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ORIGINAL PAPER

Disaster education for landslide risk reduction: an experience in a public school in Rio de Janeiro State, Brazil

Marcos Barreto de Mendonca[1] · **Adriana Sobreira Valois**[2]

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Abstract Public policies for reducing the disaster risk associated with landslides in Brazil, based almost solely on the implementation of engineering works to stabilise hillsides, have proved ineffective, with this type of disaster becoming more common and more severe. There is therefore an urgent need to form a culture that encourages the public to participate directly in disaster management and develops community capacity, which requires a broad disaster education programme on formal, non-formal and informal levels. Given the recent approach to the topic, this study aims to contribute to the development of a disaster education methodology for landslides, based on an experience that was coordinated by the authors within formal education. The experience was implemented in a state school in the city of Niterói (Rio de Janeiro State, Brazil) which is recurrently affected by disasters associated with landslides. The issue of disasters associated with landslides was addressed in a one-semester course, using the theory of meaningful learning and a range of pedagogical tools in both theory and practical classes, for a total period of 16 h. The educational activities were preceded by a landslide risk perception survey and teacher training. The study concluded that the course promoted interactive and participatory learning, a connection to the real problem in the field and an affective relationship with the issue.

Keywords Landslide · Risk · Disaster education · Participatory management · Meaningful learning

✉ Marcos Barreto de Mendonca
mbm@poli.ufrj.br

Adriana Sobreira Valois
asvalois@gmail.com

[1] Polytechnic School, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil

[2] State Education Secretary, Rio de Janeiro, Brazil

1 Introduction

Landslide disasters that occur due to a combination of natural characteristics and human settlement are nothing new in Brazil (Brandão 2009). In recent decades, there has been a significant increase in the number, magnitude and geographical area affected by disasters associated with landslides in Brazil (Fig. 1, CEPED-UFSC 2013).

With the sole purpose of simplifying terminology, the word *landslides* is used in this study to describe different types of movement of mass, including translational and rotational landslides, creeps, mudflows or debris flows and rock falls.

These events result in a wide range of consequences, including death, homelessness and displacement, social and psychological damage, and material and economic losses (Wold and Jochim 1989). Figure 2 shows the human damage caused by landslides that occurred in Brazil from 1991 to 2012, based on 699 official records, 78% of which are for the State of Rio de Janeiro (CEPED UFSC 2013).

The natural geological, geomorphological and geotechnical features of an area are important in determining the degree of landslides hazard (Fell et al. 2008). However, human activities inherent to the disorganised use and occupation of the land (cut-and-fill on the hillside to build housing or roads; trash dumped on the land; deforestation; inadequate water supply, sewage and drainage systems; obstruction of natural watercourses; and overloads due to construction works and traffic) alter the natural conditions, increasing the landslides hazard (Mendonça et al. 2000; Michoud et al. 2011).

Studies on the problem of landslides in society should not be limited to the scope of the hazard to these events, deserving a broader focus of the disaster and the social problems caused by the impact of these events on society. With this focus, the approach to the problem goes beyond the limits of the technical hazard studies, seeking to explain them and respond to them in the form of social organisation (Marchezini 2009, 2015; Macias 2015).

The disorganised occupation of the land is primarily a result of the territorialisation processes caused by social inequalities. The areas "left over" for occupation by low-income inhabitants are territories that without prior treatment are unsuitable for housing,

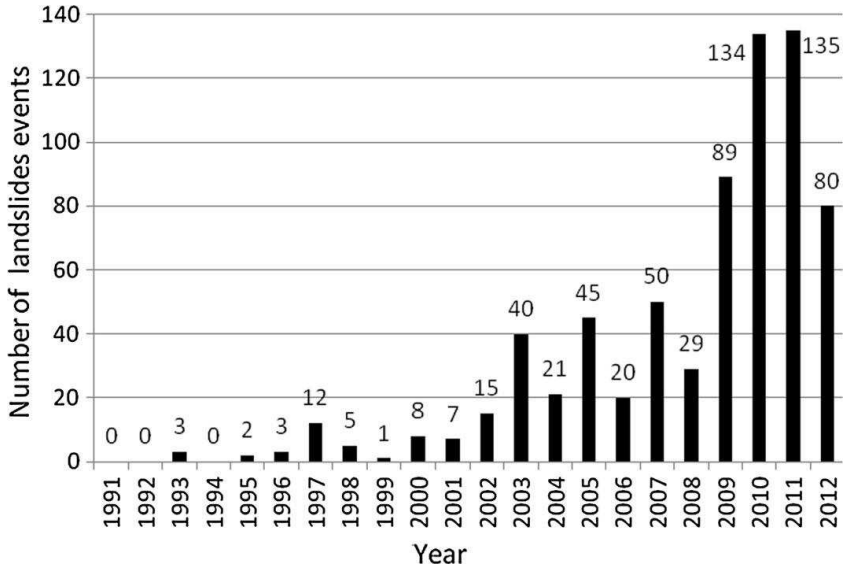

Fig. 1 Evolution of the number of landslides officially recorded in Brazil by Civil Defence agencies from 1991 to 2012, according to CEPED UFSC (2013)

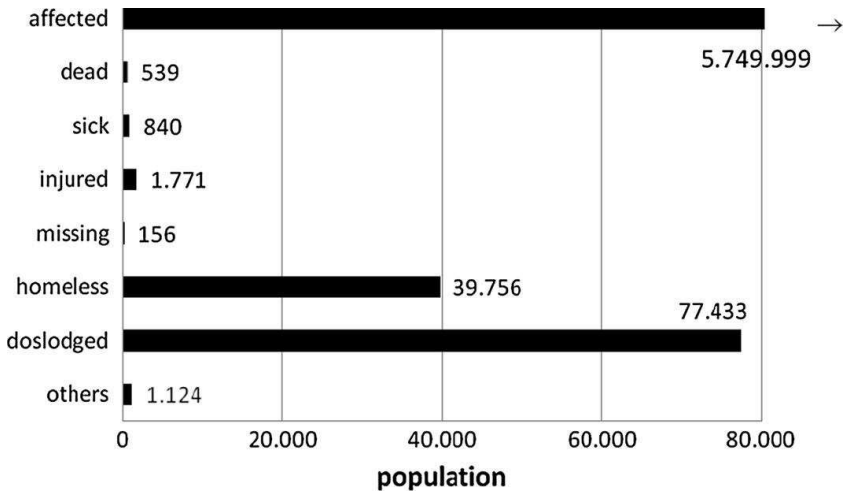

Fig. 2 Human damage caused by landslides in Brazil between 1991 and 2012 (CEPED UFSC 2013)

because the slopes and surrounding areas are highly susceptible to landslides. This socially perverse form of territorial organisation results from the everyday indifference of ordinary citizens towards structural, distributional inequity and the technical inability of the public sector, which leads to corporate interests prevailing at the expense of social welfare (Wisner et al. 2003; Valencio 2009, 2010).

Vulnerability is the characteristics and circumstances of different aspects (physical, social, economic and environmental) of a person or community that make them susceptible to the damaging effects of a hazard, being independent of its exposure (UNISDR 2009). Disaster is defined as a disruption of the function of a community or society involving widespread impacts, and disaster risk can be expressed as the combination of hazard, the exposure to such hazard and the community vulnerability.

Then, in context mentioned above, potential disasters are even more serious, because in addition to occupying areas that are highly susceptible to landslides, the population is also more vulnerable, due to their socioeconomic situation and the low-quality construction standards of their homes (Turner et al. 1990; Smyth and Royle 2000; Alcantara-Ayala et al. 2015). The environmental problems and risks are thus linked to the social problems, resulting in a socio-environmental framework of injustice (Da-Silva-Rosa et al. 2015).

Due to the high social inequality in Brazilian society, unjust territorial disputes are expected to continue in the years to come, as is the consequent pressure related to the occupation of unsuitable areas—such as hillsides that are highly susceptible to landslides—by those who are most vulnerable socio-economically. As a result of an unsustainable development model, this process of irregular and disorganised occupation and its exposure to landslide hazards is intensifying, not only in big cities, but in smaller towns too, creating new settings for the potential disasters associated with landslides.

Given this situation, the guidelines for disaster risk reduction (DRR) regarding landslides, which were adopted decades ago and basically consist of the implementation of structural actions (engineering works), have proven to be severely lacking, since such interventions, even at high costs, fail to stop the increased frequency (Fig. 1), magnitude and geographical area of the disasters.

It is therefore important to advance the implementation of non-structural DRR actions, such as urban planning, legislation, contingency plans, training of public officials, housing policies, warning systems and education.

In 2005, the United Nations International Strategy for Disaster Reduction (UNISDR) proposed the Hyogo Framework for Action (HFA)—"Building the Resilience of Nations and Communities to Disasters" (UNISDR 2007). This document was endorsed by United Nations member states in 2005, and its purpose was to guide national public policies and international organisations in their efforts to substantially reduce disasters between 2005 and 2015. Based on the concept that disaster risk arises when hazards interact with physical, social, economic and environmental vulnerabilities of communities, HFA establishes that DRR actions must be addressed by different stakeholders in a multi-sectoral approach, involving physical and social issues. This kind of approach and DRR strategies were reaffirmed by the Sendai Framework for Disaster Risk Reduction, the new structure adopted for the 2015–2030 period at the Third United Nations World Conference on Disaster Risk Reduction (UNISDR 2015).

It is necessary to call attention to the requirement for an interdisciplinary approach to disasters and, hence, DRR measures. There must be effective combination of simultaneous approaches by physical and social sciences as disaster risk emerges from a complex interrelationship among human and natural (hazardous processes) systems (Wisner et al. 2003; Malamud and Petley 2009). But even when it is admitted that social and economic factors are the most crucial to disasters, there is a reluctance to deal with such factors because it is politically expedient to address the technical factors (Wisner et al. 2003).

Wisner et al. (2003) propose a schematic Press and Release (PAR) disaster model, in which the pressure on people arises from their vulnerability and the hazard, and the "release" idea is provided by reducing vulnerability. These authors mention that there is little long-term value in confining attention about disasters and its reduction primarily to hazards, in isolation from the different aspects of vulnerability.

Among the DRR strategies to reduce vulnerability, HFA highlights the necessity to empower communities to manage and reduce disaster risk and promote community participation in disaster risk reduction. Given the social aspects mentioned above, efforts to change the individual attitudes of citizens in order to stimulate public awareness and participation in the management of DRR actions stand out from among these non-structural actions. This transformation of individual attitudes must occur through empowerment, by making the individual and the community aware of their skills and ability to produce, create and manage disaster reduction (Romano and Antunes 2002; Pandley and Okazaki 2005; Wallerstein 2006; Gibson and Wisner 2016). This form of public engagement is fundamental to develop community capacity and resilience in relation to socio-environmental disasters and would make the DRR management guidelines more efficient.

In this sense, educational activities play a key role, by promoting a dialogical relationship between the different people involved (community residents, government agents that work with disaster risk management, academicians/scientists, decision-makers, among others) and reducing the distance between them—a basic condition of participative management for disaster reduction. This dialogical relationship facilitates communities in taking some landslide risk reduction actions such as: avoidance or mitigation of anthropogenic actions inherent in disorganised occupation processes that contribute to slope instability (deforestation, hillside cutaways, waste dumped on the land; inadequate water supply, sewage and drainage systems); community organisation and interaction with public agencies with a view to local risk reduction; flagging any indication of slope instability processes (ground cracks, tilting trees, fences or other structure, sticking doors and windows, cracks in house walls, etc.), in order to improve hazard mapping; implementation of structural hazard reduction measures in the residential location (principally drainage systems and small, simple slope stabilisation works); provision of information to improve

technical know-how on slope stability and more efficient risk reduction measures on site; and evacuation from homes to emergency shelters immediately following an alarm.

Addressing various DRR measures, Anderson and Holcombe (2013) state that it is cost-effective to educate communities about the risks they face and to give them access to resources and knowledge. These authors mention the implementation of structural hazard reduction measures (construction of surface water drains) undertaken through teamwork by government decision-makers, community development practitioners, engineers and community residents. Education came about through learning-by-doing during drain design and construction, which thus led to greater awareness of low-cost ways to reduce landslide hazards at a household level.

It should be noted, however, that the role of education providers is to catalyse the empowerment process. Governments or NGOs contribute to people empowering themselves through the creation of a favourable environment for the empowerment process (Sen 1997).

It is therefore important to question the educational methodology that shall be adopted for this purpose. To this end, this study aims to contribute to the discussion on this disaster education methodology based on an experience conducted in formal education. It involves integration of the issue of disasters associated with landslides and was devised and implemented by the authors of this study with support from Faperj (Rio de Janeiro State Research Foundation), in a state school in the city of Niterói, in the metropolitan region of Rio de Janeiro, Brazil.

2 Educational activities for disaster reduction

Among the five Hyogo Framework for Action (HFA) priorities, one was "to use knowledge, innovation and education to build a culture of safety and resilience at all levels" (UNISDR 2007). Among the specific actions outlined for this priority, the HFA mentions the inclusion of DRR in school curricula for formal, non-formal and informal education. This importance of education as a DRR strategy was reaffirmed by the Sendai Framework (UNISDR 2015).

Despite the advances introduced by the HFA, reports regarding national progress in implementing the HFA from 2009 to 2011 indicated that few countries included issues and topics related to DRR in formal education, demonstrating that although governments were generally ready and willing to respond to the HFA, they still lacked an understanding of the nature of DRR-related curricula and how to develop and implement them (Selby and Kagawa 2012). Based on available literature and case study documentary research into the experiences of thirty countries, Selby and Kagawa (2012) observed that the educational activities basically involve including the issue in various curricular subjects, with little evidence of any interdisciplinary approach and with no community involvement, which undermines its effectiveness. These authors emphasise the need for interactive, participatory, affective and "in practice" learning.

Regarding the content covered in disaster education, Lidstone (1996) suggests that instead of the current emphasis on the physical nature of disastrous events, disaster education should concentrate on the students' involvement in the context of disasters, to encourage them to regard themselves as living in a dynamic, physical environment and to engage them in the real-world problems experienced by their communities.

In the case of formal education, Selby and Kagawa (2012) state that the limited inclusion (issue addressed in a single discipline only) restricts the areas under which the issue is discussed. In this case, classroom culture probably aims to guide the results of learning towards the acquisition of limited knowledge and skills, which hinders the implementation of DRR activities. In turn, a holistic approach would help to overcome the restrictions of specific subjects, giving students a range of different lenses through which they can view and understand DRR.

Bangay and Blum (2010) discussed educational responses to climate change and concluded that it requires not only the provision of new curricular content, but sound pedagogical approaches, curricula and assessment strategies, as well as conducive learning environments both inside and outside of educational institutions, in order to help learners to develop the knowledge, skills and capacities to think critically, to solve problems and to address uncertainty.

According to Shaw et al. (2009), disaster reduction education should be treated as an interdisciplinary issue and should be incorporated in different educational structures. They state that the educational process and approach to the issue should be innovative and based not only on theoretical presentations (lectures), but also on observations and experiments.

The three modes of education—formal (regular school), non-formal (outside educational institutions) and informal (daily activities related to work, family life or leisure)—can incorporate disaster education (Shaw et al. 2011). According to these authors, disaster education should not be considered an event, but a process that in turn should go beyond the school boundaries, being connected to the community and the family.

From the observations made above, the following characteristics should be sought for efficient disaster education:

- interdisciplinary approach to the issue—issue is covered across multiple disciplines;
- interactive, participatory, affective, practical learning method;
- emphasis on contextualisation of disasters, in addition to the physical processes involved; encouragement of critical thinking;
- connection to the real world;
- student involvement with the community that is susceptible to the threat;
- use of different educational structures: formal, non-formal and informal education;
- teachers trained on the issue.

Despite advances in the development of guidelines for disaster education programmes, there is demand for more detail regarding the content and method that the educational actions should involve.

In this sense, the main justification for the activities that were implemented as part of the study described by this article is the need for experimental research into disaster education that can contribute to the proposition of appropriate content and pedagogical tools.

3 Experience implemented

3.1 Institution involved

The integration of the issue of disasters in formal education was implemented in a public state school called Colégio Estadual Joaquim Távora, in Niterói, in the metropolitan region of Rio de Janeiro, Brazil.

The natural geotechnical conditions, intense rainfall and human activities related to disorganised occupation in Niterói are not conducive to slope stability, and so the city is recurrently affected by disasters associated with landslides (Smyth and Royle 2000), with special mention of those that occurred in April 2010, which affected the entire municipality and resulted in 168 deaths.

3.2 Initial considerations for the methodology

The educational activities were introduced in the "Sciences" subject of the 6th year of elementary school, taught in the second semester of 2013. The study was conducted in two classes separately, one with 30 students and the other with 34 students, all between 11 and 12 years of age.

According to the objectives outlined in this article and the guidelines observed in the literature, the project's basic methodology was based primarily on prior knowledge of how residents deal with the issue of landslide disasters; training of teachers by experts; planning of educational activities and pedagogical tools; carrying out the pedagogical activities; a closing event; and general assessment (Fig. 3).

The landslide risk perception by resident population before the educational activities for DRR was implemented. Risk perception is the set of intuitive judgments made about risk

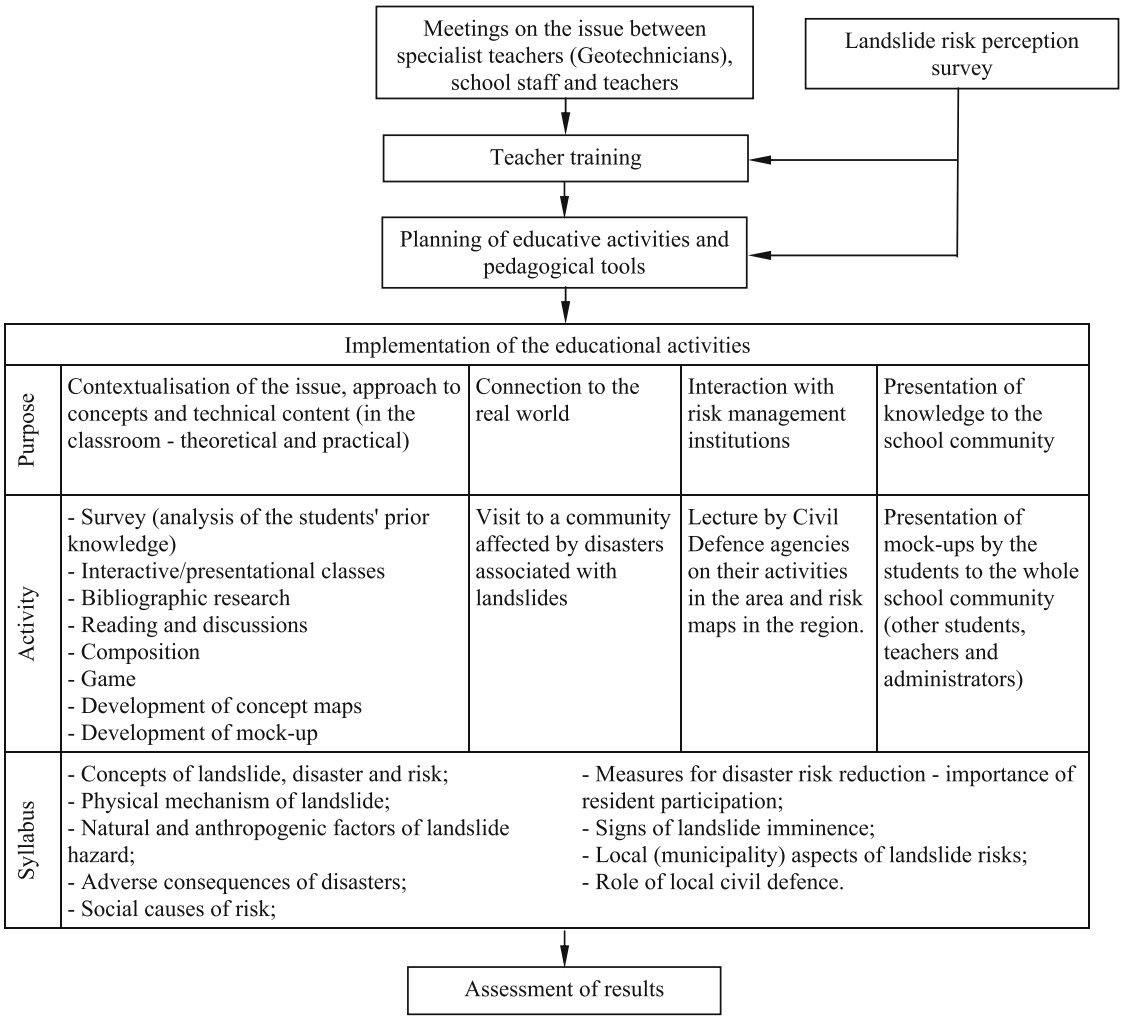

Fig. 3 Plan of disaster education stages and their activities carried out at the school

by those subject to a particular danger (Slovic 1987; Ho et al. 2008). There are differences between the risk perceptions of highly technical professionals, the affected population and the general public, as the experiences, culture and values of these social groups are quite different (Vargas 2006).

Given the above, a risk perception survey was conducted in a typical community situated on a hillside area in Niterói, which provided information to aid the planning of educational activities. The terrain where the community of Maceió lives (5 km from the school where the educational course was given), takes the form of a valley with abrupt southerly slopes and sharp, rocky peaks, where land occupation, primarily on hillside areas, is significantly disorganised, with evidence of deforestation, cut-and-fill for construction of housing and roads, and discharge of wastewater directly onto the land. In 2010, its population was approximately 4500 inhabitants. A risk perception survey was conducted through the application of a semi-structured questionnaire to a total of 50 residents, with a view to gauging opinions, ideas and conduct regarding landslide hazard, their causes, the influence of human actions, the ranking of this type of threat against others to which the population is exposed and the personnel/institutions that respond to emergency situations (Mendonça and Pinheiro 2012). This population has not been previously involved in any form of disaster education. To this end, this study revealed the following:

(1) Playing down of the landslide risk by residents, without their going so far as to fully deny it—70% of residents cited such a danger in periods of heavy rain—comparing everyday problems: lack of basic sanitation, deficient public transport—and opportunities available in the location—77% highlight the advantage of the community being a peaceful place to live;
(2) Despite 92% of residents having experienced landslide disasters, they attach little importance to this type of danger—only 10% believed such a threat to be important;
(3) Little importance given to certain human actions such as deforestation and hillside cutaways;
(4) Distancing and abandonment by public agencies involved in disaster management; and
(5) The impotence of residents in implementing DRR prevention actions.

Before planning the activities and pedagogical tools, training sessions were held by a geotechnics professor from the Federal University of Rio de Janeiro (UFRJ) Polytechnic School, covering the general context of the problem, the social causes, a general view of landslides, human actions inherent in disorganised occupation without adequate urban infrastructure, signs of imminent landslides, prevention and the general attitude of the public with regard to the issue. During this training, the results of the public risk perception survey were discussed. This stage aimed to train the school teacher on this specific subject.

The UFRJ professor and school teachers then worked together in order to design the educational activities and their tools. The content of the activities aimed to conceptualise and contextualise risks and disasters, including the broad concept of disasters, the socio-environmentally vulnerability of the population, the mechanisms that destabilise the slopes, the human actions inherent to the occupation of land, landslide hazard, risk reduction actions, the role of Civil Defence agencies and the importance of public participation in DRR actions. The types of educational activities largely followed the rules outlined by Shaw et al. (2009) and Lidstone (1996) that the educational process and approach to the issue of DRR need to be innovative, based not only on theoretical presentations (lectures), but also on observations and experiments, and making a connection to the real world, to the community.

The intended learning outcome on completion of these activities is basically to enable the students, after understanding physical and social factors involved in the landslide disaster, to disseminate and apply the information to reduce the risk in their residential area and contribute to creating a culture of more effective participation of the population in DRR.

3.3 The activities carried out

The activities were designed and the pedagogical tools were developed based on the theory of meaningful learning (Ausubel 1968; Ausubel et al. 1978; Moreira and Masini 1982), in which students use learning processes to relate new information (concepts, ideas, propositions) to what they already know. An interaction occurs between the new knowledge and the pre-existing cognitive structure, where both are modified through a dynamic process in which knowledge is developed. Learning heavily involves assigning meanings, and these meanings always have personal components (Moreira 1999).

During the activities, the students developed and acquired new knowledge on the issue, experimenting with it and testing it using a variety of tools. The activities were taught by just one teacher from the school, but the specialist geotechnics professor from UFRJ participated in some of them.

The activities carried out with the students were:

(a) Initial survey of prior knowledge

A questionnaire was applied regarding some of the issue's concepts, to gauge the students' prior knowledge and to guide the next steps.

(b) Film session on the issue, discussion and collective development of a concept map

UFRJ presented two films: one a movie about the physical mechanisms and conditioning factors of landslides through a dynamic physical model, and the other about a specific case experienced by a community in Niterói (Mendonça 2016). After each film, there was a discussion. From there, the key concepts of the issue were highlighted and the first concept maps were then collectively developed.

A concept map is a diagram formed by graphical representations that shows the relationships between concepts or between words that we use to represent concepts, and its development is used to facilitate the organisation and display of knowledge in relation to a particular issue (Moreira 1999). The map should be capable of showing meanings assigned to concepts and relationships between concepts in the context of a body of knowledge.

(c) Readings of reports on the issue, discussion and individual development of an individual concept map

After reading two reports, there was a discussion, used to relate the students' prior knowledge to the basic concepts addressed in the previous activity, from which individual concept maps were drawn.

(d) Composition

This activity was the result of student demand. In the previous activity, a student raised the importance of talking about the "solutions" to the problem of disasters associated with landslides, saying: "We already know how landslides happen, but what is the solution? What do we do? And how do we do it?". Several other students then agreed that they would like to discuss this, since they live in a place that they recognised as an

area of risk. Thus, it was decided that each student would respond to a letter from a friend who wanted to know the signs observed in the field regarding the danger of landslides and the solutions to the problem, since they would be at risk. Before the students wrote the letters, they held a classroom discussion on the signs of imminent landslides, and which actions residents in areas of risk can take to minimise the risks. Following this discussion, the students listed actions that the residents themselves can take in risk reduction and asked to collectively develop a concept map on this topic. Development of a collective conceptual map encouraged increased student participation in the task.

(e) Class game on the knowledge acquired in previous lessons

This activity consisted of a question-and-answer game played between two groups in each class (girls against boys) reviewing the content learned so far.

(f) Student field trip—visit to a community affected by disasters

Students visited the community of Maceió in Niterói, where the risk perception survey was taken (see item 3.2). The aim was to relate the concepts and elements that the students had learned in the classroom to the real environment (Fig. 4).

During the visit, students were shown an area of approximately 250 m × 250 m that would have to be represented in the form of a mock-up in the following classes. Students were asked to pay close attention to what they were seeing during the visit to facilitate construction of the mock-up.

(g) Construction of interactive mock-ups

According to Valencio et al. (2009), a mock-up is an educational resource whose material elements regarding the location (such as physical geography, topography, hydrography and the form of land use) give the basis for a creative and reflective group dynamic together with the public on the issue of disasters. The construction of mock-ups was used in a previous non-formal disaster education project in a community in Niterói and was highlighted as one of the most effective activities (Mendonça et al. 2016). In this study, the class was divided into groups of five students, each responsible for building a scaled mock-up to represent the 250 m × 250 m area of the community visited by the students (item f). The mock-up included the elements observed in the community: houses, streets, rivers, steps, stone blocks, earthworks, wastewater outlets, etc., in addition to a landslide (Fig. 5).

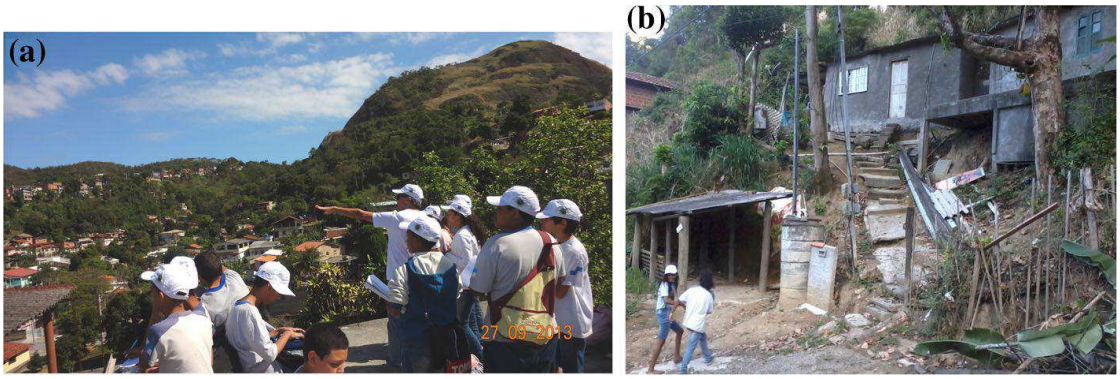

Fig. 4 Field visit to the community of Maceió: **a** overview of the community; **b** human aspects of the occupation and risk

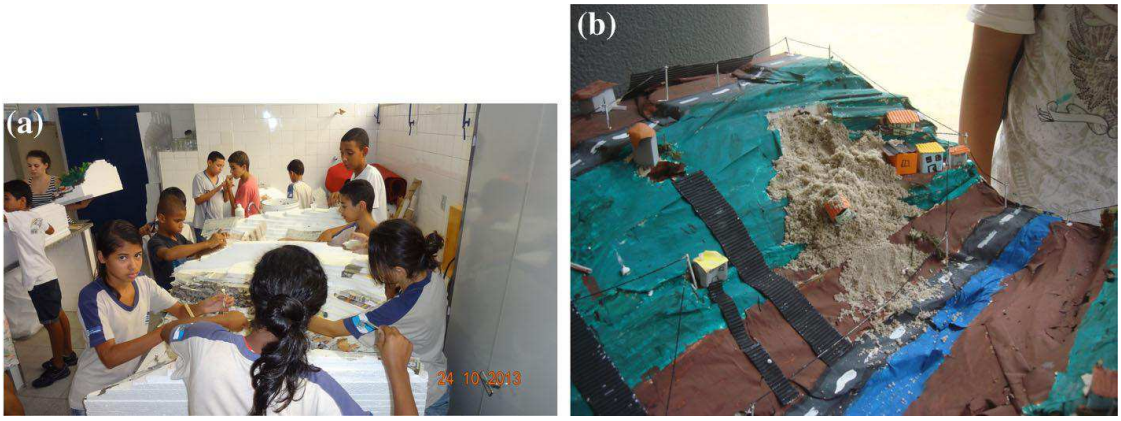

Fig. 5 Construction of the mock-up: **a** start of activity; **b** one of the mock-ups showing a landslide

(h) Lecture by local Civil Defence agencies

Members of Civil Defence agencies in Niterói gave a lecture that addressed the DRR activities they had carried out and presented photographs of the city's areas of risk.

(i) Sharing of knowledge by presenting the mock-ups to the whole school (final survey)

Soon after the Civil Defence lecture, the mock-ups made by students (item h) were presented to the whole school community and to members of the Civil Defence agencies (Fig. 6). In this activity, the students gave presentations, explaining the elements and the landslide process that they were aiming to represent.

According to Freire (1996), presentation of the results is important to verify that the students were able to retain the information, to understand it and to attribute personal meaning. This activity is therefore important in order to establish the concepts, evaluate the work and observe the educational multiplier effect.

Fig. 6 Exhibition of the mock-ups to the school community

3.4 Results and analysis

It was possible to design and implement a lesson plan related to the issue of disasters associated with landslides, including eight activities and various pedagogical tools. The activities were carried out in one or two classes at 50 min each, except for the construction of the mock-ups, which took a total of eight classes. Considering the total workload of the Science course is 160 h, these activities occupied approximately 10% of the total. It was noted that it is possible to obtain results similar to those achieved in this study even with a slightly smaller workload, provided the choice of pedagogical tools is based on the students' prior knowledge.

The prior survey of the students' knowledge indicated that although many knew that these disasters occurred, including some having personally experienced them, the concept of risk is not understood in the same way as it is used in the technical field. Less than 15% of students demonstrated prior knowledge about "areas of risk".

The concept maps were analysed based on Novak (1998) and Moreira (1999). A hierarchy of relationships was observed between the concepts presented, the repetition of concepts and/or quotes, and the propositions and descriptions of the maps. We also noted personal relationships (the feelings the students had in relation to the issue), one of the five elements of educational space described by Novak and Gowin (1984).

The students' desire to discuss "solutions" to the disasters at the end of one of the activities due to the fact that they recognised where they live as an area of risk confirms the relationship between the issue and their affective experiences (Ausubel et al. 1978).

After the fourth activity (writing a letter), the concepts addressed in class were refined, with students able to describe areas of risk, observe signs of potential landslides and propose measures to prevent this type of disaster. Most of the texts written by the students demonstrated organisation and association of the main concepts (disasters, risk, causes, signs of imminent landslides and measures to mitigate risk). Measures mentioned in students' letters were: not throwing waste directly on slopes; not removing vegetation; using more suitable vegetation for slope stability; not cutting or filling slopes for construction of houses or paths; asking for help; warning neighbourhood and Civil Defence about signs of potential landslides; bringing pressure on government to reduce risk measures; and avoiding construction of houses in hazardous areas.

During the community visit, it became clear that the students had an understanding of the issue, because 92% of them knew how to identify locations that presented a potential risk, as well as possible causes for the formation of these areas. They were also able to suggest measures to reduce the landslides hazard in the various locations visited. The students realised that disaster reduction can also be achieved by changing the attitudes of the residents, independent of any engineering works implemented by public agencies. It was found that it is important to involve a technical expert from the field of disasters associated with landslides in this activity.

The construction of the interactive mock-up allowed several aspects to be grouped together in a single tool, including natural conditions, human actions (mainly earthworks and the dumping of garbage and wastewater), signs of imminent landslides, the landslides themselves and their consequences.

The presentation of the mock-ups to other students at the school aroused interest in them, reinforcing the observations made by Valencio et al. (2009) and Mendonça et al. (2016) that this is an important tool in socio-educational activities related to the issue. Giving the students the opportunity to explain landslides to their peers during the

exhibition proved very useful, not only because it allowed them to test their explanatory skills, but also because it provoked discussions on the issue among other students.

About 25% of the students who participated in this study showed a concern for their own homes because they recognised aspects typical of areas of risk where they lived.

When looking at the photographs of areas of risk in the city of Niterói presented by the Civil Defence agencies, some students, having noticed that their homes were in "areas of risk", asked questions such as "Professor, is my house going to collapse? What am I going to do?". The response given by another student showed that, despite the problem observed, the students possessed enough knowledge to attempt a solution: "Well, ask your mother or father to talk to a social worker or the Residents Association, speak to Civil Defence agencies and see how the problem can be solved, ask for help from the city government… I don't know, there's so much you can do, it's as if you haven't learned anything!".

According to Novak (1998), it is important to continuously evaluate the acquisition and retention of knowledge, always verifying that personal meaning is being assigned to that new knowledge. These evaluations should be conducted by the students themselves and assisted by the teacher. This way, the teacher's guidance is clearer and more in line with the obstacles observed.

Considering the recommended methodology for disaster education (item 2), one critique of this study is that it did not introduce the issue in an interdisciplinary manner across several subjects, since it was limited to the "Sciences" course. However, the effects of this shortcoming were minimised by approaching the issue more holistically and including a range of aspects, both physical and social, as well as various interactive activities. Another advantage of involving other disciplines in the study would be the possibility of reducing the workload committed to the issue by each discipline.

4 Conclusions

It was possible to integrate the issue of disasters associated with landslides into a discipline at an elementary school (6th year) for one semester, addressing the different technical and social aspects of the topic. There were a total of 16 h of theory classes and practical activities, which is equivalent to 10% of the course's total workload. Various pedagogical tools were successfully tested, including a survey, collective concept map, individual concept map, composition of a text, a review, field trip (visit to a community), construction of knowledge using a mock-up and presentation of knowledge (exhibition of mock-ups).

The theory of meaningful learning served as the basis of the methodology used. In accordance with recent recommendations for disaster education, the study promoted contextualisation of the issue, interactive and participatory learning, a connection between students and the real problem in the community affected by this type of disaster, critical thinking and an affective relationship with the issue.

The teacher training and risk perception survey taken in the region were important preliminary steps for the planning and implementation of the study.

The exhibition of the mock-ups gave the students the opportunity to explain their knowledge to others and to discuss the issue, playing the role of multiplier agents. The discussions initiated by the students, mainly during the final activities, showed that the study helped to empower the students on the issue.

Lastly, one problem with the study was that it was implemented in just one discipline, when an interdisciplinary approach would have been ideal. Despite this limitation, the

issue was approached holistically in order to involve a range of aspects, both physical and social, using various types of interactive activities.

The methodology adopted and the positive results presented in this study reinforce the idea that disaster education actions are clearly feasible and that they should be the focus of public policy, because these actions can change people's attitudes and enable them to effectively participate in managing the risk of disasters associated with landslides.

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