal concerns of a community mostly worried about crime, pollution and corruption.  
62 Nevertheless, the people participating in the survey did consider the likelihood of explosive eruption as moderately high. At  
63 the same time, many failed to identify the hazards posed by the caldera, which was overshadowed by the concerns about  
64 Vesuvius. Researchers also highlighted the so-called 'optimistic bias', according to which responding citizens tended to  
65 consider themselves less prone to severe impact than their own town (Paton et al., 2008). In 2006, another study was carried  
66 out to test volcanic risk perception among 400 high-school students (Carlino et al., 2008). Results confirmed a good knowledge  
67 of the volcanic risk among the students, although accompanied by a poorer understanding of volcanic processes and, at the  
68 time, also a lack of information about emergency planning. More recently, a wider study was carried out to address different  
69 kinds of hazards (hydrogeological, seismic and volcanic, Avvisati et al., 2019). Results revealed the importance of direct  
70 experience of eruption in assessing the likelihood of a future eruption and showed that a good knowledge of the hazard does  
71 not necessarily correspond to a good knowledge of best mitigation practices.

72 Within this context, we decided to focus on existing mental models of volcanic eruptions, by forming a collaboration with the  
73 local schools (primary and junior high). The exploration of mental models usually takes the form of interviews (Skarlatidou et  
74 al., 2012) or face to face surveys accompanied by follow up questions (Lacchia et al., 2020). However, considering our  
75 particular target, we opted for a different approach. To engage participants, we proposed a creative writing and drawing  
76 exercise, asking them to describe a short story featuring an eruption and its consequences. We collected approximately 200  
77 stories that depict a range of rather plausible scenarios for this volcanic area. We analyzed all stories in detail, identifying the  
78 spatial and temporal frames in which kids place their eruption, as well as the accompanying words and feelings.

79 While certainly not comparable to the results from more structured approaches, our exercise provided valuable insights on  
80 widespread expectations and useful hints for future outreach materials. The workshop proposed enabled us to discuss about  
81 volcanoes and related hazards with the children, who are effective carrier of information for their families (Ronan and Johnston,  
82 2005; Johnston et al., 2006).

## 83 2 The project

84 “The imaginary eruption” is an activity promoted within the EDURISK framework ([www.edurisk.it](http://www.edurisk.it)), a long-term educational  
 85 project with the aim of promoting educational itineraries for risk reduction for schools of all grades, with particular attention  
 86 to ages 6 to 13 (Pessina and Camassi, 2012). Across this age range, pupils may learn about volcanoes and their activity,  
 87 however the information proposed may vary among different schools. The curriculum of the elementary schools (6-10) does  
 88 not specifically include Earth Science, but geography lessons may focus on local landforms and their development. Earth  
 89 Science becomes a curriculum only in the last year of junior high schools (11-13), when students gain a basic geological  
 90 knowledge about rock formation, plate tectonics, earthquakes and volcanic activity. Each school has the possibility to develop  
 91 specific programs to deepen the study of selected topics. Thank to this flexibility, teachers working in volcanic areas may  
 92 focus on volcanic activity and propose risk education programmes, that vary in different school districts. Only very recently,  
 93 information on natural hazards and on the functioning of the Italian Civil Protection has entered the civics curriculum.

94 The activity involved ten school districts (8 in the Neapolitan area and 2 from non-volcanic regions) and was carried out during  
 95 two school years, in 2018 and 2019. A total of 25 classes participated in the activity, 13 from primary schools (6-10 years old)  
 96 and 12 from secondary schools (11-13 years old), for approximately 500 kids. In 2020, we proposed the same workshop to the  
 97 schools on the island of Stromboli. Due to the restrictions related to the COVID-19 pandemic, we held this activity remotely,  
 98 via videoconference. On Stromboli, we gathered 11 stories on the island, 9 of which completed with drawings, and 2 featuring  
 99 only written text. Among the complete stories, 6 were from primary school and 3 were from secondary school. The analysis  
 100 presented below focuses on the earlier workshops run in presence, while results obtained in Stromboli are discussed aside. A  
 101 list of the schools involved is provided in Table 1.

102 The Imaginary Eruption workshop was carried out within the framework of the Edurisk Project, proposed to all Italian schools.  
 103 The schools’ enrollment into the project is discussed by each school board and once the project is approved, it is usually  
 104 introduced into the school curriculum (*Piano Triennale di Offerta Formativa*) that is shared with the families every year. At  
 105 the beginning of each school year, all schools require a written consent from the families about the student’s engagement in  
 106 the activities and projects proposed in the curriculum. The participation of each school into the project follows an official  
 107 procedure that also ensures ethical clearance, considering that: we did not collect any personal information about the  
 108 participating students; students always worked in pairs or small groups; students were asked not to print their full names on  
 109 their compositions; and producing an outcome was not compulsory and students were free to decide the degree of their  
 110 involvement in the exercise.

111

112 **Table 1: List of attending schools.**

School district and name	Classes	School level
IC 3 De Curtis Ungaretti, Ercolano (NA)	3A, 3B	Primary
IC 2 F. Giampaglia, Ercolano (NA)	4	Primary
IC 6 Quasimodo Dicearchia, Pozzuoli (NA)	4D	Primary
DD Scafati 1, Scafati (NA)	2A, 2B, 2C, 3B, 4A, 5D	Primary
IC Bonati, Bondeno (FE)	3A	Primary
IC San Rocco di Marano, Napoli (NA)	3A, 3B 1A	Primary Secondary
IC 5 Testoni Fioravanti e Federzoni, (BO)	3A, 3B 3E	Primary Secondary
IC 3 Rodari-Annechino, Pozzuoli (NA)	1C, 1F	Secondary
IC 3 CD S. Gaetano-Gadda, Quarto (NA)	1A, 1D, 1F, 2C, 2E, 2G	Secondary
IC S De Nicola Sasso, Torre del Greco (NA)	1B, 1D	Secondary
IC 2 De Amicis-Diaz, Monteruscello (NA)	1C, 1E	Secondary

IC Isole Eolie – Stromboli	Multi-age class Multi-age class	Primary Secondary
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114 The activity featured an initial phase of direct interaction with the attending students. During this workshop, we guided the  
 115 stories' completion, as better specified below. We introduced "The imaginary eruption" as a creative exercise rather than a  
 116 science essay. This was important to collect stories that probed the kids' mental model rather than reflecting lesson' contents.  
 117 We stressed the absence of a formal evaluation of the "correctness" of the description and suggested the possibility of fantastic  
 118 settings or characters. At the end of the workshop, participants shared and discussed their stories. Each tale provided many  
 119 opportunities to discuss eruptions, volcanic phenomena, various hazards, and their mitigation.

120 After the workshop with the students, we held three meetings with the teachers. During these encounters, we adopted  
 121 participatory techniques and explored the thoughts and feelings that emerged from the collected stories. In a few cases, the  
 122 teacher also participated in the same laboratory as the kids, producing their own stories about the eruption. The meeting with  
 123 the teachers explored different aspects of volcanic risk and resilience: during the first meeting, we addressed the environment  
 124 and its relations to volcanic hazards and risks. The teachers explored the visible and invisible features characterizing the  
 125 landscapes where they live and work. The analysis provides clues about volcanic risks and what factors amplify or mitigate  
 126 them. The second meeting focused on responsibility, community, resources, and problems: the group assessed how to prepare  
 127 and what to do to mitigate the risk. Finally, the last meeting revolved around resilience, identifying the times and means to  
 128 share information and understanding.

129 During the analysis we used all of the considerations raised during these discussions to plan future outreach activities related  
 130 to volcanic hazards.

131 **3 The workshop**

132 Students worked in pairs or small groups, and their assignment was to invent a story in four frames, each featuring both  
 133 drawings and a written description. The materials required for the story's realization included: 4 sheets of paper (A4); pens,  
 134 pencils, and colours; eraser and sharpener; scissors. We asked participants to cut the sheets into a square (21x21 cm) destined  
 135 for the drawing and use the remaining rectangular stripe for the written text. Once the material is ready, we provide instructions  
 136 to start, and we specify the time (approximately 15 minutes) allowed for the completion of each frame. We instructed  
 137 participants to complete one frame at a time, following simple instructions often offered in terms of guiding questions. An  
 138 important detail is that students were unaware of participating in a volcanic risk project and that the stories should have a  
 139 volcanic eruption as their main theme. Instructions were as simple as possible to allow ample creative freedom but were needed  
 140 to focus on volcanic eruptions and make the drawings comparable.

141 The first frame sets the story's scene. Students had to describe the main characters involved, the general setting, and the  
 142 environment in which they move. We only gave the constraint that a volcano should be present. Guiding questions for this  
 143 frame could include: *Our character(s) live(s) near a volcano: what kind of place is it? Who is the protagonist? What is she/he*  
 144 *doing? How does she/he feel?* Only when the first frame was finished (or when the allotted time passed), did we provide  
 145 information on the successive step.

146 In the second frame, something unusual happens with the volcano. Participants had to describe what was going on and the  
 147 characters' reactions. The guiding questions inquired if someone noticed the changes or took action: *the volcano is doing*  
 148 *something unusual; perhaps it's waking up What does the volcano do? Does the character see that? Does he/she talk about*  
 149 *that with someone? Do they do something about it? How do they feel about it?*

150 The third frame focuses on the eruption. We asked participants to describe the volcanic event and tell about its impact on the  
 151 surroundings and how it affected the characters. Guiding questions included: *The eruption begins, what does the protagonist*  
 152 *do? What do other people do? What is happening around them? How do they feel?*

153 The fourth frame is the story's epilogue: the eruption is over. Participants described the new setting, where the protagonists  
154 are now, how much time had passed since the eruption. Possible guiding questions were: *The eruption is over: where are the*  
155 *characters now? What do they do? How do they feel?*  
156 An example of a full story is provided in Supplement 1 ("Whole stories").

## 157 **4 Results**

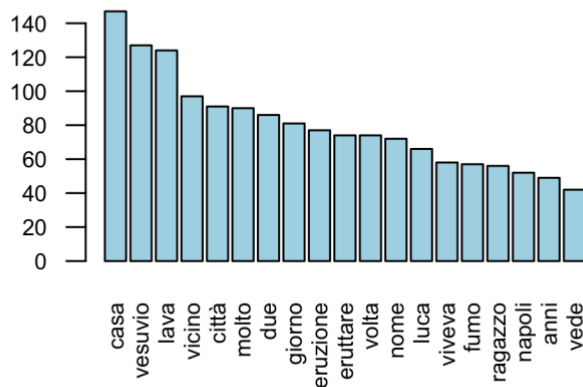
158 We collected 188 stories completed with text and drawings (148 in colour) and two stories without written text. The stories  
159 often describe realistic settings, but many contain imaginary situations or magic characters and events. Stories take place in  
160 all sorts of locations, from the close neighbourhood to far, exotic places, as distant as other planets. Among the protagonists  
161 we find kids, youngsters, adults, superheroes, animals. While stories tend to have a happy ending (in 163 cases), most of them  
162 acknowledge severe destruction caused by the volcano. Some stories (25) have a dramatic conclusion, and a few culminate  
163 with the protagonist's death. In the following, we first analyse the words used by the pupils to describe their stories. Then, we  
164 compare the stories that are narrated in the four frames.

### 165 **4.1 The stories' language**

166 We scanned all the stories and digitized the written descriptions (available for 188 stories) to perform a simple text analysis.  
167 All stories were analysed together as a unique dataset of words. Text mining was performed with the R software (R Core  
168 Team, 2020), using a specific package (tm), and involved a preliminary manipulation to remove the punctuation, extra white  
169 spaces, and the common words (or stopwords), like articles or prepositions, which are not expected to bear specific information  
170 for the analysis. A collection of stopwords is available for the Italian language in the R function we used (tm\_map), but we  
171 added a few more that emerged from a first text review (as reported in the caption of Figure 1). The resulting assemblage  
172 contained 3428 terms that were used with different frequencies. More than 1950 words were used only once. As expected, the  
173 most common term is vulcano [volcano], which is mentioned 581 times. Focusing on the other terms, the three most frequent  
174 words are casa [home], with 147 occurrences, Vesuvio, mentioned 127 times, and lava, which appears 124 times. Figure 1  
175 shows a histogram of the 20 most used words (translation in the caption). A more general idea is provided by the word cloud.  
176

177 **Figure 1: Frequencies of the most used terms in the written descriptions of the imaginary eruption and associated word cloud.** The  
178 meaning of the terms are as follows: casa [home], Vesuvio [Mt. Vesuvius], lava [lava], vicino [nearby], città [city], molto [much], due [two],  
179 giorno [day], eruzione [eruption], eruttare [to erupt], volta [time, turns], Luca, viveva [lived], fumo [smoke], ragazzo [boy], Napoli, anni  
180 [years], vede [she/he sees], subito [now], inizia [begins], fare [to do], vide [she/he saw]. Stopwords added to the original list and not included

## Most frequent words



181 in the count are: perché [why], così [therefore], poi [after], allora [then], cosa [what, thing], quindi [therefore], però [however], po' [a bit],  
 182 dopo [after], mentre [meanwhile], lì [there], quando [when].

183  
 184 The digitized text allows us to verify how many times specific words are used. We can see how many times death or survival  
 185 are explicitly mentioned in the descriptions searching for the recurrences of the words related to death (including the  
 186 declination of the verb to die) and those related to survival or salvation. Frequencies of each term are listed in Table 2. The  
 187 simple frequency of these terms does not reflect the actual meaning of the story, as it does not account for possible negation  
 188 (“I did not die” or “they did not survive”). Table 2 shows that terms referring to salvation are slightly more mentioned than  
 189 those referring to death.

190 The same exercise can show how many times the words girl(s) (ragazza) and boy(s) (ragazzo) are mentioned. The search  
 191 included words for baby girls (bambina) and baby boys (bambino). The masculine term ragazzo (56) is almost twice more  
 192 frequent than the feminine ragazza (33). Baby boys and girls are less mentioned, but the difference between them is much  
 193 smaller (bambino (16), bambina (14)). The feminine plural terms are not common (ragazze (7), bambine (0)), while the plural  
 194 masculine, which in Italian may refer to both genders, is more frequent (ragazzi (34), bambini (15)). These kids and youngsters  
 195 are often protagonists of the stories and are commonly surrounded by their friends and family or by other people. Sometime,  
 196 the pupils themselves are the protagonists in their own stories. Figure 2 illustrates the frequencies of the terms related to the  
 197 people who are protagonists of the stories (specific Italian terms are listed in the figure caption).

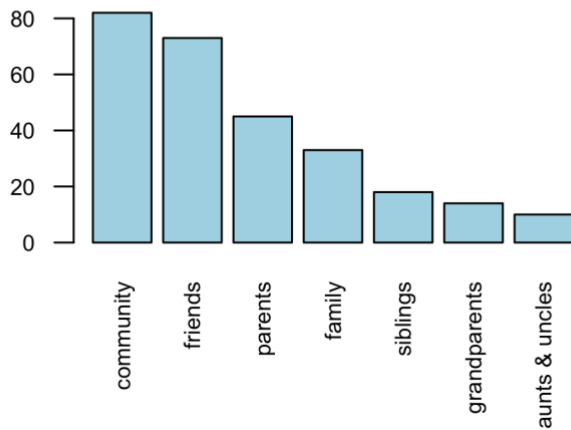
199 **Table 2: Recurrences of terms related to death and to the verb to die (*morte, morire*) and survival (including references to the words**  
 200 **safe, alive, and the verbs to save, to survive) in the written descriptions of all collected stories.**

Word	Frequency	Word	Frequency
morte	7	salvo	11
morì	7	salvi	8
morti	7	salvò	8
morto	5	salvati	7
muore	4	salvato	6
muoiono	4	salvarono	5

morirono	4	salva	4
morta	3	salvano	4
		vivi	2
		sopravvissuti	1
		salvata	1
<b>Total</b>	<b>41</b>		<b>57</b>

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The written descriptions shed light on the words used to describe the volcanic phenomena and products. The imaginary volcanoes mostly emit lava (124) and smoke (57) (Figure G), but products of magma fragmentation are also described as ash (19), stones (18), and lapilli (11). Magma, volcanic gases and dust are also mentioned a few times.



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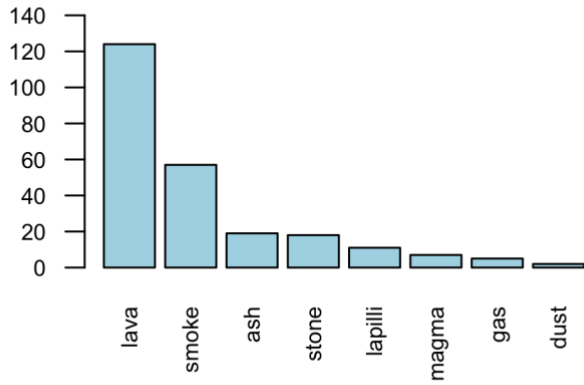
**Figure 2: Frequency of words related to friends, families and communities.** The categories shown in the figure include the following Italian terms: ‘community’: cittadini [citizens], abitanti [residents], persone, gente [people]; ‘friends’: amico [friend] and compagno [companion]; ‘parents’: mamma [mum], madre [mother], papà [dad], padre [father]; ‘family’: famiglia [family]; ‘siblings’: fratello [brother], sorella [sister]; ‘grandparents’: nonna [grandma], nonno [grandpa] (note: the Italian language does not have a formal expression for grandmother or grandfather); ‘aunts & uncles’: zia [aunt], zio [uncle]. Both singular and plural, and masculine and feminine are always counted.

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Other words that may be of interest in this analysis are those referring to professional figures that may be related to the assessment and the management of volcanic crises. Terms associated with these professional roles include scientists (16, one of which female), volcanologists (17, one of which female), geologists (8, four of which female), firefighters (12), civil protection, police, rescuers, and the mayor (2). The corresponding Italian terms are: ‘volcanologist’: *vulcanologo*; ‘scientist’: *scienziato*; ‘geologist’: *geologo*; ‘firefighters’: *pompieri*, *vigili del fuoco*; ‘civil protection’: *protezione civile*; ‘police’: *polizia*; ‘rescuers’: *soccorsi*; ‘mayor’: *sindaco*. Both singular and plural, and masculine and feminine are always counted.

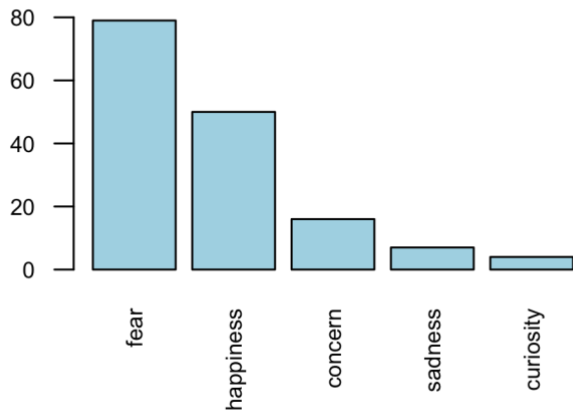
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Words can also tell us something about how the characters feel about the events. Figure 4 shows the most common words related to sentiments: fear (79) includes terms such as *paura* [fear] (31), *panico* [panic] (10), *impaurito/a* [scared] and various forms of the verb *spaventare* [to be scared]; *happiness* (22) includes words like *felice* [happy] (26), *contento* [glad] (20), or *felicità* [happiness] (1).



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225 **Figure 3: Frequencies of words used in the description of volcanic products.** The corresponding Italian terms are: ‘lava’: lava; ‘smoke’:  
 226 fumo; ‘ash’: cenere; ‘stone’: pietra; ‘lapilli’: lapilli; ‘magma’: magma; ‘gas’, gas; ‘dust’: polvere. Both singular and plural are always  
 227 counted.



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229 **Figure 4: Frequencies of terms related to sentiments like fear, happiness, concern, sadness and curiosity.** The corresponding Italian  
 230 terms are as follows: ‘fear’: paura [fear], panico [panic], impaurito [frightened], spaventato [scared], spaventare [to scare]; ‘happiness’: felice  
 231 [happy], contento [glad], gioia [joy]; ‘concern’: preoccupato [worried], preoccupazione [concern]; ‘sadness’: tristezza; ‘curiosity’: curioso  
 232 [curious], incuriosito [intrigued]. Both singular and plural, and masculine and feminine are always counted. In the case of verbs, different  
 233 tenses and persons are considered.

234

## 235 4.2 The frame contents

236 In the following, the collected stories are compared, frame by frame, with respect to their content. The following analysis takes  
 237 into account both the written text and the drawings, and focuses on the plot of the collected stories, with particular attention  
 238 on the description of natural phenomena and human response.

### 239 4.2.1 Frame– 1 - The protagonists and the environment

240 In 148 stories (78% of the total), the main characters are real people, often representing the authors themselves or other kids  
 241 slightly older than them. In 43% of the stories the protagonists are referred to as boys (55 times) or girls (27 times), but in  
 242 many stories one or more adults are present. Adults are mostly men (77% of adults) and are often identified through their



243 employment (e.g., farmer, scientist, explorer, rock star, hunter, lumberjack, astronaut, soccer player...). Scientists are  
244 mentioned as leading characters in 12 stories, 4 times as volcanologists, and 2 times as geologists. In 2 stories, the protagonists  
245 are related to civil protection. In a smaller number of cases, the adults are identified through their family relations with other  
246 characters (grandpa, husband, wife, mother, father). Often the protagonists are accompanied by friends or pets and in a few  
247 stories the animals are the leading characters. Fantasy characters appear in 54 stories and include princes and princesses,  
248 magicians and fairies, cartoon characters and superheroes, aliens, gods, and pirates. In a few cases, the volcano itself becomes  
249 a character, with anthropomorphic features.

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251 The volcano is always represented as a conic mountain, generally rather small. Sometimes it is depicted with two peaks,  
252 mimicking the profile of Mt. Vesuvius surrounded by Mt. Somma, the remnant of an ancient caldera structure (interestingly,  
253 Mt Somma is often represented as a second volcano, with its own crater). Only one story features a submarine volcano. The  
254 volcano can be a real one, with Vesuvius being the most common choice (named in 32 stories), followed by Etna (13) and  
255 Solfatara (2). Stromboli, Vulcano, Ischia and Monte Nuovo are also mentioned once. In a few cases, the volcano has a fantasy  
256 name, while often it is nameless. Explicit reference to the city of Naples is also present in 17 stories. Other localities mentioned  
257 include Sicily (8), Pompei (4), Ercolano (3), Torre del Greco (2). Exotic settings are also frequent, with reference to Hawaii  
258 (4 stories), Arequipa (Perù), Australia, Hollywood, Los Angeles, Paris, Alaska, Russia, Texas, Norway, the Caribbean. The  
259 volcano can be on an island (18 stories) or surrounded by woods (8), in the countryside (9). Exotic environments include the  
260 savanna, the Indian jungle, or the desert. Four stories are set on other planets.

261 Inhabited areas are rare and often represented by a single house (17 stories) usually built near the volcano. In a few cases, there  
262 is specific mention of a small town or a village nearby (13 times) and only 7 stories mention a city.

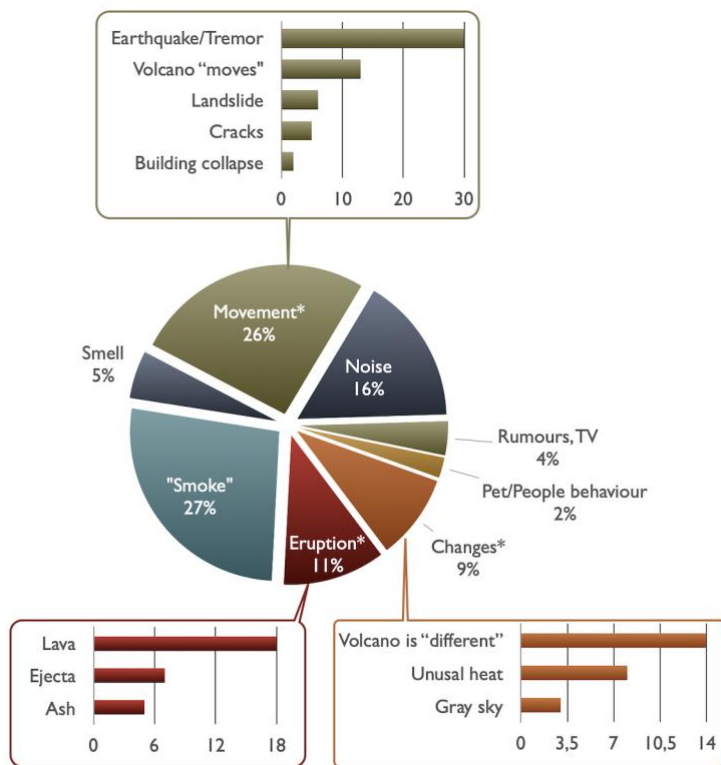
263 A few examples of the first frame are collected in the Supplement 2 (“Frame 1 - The story’s settings”).

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#### 265 **4.2.2 Frame 2 - Something happens**

266 The most frequent sign of volcanic unrest is ground shaking (in 48 stories), sometimes described in terms of seismicity (the  
267 word earthquake is used 12 times, with a couple of references to its magnitude). Other stories use generic terms like tremor  
268 (20 times), or ground movements (15 times). Opening of cracks, landslides or building collapse are also mentioned (Figure 5).  
269 Another common signal of volcanic unrest is the presence of smoke on top of the crater, which is mentioned 44 times in this  
270 frame. Based on both the written description and the drawings, the word smoke is used to intend volcanic gases (which are  
271 explicitly mentioned only 2 times). Another reference to degassing activity is the smell (sometimes specifically sulphur smell),  
272 that is mentioned in 8 stories. Volcanoes also make noises, which are mentioned in 33 stories. Other signs of unusual behavior  
273 refer to actual eruptive processes, like the emission of lava (20), or various ejecta (stones and rocks, lapilli, and volcanic ash,  
274 mentioned in 14 stories).

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276  
277 **Figure 5: Signals of unrest mentioned in the collected stories (frame 2).**

278  
279 Eruptions or explosions are mentioned 47 times at this stage of the story. In a few cases, the signals that something is going  
280 on are changes in the volcano's colour or appearance, or the characters perceive an anomalous heat. Flames and burned  
281 vegetation are mentioned in a few cases, while animals detect the unrest in a couple of stories. In most cases, evidence of  
282 volcanic unrest is obvious enough for the protagonists to notice themselves. The only (indirect) reference to sensors installed  
283 to monitor the volcano is a seismogram drawn in one of the stories, while other 3 mention the magnitude of the earthquake,  
284 which presupposes the presence of seismometers in the area. In all other stories (the great majority) the signals from the  
285 volcano are easily detected by residents, with no need for monitoring instruments. Sometimes the characters learn (or have  
286 confirmation) that something is going on by watching the television (8 stories).

287 Most characters are frightened by the unrest (39 stories mention fear in this frame). Common reactions include talking to other  
288 people (50% of the stories) to warn them, but also to ask for explanation or seeking help. In about 30% of the stories, the  
289 protagonists have a companion, and sometimes they may talk to each other about what is going on. Talking to other people  
290 involves friends (26 stories), family (22), scientists (12), the community (either everybody, or the neighbours) (10). The  
291 authorities (police, firefighters, civil protection, but also the mayor, the professor, the director...) are called upon in 9 stories,  
292 while 5 times the protagonists refer to a wise, old character for advice.

293 In a few stories the protagonists try to warn others but are not believed or receive no answer. In one story, the volcano itself  
294 talks to the protagonist warning him to go away. In another story the warning comes from the mailman. In most cases, the  
295 protagonists realize that an eruption is possible, sometimes thanks to the opinion of others. Only in a few cases, the characters  
296 fail to recognize the danger or consider the signals a normal feature of the volcano that raises no worries.

297 In the majority of the stories, this frame does not specify whether the characters are going to take action. Only 22 stories (12%  
298 of the total) explicitly refer to leaving the place because of the impending danger, while in 15 cases, the character goes or  
299 remains home, or seeks shelter, waiting for further development. While most of the protagonists are worried, some are  
300 fascinated by the unusual phenomena, or look for answers and willingly move toward the volcano (17 stories). In a few stories  
301 (12), the characters seek a remediation for the problem: sometimes it's a magical intervention, while others refer to some kind

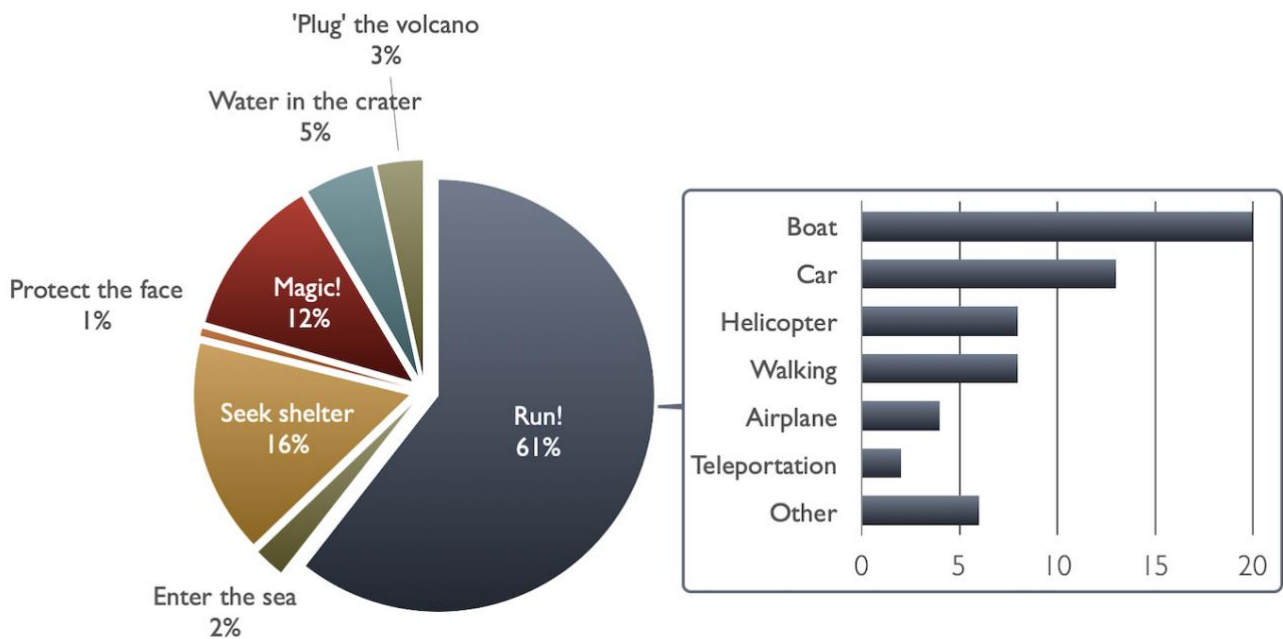
302 of authority to ‘fix the problem’ (usually, in an unspecified way). A small number of protagonists take actions to mitigate the  
 303 hazard, obstructing the volcanic vent with rocks (or even a cork), or pouring water inside the crater.  
 304 Examples of frame 2 are provided in the Supplement 3 (“Frame 2 – Volcanic unrest”).

305 **4.2.3 Frame 3 - The eruption**

306 The eruption is usually sudden: the terms *improvviso* [sudden] and *improvvisamente* [suddenly] are used 26 times in this frame,  
 307 and *subito* [immediately] appears 8 times. The event may be described as an explosion or a blast (32 times). Based on drawings,  
 308 it is usually a small-scale event, whose impact is generally confined to the upper portion of the volcanic cone. It commonly  
 309 involves the emission of lava (mentioned in the text 60 times), but the Strombolian ejecta are present in several drawings.  
 310 Written text mentions ash, rocks and lapilli (23 in total, for this frame). Flames are also mentioned about 10 times, as a result  
 311 of fires set by the incandescent eruptive material. Only a few stories actually depict a major explosive eruption that occupies  
 312 most of the drawing area and generate clouds of ash that could represent pyroclastic flows. The terms pyroclastic flow, or *nuée*  
 313 *ardente*, are never used in the written descriptions.

314 As the volcano erupts, people scream and run away, but also watch, in a few cases with fascination, while many are frozen in  
 315 fear. Many characters just watch, gathering in the streets but without leaving. In several stories, the onset of the eruption is the  
 316 time when the characters begin to worry and start wondering what to do next. In a few cases, this is the frame where people  
 317 are warned about the danger, often by word of mouth, and only in very few cases through official actions (a siren, or police or  
 318 civil protection authorities alerting the population). The word evacuation is only mentioned twice.

319  
 320 The most common reaction to the eruption is to take the flight (83 times, in this frame, 60% of the stories considering both  
 321 text and drawings), mostly by running (Figure 6).



322  
 323 **Figure 6: Characters' actions and response to the eruption (frame 3).**

324  
 325 Many escape on a boat or a raft (20), others rely on their car. Airborne vehicles are also popular, helicopters in particular but  
 326 also airplanes, air balloons, or fantastic vehicles. Only a few leave the town by train or bus, or use animals. Many seek shelter,  
 327 often returning to their home (26 times), or entering into the sea. Also in this frame, a few bravely take some sort of action to  
 328 mitigate the hazard (34 times), either through magic intervention but also by pouring water into the crater, or by throwing  
 329 rocks into it, to obstruct the conduit. Rarely the action is taken by the community, or by public authorities.

330 Others call for help (21 times), sometimes hopelessly.  
331 Text and drawings also reflect the damage (mentioned 34 times) to the environment (burned vegetation) and to infrastructures  
332 (houses, mostly, but also cracks or lava interrupting roads). In 9% of the stories the destruction is pervasive and impacts the  
333 entire city. In 11 stories someone dies in this frame, in a few cases the protagonists themselves do not survive. Examples of  
334 the third frame are collected in the Supplement 4 (“Frame 3 – The eruption”).

#### 335 **4.2.4 Frame 4 - The epilogue**

336 This frame shows how things ended, and the participants imagined a rather wide spectrum of possible outcomes: in some  
337 stories the old life resumes, as if nothing happened, thanks to magic interventions or because it turns out it was just a dream.  
338 In other cases, nothing will be the same ever again, because someone died or because it was necessary to move and live  
339 elsewhere. Most of the stories end well (58%): the characters survive, perhaps a little battered (bruises or wounds are  
340 mentioned; in one story the two characters end up with a headache). They often contribute to save their community, and  
341 happily celebrate the end of the eruption. The relief is usually burdened by the damage caused by the volcano: even though  
342 the characters are alive, in several stories (28%) they face destruction and losses. Destruction is mentioned 38 times in this  
343 frame, and it affects both the environment (trees, animals) and urban infrastructures (buildings, roads), that are burned (15  
344 stories) or covered in ashes (11 stories).

345 The disconsolate assessment of the devastation may be accompanied by the idea of reconstruction (13% of the stories), which  
346 may take place either right away or after a long time. The protagonists may or may not be directly involved. Some choose to  
347 rebuild elsewhere. Sometimes, the reconstruction is carried out while the characters are away, in a safe place. Other times  
348 (11%), the reconstruction is described as a community effort acted by everybody, or by the city, or by the inhabitants. Only in  
349 a few cases (3%) specific categories are mentioned to be in charge of reconstruction (masons, firefighters). Sometimes the  
350 community that builds a new life after the disaster is limited to the characters and friends or relatives. Rescue teams of some  
351 sort are mentioned only 6 times in this frame.

352 The need to move away is again mentioned (24% of stories) and only some of the protagonists (7%) envisage returning home,  
353 perhaps after a long time. A small number of stories (10%) do not end well, and remind us that things can go bad. Death is  
354 explicitly mentioned 38 times in this frame, and in 15 stories the protagonists themselves die, sometimes in the heroic effort  
355 to save their community, other times in loneliness or because nobody survives. In a couple of cases, the death is not directly  
356 related to the eruption, but due to indirect or independent causes (heart attack, being hit by a firefighters’ truck, and even by  
357 an atomic bomb, totally unrelated to the story).

358 A few stories do not provide details on the epilogue and simply state that the eruption ended, without further comments. The  
359 story simply ends because the volcano “turns off” (or it rains, and this stops the eruption). There may be an acknowledgment  
360 that everything is “burned”, but without information on what happens to the characters. In one story, the houses are only  
361 covered by ashes, but still habitable. In another one, the bad ending features widespread destruction and scientists who do not  
362 know what to do.

363 Examples of the fourth frame are collected in the Supplement 5 (“Frame 4 – The epilogue”).

#### 364 **4.3 Stromboli**

365 The same workshop was later proposed to the student living on the island of Stromboli (Aeolian Island, north of the coast of  
366 Sicily). This offered us the opportunity to collect stories from a context that is very different in terms of its geographic,  
367 volcanic, and social settings. Stromboli is an open-conduit volcano, usually characterized by a mild Strombolian activity  
368 (which takes its name from the island itself) and features continuous degassing and repeated explosions ejecting materials up  
369 to tens or hundreds meters above the crater. Lava flows may occasionally form along the deserted slope of the volcano. This  
370 persistent activity typically impacts only the summit of the volcano and is considered one of the main touristic attractions on

371 the island. This behaviour is sporadically interrupted by greater explosive events, known as paroxysms. The Imaginary  
372 Eruption workshop was carried out in 2020, right after two paroxysmal eruptions took place in 2019, on July 3 and August 28  
373 (Giordano and De Astis, 2021). Both events raised an eruptive column of several kilometres and generated pyroclastic flows  
374 that rushed down the deserted slope of the island to reach the sea. The two paroxysmal eruptions occurred without noticeable  
375 precursors, were unusually close in time and the first one caused one causality, shaking the busy touristic season that revolves  
376 around guided tours of the volcano's summit. Residents had to face the fear of both volcanic eruption and economic disruption  
377 at the same time. In this context, we planned a workshop for the spring 2020 but, because of the COVID-19 pandemic, we  
378 couldn't travel to the island. We did not want to miss the opportunity to get in touch with the students and to offer them a safe  
379 space to discuss volcanic eruptions and their consequences. We therefore adapted the workshop to make it suitable for remote  
380 fruition. Participants connected from their home and since it was not possible to organize the work in pairs, each student  
381 elaborated her/his own story. We allowed longer times to work and to discuss the stories at the end. The workshop was  
382 therefore organized in three days, with one session of 1 hour each day. The attending students were 13, from both primary and  
383 secondary schools but we could collect only 9 stories featuring both drawing and written descriptions. This is a very small  
384 number to allow for wide considerations. Nevertheless, we do consider these stories of interest for the peculiar circumstances  
385 they reflect and we therefore provide here a terse description. Most stories are set on the island itself which, in two cases, is  
386 the actual protagonist. The impending eruption can be announced by rock fallout (which in one case set the vegetation on fire),  
387 small tremors, or even small eruptions. In one case, the eruption is announced by an "air pocket". The eruption is often a  
388 typical strombolian eruption, with a lively launch of ash and scoriae, sometimes associated with a lava flow. In one case the  
389 eruption begins under water, while in another one pyroclastic flows and their destructive power are mentioned. The stories  
390 mostly feature a happy ending, with the volcano returning to its usual behaviour and inhabitants can resume their usual lives.  
391 In a few cases, however, consequences are more serious and involve injured people or imply leaving the island and friends.

## 392 **5 Discussion**

393 The Imaginary Eruption provides a composite portrait of volcanic eruptions and their impact, as perceived by the kids and  
394 youngsters, mostly from the urban area of Napoli. As a whole, it is a rather accurate portrait featuring many realistic features  
395 that can be expected during a volcanic event. Collected stories provide a wide range of plausible eruptive scenarios. A  
396 comparison with those envisaged by the scientific community reveals a few gaps and discrepancies that could inform future  
397 outreach programs.

### 398 **5.1 The volcano and its activity**

399 In all collected stories, the volcano is an obvious geological feature of the landscape and the eruption invariably takes place at  
400 the summit of the cone. A caldera setting is never mentioned, nor the possibility of new vents opening along the slope of the  
401 volcano, or elsewhere. Pupils and students are commonly very passionate about volcanoes, and this passion is generally  
402 accompanied by a good knowledge of different volcanic structures and phenomena. While many of the kids involved are  
403 certainly aware about calderas and their behaviour, the choice of representing classic volcanic cones reflects the conventional  
404 image that we all picture when we think about volcanoes. Some drawings explicitly refer to Vesuvius, and realistically feature  
405 two peaks: one representing Vesuvius' cone, and the other being the remnants of the Somma strato-volcano. These drawings  
406 testify to the interest and good knowledge of the local landscape. In most stories, however, the imaginary volcano is located  
407 in remote regions, surrounded perhaps by a few isolated houses and, in general, at safe distance from populated areas. Only in  
408 a few cases the volcano is portrayed in an urban environment.

409 Volcanic unrest is marked by a number of realistic precursors, such as shallow seismicity or the emission of smelly volcanic  
410 gases, and is often associated with noise. Interestingly, in some cases, the first signs of volcanic unrest are actual eruptive

411 events, involving explosions and the launch of ejecta. In general, the unrest phase is too short to take action before the volcano  
412 erupts. The quick transition from unrest to eruption suggests that most stories feature volcanoes with an open conduit. Open-  
413 conduit volcanoes erupt more frequently and their activity is more likely to appear on television or social media. These images  
414 easily contribute to building our mental model of erupting volcanoes. The eruptions from open conduit volcanoes are easily  
415 strombolian, featuring launches of volcanic bombs, lava flows and spectacular lava fountains that closely resemble the events  
416 drawn by the kids.

417 Most imaginary eruptions are small events, if seen through the eyes of a volcanologist. The main feature is usually a lava flow  
418 that propagates along the slope of the volcanic cone. This effusion is commonly accompanied by the emission of gas and by  
419 the launch of lapilli and bombs that in a few cases may reach beyond the volcano's slopes. This eruptive style recalls common  
420 footage from frequently active Etna or Stromboli volcanoes, in Italy. Some stories mention ash, and this may reflect family  
421 anecdotal accounts of last Vesuvius' eruption, in 1944. A small number of drawings show the development of an eruptive  
422 column (that is never mentioned in the written text). The height of the column is usually small compared to the size of the  
423 volcanic edifice. Only in a few cases, the drawing suggests that the eruption impacted a wider area (i.e., the entire city). Most  
424 stories provide little or no evidence to assess the duration of the eruption. When they do, the event is short-lasting and usually  
425 ends within a few hours or a day.

426 The imaginary eruption has consequences: most stories describe burnt vegetation and damages to houses and roads. In some  
427 stories people are hurt or killed. Almost half of the stories (42%) mention casualties, but most stories reflect the optimistic bias  
428 already seen in the analysis of risk perception conducted among adults. In these cases, the protagonists survive even though  
429 others are severely affected. Ash covering the landscape and causing respiratory problems is also mentioned a few times.  
430 Damage may be limited (especially when the eruption itself is small), but in a few stories destruction is pervasive. In many  
431 cases, the eruption's consequences are long-lasting, and affect the lifestyle of the characters involved.

432 Interestingly, in a few stories the characters are killed or injured by events that have nothing to do with the eruption, suggesting  
433 a clear understanding of the multiple hazards that threatens our communities.

434 The stories collected in Stromboli reveal a strong relation with the volcano and a good knowledge of its various eruptive styles  
435 and products. The two stories that feature the volcano itself as a protagonist both suggest a strong tie connecting Stromboli  
436 with its islet Strombolicchio and with the other Aeolian islands. This is consistent with the geological evolution of the  
437 archipelago. In general, both the drawings and the written descriptions of the stories reveal a close attention toward eruptive  
438 phenomena and their consequences.

439 As mentioned in section 2, some of the stories (39) were collected in schools located in non-volcanic areas. We did not perform  
440 a systematic comparison of stories drawn in different regions, but we can say that those collected in non-volcanic areas often  
441 lack details in the drawings and descriptions of volcanic activity, both before and during the eruption. The presence of  
442 suspended ash, which can cause coughing and hinder respiration, is only mentioned in stories collected in the Neapolitan area,  
443 and may reflect familial accounts of the 1944 Vesuvius eruption.

444

## 445 **5.2 The people**

446 The characters who live or find themselves near the volcano are commonly alone, or with a single companion. In most cases,  
447 they face the unrest and the eruption without the support of a wide community. The protagonists are mostly well aware of the  
448 impending danger, and discuss their options and fears with friends or neighbours. The stories provide a very realistic picture  
449 of people's behaviours, highlighting well known issues, such as warning signs or alerts that are met with disbelief and lack of  
450 action. The stories also capture both the fascination and the fear for the natural phenomenon, as major drivers for people's  
451 actions. While most run or seek shelter, some are paralyzed by fear and a few reckless are rather attracted than scared by the  
452 volcanic activity. The struggle to decide whether or not to leave is also present. The need to move somewhere else to be safe

453 is a recurrent concept, likely reflecting some knowledge of the emergency plans for the Neapolitan area. However, leaving is  
454 always depicted as a personal decision that not everybody is willing to make.

455 Moving away from the volcano as a safety measure is described with different nuances in different geographic areas: kids  
456 living far away from actual volcanoes may describe the departure with relief, as a permanent solution to the problem with no  
457 apparent drawbacks; kids from the Neapolitan area, on the other hand, seem to be sorely aware of the many difficulties  
458 associated with leaving, and often describe the characters as sad, lonely and homesick.

459 A good perception of the complexity of life on an active volcanic system also emerges in a couple of stories from Stromboli,  
460 where people's concerns are mentioned as well as the necessity to leave to be safer elsewhere. One story addresses the very  
461 different perceptions that different people may have of the same phenomenon, ranging from admiration to fear.

462 In general, the departure is not a planned evacuation, organized and carried out before the eruption, but rather an escape from  
463 the ongoing phenomenon. In several cases, it takes place after the eruption ended, not as a defensive measure but because  
464 houses are damaged, as it happens in case of earthquakes. In the (rare) description of rescue teams, they also intervene in the  
465 aftermath of the eruption. In a seismic country like Italy, images of rescue teams at work after major seismic events is  
466 unfortunately a rather common sight that easily entered the mental model of the kids.

467 An organized approach to hazard assessment and mitigation is missing. There are no monitoring networks to capture signals,  
468 nor experts capable of interpreting them. If scientists are at the scene, they mostly acknowledge the ongoing activity, without  
469 providing further information, or useful advice. Public authorities are rarely mentioned (less than 5% of the stories), and there  
470 is no coordinated, public response to the change in the volcano's state of activity. Most of the characters face the impending  
471 danger on their own and if action is taken to lower the risk, it mostly happens thanks to individual initiative.

472 In a small fraction of stories (approximately 10%), the aftermath of the eruption is characterized by reconstruction that sees a  
473 full involvement of the entire community.

## 474 **6 Conclusions and steps forward**

475 The kids and youngsters attending the Imaginary Eruption workshop revealed sharp eyes and a keen attention to the dynamics  
476 of both the natural phenomena and human interactions. Their works, considered together as a whole, capture most of the key  
477 issues related to hazard assessment and mitigation. These were discussed at length in the meetings with the teachers after  
478 working with the students.

479 The outcome of an eruption does not only depend on the magnitude and explosivity of the volcanic event: people play an  
480 important role. The conclusion of the story always depends on what goes on in the preceding frames. The kids' drawings well  
481 represent the wide spectrum of possible combinations of eruptive styles and sizes and people's behaviours.

482 The collected stories are works of fiction, and do not necessarily represent the actual beliefs or mental model of the drawers.  
483 Nevertheless, in setting up the scene, the students made use of their personal knowledge, and the stories reveal what they think  
484 could get their protagonists in trouble. The analysis of individual stories can be used to identify sound elements of their  
485 understanding of volcanic eruptions and point at topics that may deserve further attention in future outreach work. In the future,  
486 scientists and textbook writers should become acquainted and agree on the choice of images and terms to better convey a more  
487 realistic picture of volcanoes and their behavior. Graphics could illustrate possible sequences of events before, during and after  
488 the eruption, together with the timescales and magnitudes involved. In the following, we provide a few indications.

489

490 **Unrest and uncertainty.** Among the positive elements, kids are aware that there will be precursors to an eruption in the  
491 Neapolitan area, and can name several of them. On the other hand, the stories typically describe a very short unrest phase, with  
492 macroscopic signals that are detected shortly before the actual onset of the eruption. The stories do not capture the uncertainty  
493 associated with long-lasting unrest periods, featuring signals whose interpretation may be difficult or controversial. This crucial

494 phase requires a continuous effort to find an acceptable balance between costs and benefits of possible mitigation actions,  
495 causing great stress in the resident population. Yet, the description of the unrest phase is easily neglected in the concise  
496 descriptions that classifies volcanoes as dormant or active. New outreach materials could focus on what it takes, and how long  
497 it takes, to actually reactivate a dormant volcano. Dealing with uncertainty is hard on emergency managers and citizens. Being  
498 aware that a period of uncertainty is ahead of us is a first step to get ready for it, and possibly take actions to mitigate the  
499 fatigue associated with it.

500

501 **False alarms.** Some volcanic unrests terminate without culminating in an actual eruption. This has occurred at Campi Flegrei  
502 several times (Del Gaudio et al., 2010) and has important implications for hazard assessment: if an eruption is not the only  
503 possible outcome of precursory signals, false alarms based on monitoring signals are bound to happen. This possibility is never  
504 mentioned in the collected stories, and should be perhaps better emphasized when discussing volcanic hazards.

505

506 **The magnitude of eruptions.** When the imaginary eruption strikes, it is usually small. The drawings may in part reflect images  
507 and sketches that students find in their books, where the various features of explosive eruptions are concentrated in a small  
508 space for publishing constraints. We may collaborate with graphic designers to devise sketches of volcanic eruptions that  
509 provide a better understanding of the actual size of big explosive events. And we can highlight that the same volcano can  
510 display very different eruptive styles and generate big and small events.

511

512 **Time for action.** The frame describing the eruption is also the one when most protagonists decide to take action. The kids  
513 expect that an eruption will have a great impact and know that it will be necessary to run or seek shelter. Outreach material  
514 and education itineraries should emphasize that there is time for evacuation, and this time is before the actual eruption begins.  
515 Although distressing, a prolonged unrest phase is just what grants us enough time to organize an orderly evacuation.

516

517 **Planning ahead with families.** As mentioned above, the characters of the Imaginary Eruption do not evacuate, but try to  
518 escape, while others hide inside huts or other improbable shelters. The decision is never planned ahead, but is made in the heat  
519 of the moment. In making these decisions, the characters of the stories mostly rely on their families. In reality, plans for an  
520 organized evacuation exist for exposed areas (red and yellow zones), as detailed in the National Civil Protection Plans for  
521 Vesuvius and Campi Flegrei. However, in a social context where family's ties are strong, outreach activities should take into  
522 account that important decisions will be made inside the families. Education efforts should target all family members, helping  
523 the kids to identify unsafe behaviour and the adults to recognize the optimistic bias. Outreach activities that target the entire  
524 family could significantly improve the preparedness of the communities.

525

526 **Taking responsibility.** A small but significant number of stories describe efforts to stop the eruption from happening. While  
527 we certainly cannot control volcanic activity, there are common actions that are taken to hinder lava flow propagation, either  
528 using cold water or building dams to temporarily contain or divert the lava. The problem-solving attitude should be encouraged  
529 by showing the kids that their thinking was very much consistent with existing mitigation strategies. Kids are willing to take  
530 responsibility and act to mitigate the hazard. We must emphasize that in case of large explosive eruptions evacuation is the  
531 only viable option.

532

533 **Science and scientists.** In a few cases, the characters refer to scientists for help, but the nature of the support provided is  
534 somewhat blurred. We can work to better emphasize the insights we gain from volcano monitoring and from experience  
535 gathered at different volcanoes. This knowledge provides the information based on which mitigation actions such as evacuation  
536 can be taken. Volcanic gases are recognized as an integral part of the volcanic activity, but gas is commonly confused with



537 smoke. Specific outreach material should stress the differences between volcanic gas and smoke, and provide information on  
538 the key role of gases in hazard assessment. Finally, a few stories reveal the fear that scientists or authorities will not listen.  
539 We need to reinforce the bond between scientists, emergency managers and the population exposed to volcanic hazards. All  
540 the initiatives such as science fairs, citizen science programs, evacuation exercises, or community meetings bring these  
541 stakeholders together and contribute to build and reinforce mutual trust and understanding.

542  
543 The Imaginary Eruption has been an interesting exercise that provided us with an unusual insight into how volcanic eruptions  
544 are perceived by kids and youngsters. Far from being a formal assessment of the students' understanding of volcanology, these  
545 stories provided valuable cues to discuss volcanic activities with the kids and explore a wide range of emotions and sentiments  
546 stirred by the thought of an impending eruption. The teachers involved mostly found this an effective tool to approach a  
547 complex topic, and to build the lecture around the themes that the students propose in their stories.

548  
549 This approach can be easily implemented to explore the mental model related to different natural hazards. We proposed to the  
550 schools of various Italian regions “Imaginary Earthquake” workshops to address seismic risk. During the Edurisk activities  
551 (Camassi et al., 2021) we learned to constantly adapt our approaches and procedures during the projects in the schools, and  
552 when the Covid-induced restrictions stimulated to adapt our teaching activities to the new constraints, we experienced closer  
553 and immediate contact with students and teachers. The tools we used in attendance have been adapted to remote teaching: the  
554 activity was structured in the same way, throughout a 4 sheets story, drawn and written, and we managed to keep the same  
555 style of active participation, built on stimuli and discussions. The results we have obtained, in terms of students' laboratory  
556 restitutions, are fully comparable with those above described obtained from the students of the Neapolitan area. We believe  
557 that this approach could be further extended to other natural hazards.

#### 558 **Author contribution**

559 All authors contributed to devising the workshop structure. RC provided the funding to sustain the activities and together with  
560 EE and VP granted the synergy with the EDURISK project. Workshops were held by FB, DM, EE, RC, RN, VP. Analysis of  
561 the collected stories was carried out by MT, FB, EE, DM and results were discussed by all co-authors. MT prepared the  
562 manuscript with contributions from all co-authors.

#### 563 **Competing interests**

564 The authors declare that they have no conflict of interest.

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