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Article

The Effects of Climate Change on Children's Education Attainment

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Abstract: It is proven that the consequences of climate change have grater impacts for the most vulnerable populations, and children are one of these social groups in risk of poverty and social exclusion. In this regard, education plays a pivotal role to guarantee the children's personal and professional development. In this context, there is a need for scientific research on how climate change impacts children's education attainment. This paper provides an analysis of the extent to which climate change influences education attainment among children and suggests some measures to address the problem. It reports on a literature review complemented by a set of case studies, with the purpose of exploring how child-centred responses to climate change can contribute to building the resilience of households and communities. Based on the findings from the study and bearing in mind the international literature on the topic, the paper outlines some possible areas of intervention in respect to climate literacy and climate education, which may be helpful in raising awareness among children about climate change and its many ramifications.

Keywords: climate change; effects; children; education; sustainability



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1. How Climate Change Affects Access to Education for Children

Climate change has caused many adverse outcomes around the globe. The phenomenon has resulted in an increase in adverse weather conditions, the spread of disease, resource depletion, and worsening existing inequalities [1–3]. More recently, climate change has caused an increase in the frequency and severity of climate-related disasters. This phenomenon is especially relevant in low-income and developing countries, where vulnerable households and excluded populations face severe challenges in guaranteeing access to education for their children. This had led to the destruction of property and infrastructure. In this regard, frequent climate-related events have been affecting the quality of education in many sectors of society. More specifically, as a consequence of such events, several educational institutions and schools have been destroyed, which prevents students from accessing education [4]. Furthermore, in low-income countries, it is often difficult to rebuild these places due to financial constraints or when schools are used as disaster shelters (dual function). These further delay access to education [5].

Therefore, climate change is another burden and challenge to completing children's primary education, especially in developing countries. For example, in addition to some challenges for low-income or vulnerable households due to the lack of income for paying

transportation or tuition fees, families may not be able to send their children to school during disaster or flood times. In this scenario, irregular attainment in primary education will create unequal children's development. In countries such as India, where children make up a large part of the population [6], many of them already face health-related issues such as faltered growth, impaired mental development, different types of diseases, and immediate death after birth. Already, 36 percent of children are stunted, and 19 percent show signs of undernutrition [7]. In addition, international studies estimate that 10.1 million children are engaged as labourers in India due to various family reasons, and begging children are a major issue in countries such as Bangladesh [8].

Climate change and migration can also have long-lasting consequences for children's present and future education, employment, and standards of living. For example, in 2021 there were several climate-related events such as lightning and thunderstorms (787); floods, heavy rain, and landslides (759); cyclone storms (172); and others (32) [9]. All these climate-related events highly impact the educational attainment of school children, particularly in the 5–14 years age group. Migrants, due to climate change, are not able to access housing and health care; children, specifically, lack access to quality education due to language barriers [10]. Frequent droughts and floods in India impact school attendance, especially at the primary level [11]. In addition, parental death has triggered severe psychological issues among the children [12,13].

Certain climatic conditions or climatic stressors can influence cognitive development and alter nutrition status [14], therefore resulting in the improper development of children, which may lead to an altered response to education in the early and later years of development [15]. In other instances, young girls are married off as a method to build climate resilience. Families believe that marriage will secure the future of females and enable them to be protected from some effects of climate change such as malnutrition and starvation. This prevents girls from enjoying a quality education, as they are expected to take care of their families rather than work [16].

The effects of climate change are seen in all types of households, including those that are typically considered educated [17]. In line with this, some studies indicate that exposure to higher temperatures during the prenatal stages of development is associated with lower schooling rates in Southeast Asia. Furthermore, previous research suggests that, in Africa, rainfall in the early stage of development is associated with varied amounts of schooling years. In other cases, extreme temperatures result in the spread of vector-borne diseases, while natural hazards promote waterborne diseases [1]. This adversely affects the health of children and their nutritional status. Furthermore, in extreme cases, disability or death may be encountered [18]. Such effects result in children being unable to attend school. Most of the agricultural laborers are not getting proper employment during drought, flood, and disaster periods; therefore, their children are unable to attend school regularly. There is a lack of resource mobilization post-disaster or flood in many developing countries.

On the other hand, the Internal Displacements Monitoring Centre [19] has estimated that 25.2 million children under 18 were internally displaced as a result of conflict, violence, and disasters in 104 countries and territories as of 31 December 2021. The displacement of children has an immediate effect on their education since it interrupts schooling. In addition, children are helping their families recover from extreme events; therefore, school dropout cases have increased due to climate change [20].

The COVID-19 pandemic has pushed millions of children away from classes in many developing countries. In particular, many poor and vulnerable households children were cut off due to little access to and poor quality of technology and internet, especially in rural areas. Further, students' average learning time was reduced from 7.4 h to 4.1 h. Therefore, the learning gap was experienced by many children [21]. In addition, school closures during the pandemic time increased inequalities between school children due to different socio-economic backgrounds [22]. Therefore, climate-related events have been an additional burden to millions of children around the world.

Even though there is an urgent need to develop adaptation strategies for children for a better life, there seems to be a shortage in the literature regarding how climate change impacts children's educational attainment. Against this background, this article aims to contribute to this debate by exploring to what extent climate change may have negative consequences on children's education and to identify successful initiatives employed to assist children in dealing with and adapting to climate change. To achieve this goal, a literature review was performed in combination with a detailed analysis of a set of selected case studies.

This article is structured into five sections. The following section explores the issue of climate change adaptation among children. This is followed by a detailed explanation of the methodology used to undertake this research. The subsequent section presents the results and discusses the main findings. Finally, the conclusions section provides an outlook of the topic and suggests some possible strategies that could be implemented in the future to help children enjoy proper education.

2. Climate Change Adaptation among Children

Climate change is continually affecting the global population, exacerbating existing problems such as poverty, inequality, and health complications, and is often associated directly or indirectly with deaths. The effects of climate change seen in children are more drastic due to their vulnerability and inability to protect themselves or engage in mitigation strategies. Studies indicate that climate changes directly affect the socio-physical environment of children. In this regard, adequate adaptation techniques need to be developed to ensure children are protected from the severity of climate change [23], which may even result in the loss of lives due to their increased vulnerability [23]. This results in adverse health outcomes, decreased safety, alerted access to education, disrupted play and recreation time, and, ultimately, decreased social development [24].

Against this background, UNICEF [25] has described the need for child-centred adaptation strategies due to their susceptibility to climate problems. This involves creating simple ways for children to be educated or equipped to deal with the effects faced. One such method is child-led awareness through social media. This involves using children to educate other children about the problems at hand. Aside from this, it is suggested that disaster risk management be included in the school curriculum to prepare children for disasters and the appropriate response. This will leave children wiser during a climate crisis and decrease fatalities. Furthermore, small-scale child-led programmes should be considered where children engage in tasks that improve the climate change situation. This can include the planting of trees or learning how to filter water for instances where droughts and disasters strike. Child-centred approaches have proved useful in the past. In Fiji, children were able to identify erosion through education in the mangrove regions. They further were able to identify a solution, i.e., mangrove planting, and conduct the tasks themselves, thus restoring the beachfront in their communities [26]. Aside from this, children in Ghana were able to assist communities by clearing drainage systems and building artificial levees using sandbags as a disaster risk management strategy [27]. In other instances, children can disseminate information and stimulate discussion on climate change among their age groups. This was observed in the Philippines where a radio show was developed that was headed by children. The show engaged children and further incorporated expert knowledge to educate others about adaptation and mitigation strategies [28].

For example, natural hazards are part of the Indian education curriculum after the 2004 tsunami in the Indian Ocean; therefore, children are understanding about the past negative impacts during their schooling period. In addition, the recent Indian National Education Policy (2020) also mentioned children and disaster response at their schools. Apart from this, children are actively participating in waste segregation in many parts of Indian cities, and the greatest number of children are willing to travel by public transportation daily to attend their school supported by the local government free of cost. This is a significant result in reducing overall carbon emissions. However, the Ministry of Environment and

Climate Change has encouraged school children to participate in drawing competitions to better understand climate change and its impacts on humans and nature [29]. In the Philippines, the Ministry of Education has introduced climate change education in the public school syllabus. Thailand has also developed a curriculum about disaster risk reduction information at the primary school level, aiming to review the children-centred initiatives for climate change adaptation, focusing on coping and adaptation to climate change [30].

3. Methods

As explained in the previous section, the increasing frequency and severity of climate-related events have been affecting the quality of education in manifold ways. Against this background, a research team performed a qualitative study to identify and review a set of key case studies, aiming to assess the extent to which climate change influences education attainment among children and to show examples of successful initiatives implemented to help children cope with and adapt to climate change. The main source for the identification and selection of the case studies was the Scopus scientific database. This was completed with a search of reports and case studies on Google.

This research had a twofold focus. First, a literature review was performed to identify research articles and examples of case studies regarding initiatives to support adaptation efforts among children to climate change. Second, with the purpose of exploring how child-centred responses to climate change can contribute to building the resilience of households and communities, a set of key case studies of climate change education projects and initiatives focused on schools were identified and analysed. The final set of articles and case studies was selected by the authors to show a representative picture of successful projects executed to support children coping with and adapting to climate change in different countries. These are presented in detail in the subsequent section.

For the case studies, a bibliographic search was carried out using the desk review technique to retrieve research or dissemination articles on institutional websites of governmental and non-governmental organizations and international agencies. The case studies were selected with mixed criteria. On the one hand, we used intentional criteria to have broad geographic coverage but with a focus on the Global South, although cases with global coverage were also recovered. On the other hand, we included documents (1) focused on schools, (2) showing a contribution to resilience in households or communities, and (3) cases involving children and/or adolescents.

4. Results and Discussion

Following this methodology, a set of 25 case studies have been identified and analysed to illustrate the issue. These key documents are summarized in Table 1.

Table 1. Selected articles and case studies regarding efforts to support adaptation among children to climate change.

Category	Country/Region	Aim	Reference
Health-related issues	Sri Lanka	To evaluate children's health and explain the coping initiatives to deal with water shortage at family and community level	[31]
	United States	To explore the consequences of low prioritization of funding and resources to promote environmental health in schools and absence of clear regulatory oversight	[32]
	South Africa	Analyse the effects that heat will have on the health, wellbeing, and academic performance of learners	[33]
	Several	To detect the data for the evaluation of the efficacy and viability of multi-sectoral climate adaptation for food security and malnutrition	[34]
	Several	A systematic review of literature regarding climate change adaptation measures to cope with childhood asthma.	[35]

Table 1. Cont.

Category	Country/Region	Aim	Reference
Needs and challenges	Several	Explore to what extent mainstreaming children's needs and capacities into wider adaptation initiatives can generate more sustainable results that can contribute to build long-term community-level adaptive ability	[36]
	India	To measure the effect of maternal and parental education and other risk factors on stunting and wasting in children from households living in repeatedly flooded areas	[37]
	Several	Assess challenges and supportive approaches for infant and young child feeding throughout natural disasters	[38]
Behaviour, attitudes, and action	Vietnam	Explore the usefulness of the theory of reasoned action (TRA) to influence children's climate change behaviour intentions	[39]
	Global	UNICEF's campaign on YouTube to show what climate change means to children from around the World	[40]
	Global	App for mobile phones to enhance individual action on climate change and sustainability	[41]
Strategies and campaigns	Bangladesh	To assess the usefulness of a school manual designed to increase the understanding of the school children regarding climate change and health adaptation	[42]
	China	Assess the efficacy of a school-based intervention against heatwave and climate change	[43]
	Slovakia	Local strategy of tree planting, construction and restoration of water features, and actions designed to modify behaviour throughout heatwaves in an area with housing prone to overheating and where a high proportion of children live	[44]
	Vanuatu and Australia	Support 282 communities through advancing access to knowledge; delivering technical help and equipment to support climate-resilient agriculture and fisheries; and increasing livelihood chances for rural and remote communities	[45]

As explained before, children are amongst the most vulnerable groups dealing with health-related risks generated by climate change, mainly because of their reduced ability to cope with its related illnesses or because of their limited capacity to thermoregulate [46]. This is because of their developing organ systems, psychological immaturity, or the nature of the activities in which they are involved on a daily basis [35]. In this context, preventive health care strategies by public professionals and supplementation programs prove to be useful to foster good nutritional status among infants and preschool children [31]. At the same time, natural hazard scenarios can potentially have negative consequences for both the physical and mental health of vulnerable populations, such as mothers and their young children, and inadequately planned disaster response can negatively affect infant and young child feeding practices. In this setting, measures such as guaranteeing privacy, enhancing community and family support, or the adjustment of expert breastfeeding support can facilitate breastfeeding practices, hence contributing to improving infant and young child nutrition. Additionally, strategies to guarantee access to quality formula baby milk are crucial to deal with the challenges created by increasingly frequent and intense natural disasters [38].

As already detailed in the previous section, global rising temperatures can disturb learning outcomes among children, as high classroom temperatures can distress the capacity of the students to learn and undertake academic tasks [33]. For this reason, school building infrastructure is becoming increasingly crucial to protect children from the effects of climate change [32]. In this context, increasing awareness about climate risks among vulnerable groups and encouraging them to adopt adaptive actions remains an important challenge for children [39]. In this regard, educational programs proved to be successful in helping both students and their families to improve their understanding and behaviour to better adjust to heat waves and climate change [43]. For example, a successful project was implemented

in Bangladesh to deal with this issue. It consisted in the use of a school manual to help high school students improve their knowledge regarding climate change, its effects, and health adaptation [42]. However, while most approaches to adaptation efforts are child-centred initiatives promoted by child-focused organizations, mainstreaming children's needs and capacities into wider adaptation strategies can help build more sustainable results, hence contributing to fostering a long-term adaptive capacity at the community level [36]. In line with this, education promotion and schooling among children, along with the educational level of their parents, can prevent child undernutrition in post-flood scenarios [37].

In this context, it is important to highlight the role which multi-dimensional local strategies can have to help vulnerable communities deal with the negative consequences of climate change [34]. For example, a 6-year strategy will be implemented in all 6 provinces in Vanuatu with the purpose of helping 282 communities and reaching more than 90,000 people (almost 50% of the country's rural population). This national strategy will focus on enhancing access to knowledge, delivering technical assistance and gear to support climate resilience in the agriculture and fishing sectors, and also seeking to increase livelihood opportunities for people living in rural and remote areas [45]. In Slovakia, a local assessment was carried out in a region with a high proportion of older people and children to assess the vulnerability to high temperatures and heat waves, and several adaptation strategies are currently being implemented based on the results of the study [44]. In addition to this, the United Nations and some of its branches are taking advantage of the potential of new technologies and social networks to promote more sustainable behaviour and consumption [41] and to help children from all around the world share their worries about the future, their expectations for a better world, and what they would expect from their leaders to act towards reversing climate change [40]. Consistent with the need to provide additional information, some case studies of climate change education projects and initiatives focused on schools were identified, which may contribute to building the resilience of households and communities and, as such, can be considered good practices to replicate in other countries or regions. These initiatives promote actions to improve climate change education in the least developed countries and Small Island Developing States, with particular emphasis on children and adolescents from local communities.

Schools, in their daily work with children, can contribute to adaptation to climate change within the framework of the SDGs but specifically with SDGs 4 "Quality education", 13 "Climate action", 14 "Life below water", 15 "Life on land", and 17 "Partnerships for the goals". The relationship between the education of children and adolescents and these SDGs has several meeting points in two ways. On the one hand, education is necessary to teach children and adolescents about the impacts of human actions on the environment. However, on the other hand, environmental change and events related to climate change impose significant barriers for children and adolescents to access quality education. To develop these issues, Table 2 presents a set of case studies of climate change education projects and initiatives focused on schools.

Table 2. Case studies of climate change education projects and initiatives focused on schools.

Action/Project	Setting	Aim	Reference
Bamboo bikes	Ghana	The aim is to promote an alternative, healthy, and non-polluting form of transport to respond to the growing needs for mobility in adolescents while addressing problems such as climate change, environmental degradation, and the high unemployment rate among young people in Ghana. The young participants received technical advice to plant and maintain bamboo.	[47]
Tree planting campaign	Ethiopia	UNICEF engaged 50,000 school children to plant 50,000 trees in the Addis Ababa region. Tree planting is both a mitigation and adaptation measure.	[48]

Table 2. Cont.

Action/Project	Setting	Aim	Reference
Production of Biodiesel	Barbados	A secondary school in Barbados with 1100 students launched a project to raise awareness among adolescents about using biodiesel as an environmentally friendly alternative fuel for diesel vehicles.	[49]
Protection of Tropical Forests	Guyana	The aim was to ensure the continued protection of forests as a means of mitigating climate change. Thus, an educational project was designed to engage children so that they feel ‘custodians of the tropical forest region’.	[50]
Green, Cyclone-Resistant Schools	Madagascar	New classrooms, built with support from the UNICEF, mean that the students can study while being sheltered from the rain and sun.	[51]
Sandwatch	Global	“Sandwatch” is an educational process through which school students, teachers, and local communities work together in the field to monitor their coastal environments; identify and evaluate the threats, problems, and conflicts facing them; and develop sustainable approaches to address them.	[52]
Earth Child Institute	Brazil, Cameroon, Ghana, Uganda	More than 300 children engage with others from all continents and time zones on environmental issues in their country through the Earth Child Institute’s Global Classroom for Action program, coordinated in collaboration with the New York University Environmental Conservation Education Program.	[53]
Campaign on food security and climate change	Global	Youth and United Nations Global Alliance (YUNGA, under the auspices of FAO) launched the Food Security and Climate Change Badge in 2010, designed to raise public awareness of climate change, motivate children and youth, especially girls, to carry out adaptation and mitigation activities, and introduce better food security strategies.	[54]
Unite4Climate	Zambia	This program has trained over 1600 children and youth as climate ambassadors in Zambia. The students are also trained on conservation issues such as deforestation and waste. The ambassadors gain not only an awareness of climate change but also skills in leadership and communication to be lifelong leaders for change.	[55]
Girl-led action on climate change	Global	Through the curriculum, girls and young women learn about how to adapt to and mitigate climate change through practical interactive activities. They also learn about its gender dimension and apply what they have learnt to their own lives and their families’ lives, contributing to greater community resilience to climate change.	[56]

Goal number four of the Sustainable Development Goals is to ensure inclusive, equitable, and quality education and promote lifelong learning opportunities for all. On the other hand, objective number 13 of the SDGs consists of adopting urgent measures to combat climate change and its effects, while objectives 14 and 15 advocate the protection of life underwater and on land. For its part, objective 17 outlines the possible alliances that schools can make with the community and with NGOs and governments to include children and adolescents in climate action and in the protection of life underwater and on land. Furthermore, what is being proposed here is that all schools, to a greater or lesser extent, can take part in climate action involving children and adolescents. This is going to have a multiplier impact on homes and communities. Within the context of school

education, climate literacy interventions can be considered with younger children, while climate education interventions can be considered with adolescents.

To sum up, efforts to support adaptation among children to climate change have focused on four core areas: first, on guaranteeing and improving children's health, either by designing and implementing strategies to enhance feeding or by protecting infants and children against allergies and illnesses that affect them more than other groups in society; second, on enhancing education and training, both for children and their parents, as regards to climate change and its effects; third, on the analysis of the effects and potential of funding and/or local and community initiatives to protect children and infants from the negative consequences of climate change; finally, on the usefulness of new technology and social media to raise awareness and spread the voice regarding the challenges generated by climate change and the effects that it may have on children and the youth.

5. Conclusions and Outlook

Since children spend most of their time in schools, initiatives that improve children's education about climate change are assumed to be the most valuable. Advances in psychology, pedagogy, neuroscience, ecology, and sociology research have provided solid foundations that indicate that from the first years of life, a window of opportunity opens for learning about children's relationship with the environment [40]. Thus, quality and relevant educational interventions established with young children will help them be the promoters of adaptation in their own families and communities. The systematic introduction of education on climate change is included in SDG 13 'Climate action', specifically in the goal that refers to 'Improve education, awareness and human and institutional capacity regarding climate change mitigation, adaptation to it, the reduction of its effects and early warning'.

For this purpose, the United Nations Framework Convention on Climate Change (UNFCCC) provides support for child-focused actions to respond to climate change. In its article 6, the UNFCCC addresses the issue of climate change concerning education, training, and public awareness. It constitutes the primary vector of the Convention to Promote Development Activities and Implement Education and Training Programs on Climate Change for Children [57]. In this sense, children-centred responses focused on three axes: educational (school) interventions to improve literacy in disasters, capacity-building actions, and strategies to improve the quality of data on the impact of climate change on children.

Based on the experiences gathered in this paper, some conclusions can be drawn. First, it is necessary to raise some conceptual differences between literacy, education, and capacity building. Literacy refers to the ability to read and write. Since the ability to read and write is not innate, literacy usually takes place within a framework of formal education [58]. Secondly, in the field of climate change literacy, the main goal is for people to have a basic understanding of climate systems, including how natural and human factors can affect them [59]. On the other hand, education is about the holistic development of a person, turning them into complete human beings who can not only read or write but also think in broader terms and analyse things rationally. Climate change education is crucial to promoting climate action. It helps people understand and address the impacts of the climate crisis, giving them the knowledge, skills, values, and attitudes necessary to act as agents of change. It is about learning to act [60]. Additionally, more child-centred approaches to climate change are needed and may entail some measures such as environmentally conscious behaviour and lifestyle changes, supporting children to participate in activities that promote the protection of ecosystems and biodiversity, fostering a sense of responsibility and stewardship in children to care for the environment, and encouraging children to engage in creative activities that raise awareness of climate change and its solutions.

Finally, capacity building is defined as the process of developing and strengthening the abilities, instincts, skills, processes, and resources that organizations and communities

need to survive, adapt, and thrive in a rapidly changing world. What is most essential in capacity building is the transformation that is generated and sustained over time from within; transformation of this kind goes beyond performing tasks to change mindsets and attitudes. In the field of climate change, SDG 17, 'Revitalize the Global Partnership for Sustainable Development', seeks a transformation from within, with goals for capacity building, including the increase in technology and innovation in the least developed countries and the improved data collection and monitoring for the achievement of the SDGs. Here, universities, in particular, are considered capacity-building centres through research, innovation, and data collection and analysis [44].

Based on the findings from the study, and bearing in mind the international literature on the topic, some possible areas of intervention are:

5.1. Climate Literacy Interventions

In elementary schools, from the age of 6, teachers can implement one or two special projects per year [61,62]. The development of printed and multimedia materials specially adapted for these ages is also important [63]. The contents can be included in the areas of natural sciences, social sciences, arts, and physical activity, among others. The aims of climate literacy in elementary schools should be the following [64]:

- * Understand the essential principles of Earth's climate system,
- * Know how to assess scientifically credible information about climate,
- * Communicate about climate and climate change in a meaningful way, and
- * Make informed and responsible decisions regarding actions that may affect climate.

5.2. Climate Education Interventions

Evidence estimates that the formal inclusion of climate change education in schools would significantly reduce CO₂ emissions by the year 2050 [65,66]. Thus, formal education helps students develop vital empowerment, which impacts day-to-day actions to reduce their carbon footprint.

Scientific education in secondary schools can go a long way in raising students' awareness and improving their skills to adapt to climate change. Good scientific performance and awareness of global environmental issues often go hand in hand; conversely, poor scientific performance is associated with less awareness of environmental issues. Whole-school approaches for sustainable development promote active and participatory learning, engaging students, educators and administrators, and communities to participate in efforts to achieve sustainable communities. For this, the formal incorporation of these contents in school curricula is necessary. Simply introducing new content about the science, the causes, and the consequences of climate change is not enough. Hence, UNESCO has formulated recommendations and guidelines for decision-makers to adapt and reorient education systems [67].

On the other hand, UNICEF has estimated that around 1 billion children (nearly half of the world's total of 2.2 billion) live in one of 33 countries at very high risk due to their exposure to multiple climate hazards [68]. When a weather hazard impacts a community, educational services are often interrupted, and educational facilities are used as shelters. For this reason, some international organizations have issued a set of recommendations and practical guides, which constitute minimum standards for the protection of children in humanitarian action, among which are the assurance of the continuity of educational services for children [69].

This paper has some limitations. The first one is the fact that the review of the literature primarily focused on papers looking at the broad connections between children and the environment, not including young adults. Additionally, the case studies are rather broad and do not solely focus on rich or developing countries. Despite these limitations, this paper provides a welcome addition to the literature in the sense that it explores the connections between children and climate change, describes some of their features, and outlines some areas where the action is needed. Future studies may focus on the perceptions of young

adults on climate change and on various approaches and methods which may be deployed to foster their engagement in respect of climate action.

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