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CLIMATE CHANGE IMPACTS AND ROLE OF EDUCATION IN ENHANCING EFFECTIVE AWARENESS IN PAKISTAN

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ABSTRACT

Climate change is a critical challenge for Pakistan, marked by rising temperatures, glacial melting, drought, floods, cyclones, shifting weather patterns, and more frequent natural disasters. These impacts threaten the country's agriculture, water resources, public health, and socio-economic stability, with marginalized communities bearing the brunt of these effects due to limited adaptive capacity. Despite the growing urgency, public awareness and understanding of climate change remain inadequate, hindering effective responses and sustainable practices at individual and community levels. This research explores the role of education in enhancing climate change awareness in Pakistan, emphasizing its potential to equip individuals with the knowledge and skills necessary to address these challenges. By examining the current state of climate education in both formal and informal settings, the study identifies critical gaps and barriers to effective implementation. It also highlights the transformative role of educational programs in empowering communities to adopt sustainable practices, advocate for policy changes, and build climate resilience. The findings underscore the need for a holistic approach to climate education, integrating interdisciplinary and culturally relevant content tailored to Pakistan's unique socio-economic and environmental contexts. By fostering greater awareness and engagement through education, this study advocates for a more informed and proactive society capable of mitigating climate impacts and ensuring a sustainable future.

Keywords: *climate change, climate awareness, sustainable future, rising temperatures, climate resilience.*

INTRODUCTION

Climate change is one of the most pressing challenges of our time, and its impacts are increasingly visible in Pakistan (Buriro, Abro & Abro, 2024). From rising temperatures and glacial melting to more frequent and intense floods and droughts, the country is grappling with severe consequences that threaten its agriculture, water resources, and public health (Feinstein & Mach, 2020). These climate-related disruptions not only undermine economic stability but also deepen social inequalities, leaving vulnerable communities with limited capacity to adapt. Addressing these multifaceted challenges requires not just policy interventions but also a transformation in public understanding and behavior (Verschuur, Koks & Hall, 2023).

Education plays a critical role in fostering awareness and equipping individuals with the knowledge and skills necessary to respond effectively to climate change (Buriro, Abro, & Abro, 2024). In Pakistan, however, public awareness about climate change remains low, particularly in rural areas and marginalized communities (Shahid & Piracha, 2010). Despite the urgency of the issue, educational curricula and outreach initiatives have not adequately addressed the complexity of climate

change and its interconnected impacts (McCowan, 2021). This gap underscores the need for targeted educational efforts that can enhance public understanding, promote sustainable practices, and build resilience against climate-related threats.

This study examines the role of education in enhancing effective awareness about climate change in Pakistan. By analyzing the relationship between education and climate awareness, the research highlights the potential of educational programs to empower communities, particularly youth, as agents of change. It also emphasizes the need for interdisciplinary and culturally relevant approaches to climate education, tailored to the unique socio-economic and environmental contexts of Pakistan. Through education, the pathway to informed decision-making and collective action can be strengthened, paving the way for a more resilient and sustainable future.

Statement of the Problem

Climate change poses a significant threat to Pakistan, a country already grappling with environmental vulnerabilities, socio-economic challenges, and limited adaptive capacity. The impacts of rising temperatures, erratic weather patterns, and frequent extreme climate events such as floods, droughts, and heatwaves have led to severe consequences for agriculture, water security, public health, and livelihoods. Despite the increasing urgency to address these challenges, public awareness and preparedness remain insufficient, hindering effective mitigation and adaptation efforts.

Education plays a crucial role in raising awareness about climate change and equipping individuals and communities with the knowledge and skills to respond effectively. However, in Pakistan, climate change education has not been fully integrated into the formal educational system, and efforts to promote informal learning are fragmented and underfunded. The lack of a context-specific and inclusive approach to climate education limits its impact, particularly in rural and marginalized communities, where the effects of climate change are most acutely felt.

This research seeks to explore the dual challenges of climate change impacts and the role of education in enhancing awareness in Pakistan. By addressing the gaps in educational strategies and identifying the barriers to effective climate literacy, the study aims to propose actionable recommendations for developing a more informed, resilient, and proactive society.

Research Questions

- How do individuals and communities in Pakistan perceive the impacts of climate change on their daily lives and local environments?
- What are the experiences and challenges faced by educators and community leaders in promoting climate change awareness in Pakistan?
- How can culturally and contextually relevant educational approaches be designed to enhance climate literacy and proactive engagement among diverse communities in Pakistan**?**

Literature Review

Agricultural development in less-developed countries faces significant challenges due to the anticipated impacts of climate change and increasing climatic risks in the 21st century (IPCC, 2014). Climate change is a major driver of agricultural insecurity, as it disrupts key crops and the broader food supply chain, resulting in severe consequences for farm productivity (Ali et al., 2021; Ahmed & Afzal, 2020). It imposes ongoing stress on both natural and human resources, posing threats to the social, economic, and ecological sustainability of already scarce resources in developing nations (Bokhari et al., 2018). Additionally, the rising levels of greenhouse gases (GHGs) such as carbon dioxide (CO2) and methane (CH4) in the atmosphere are projected to increase global temperatures by 2.5 to 4.5 degrees Celsius by the end of the century, further exacerbating these challenges (Porter et al., 2014; Wang et al., 2018).

The growing impacts of climate change have been widely documented, highlighting significant challenges for developing countries like Pakistan (Buriro, Abro, & Abro, 2024). Pakistan is among the countries most vulnerable to climate change due to its geographical location, reliance on agriculture, and socio-economic constraints (Fahad & Wang, 2020; Sheikh et al., 2019). Researchers emphasize the importance of public awareness and proactive measures in mitigating climate change impacts

(Darjee, Neupane & Köhl, 2023). The awareness remains alarmingly low, particularly in rural areas, necessitating targeted interventions through education and outreach programs (Buriro, Abro & Abro, 2024; Imran Shrestha & Datta, 2020).

The role of education in addressing climate change has gained considerable attention in global and regional studies (Kang et al., 2020). The education can be a transformative tool in building individual and community resilience to climate-related challenges (Buriro et al., 2023). Climate education provides well-structured educational programs and can enhance understanding, foster sustainable practices, and encourage active participation in climate-related decision-making (Zittis et al., 2022).

Higher education institutions in Pakistan also play a critical role in advancing climate education and research (Hinduja et al., 2023). Universities and research centers have contributed valuable insights into Pakistan's specific vulnerabilities and adaptive strategies (Buriro et al., 2023). There is a disconnect between academic research and policy implementation (Buriro et al., 2023). Policymakers often lack access to or fail to utilize this knowledge, leading to gaps in evidence-based decision-making (Fatima, Ashraf & Zehra, 2020; Thapa & Hussain, 2021). Collaboration between academia, government, and civil society is essential to bridge this divide (Tama et al., 2023). Fostering public engagement through seminars, conferences, and citizen science projects can help translate academic knowledge into actionable community initiatives (Bukhari et al., 2024).

The integration of climate change education in the country's school curriculum revealed significant gaps in content and teaching approaches, with limited emphasis on local climate issues and their socio-economic impacts (Van Ginkel et al., 2020). There is need of interdisciplinary and context-specific approach to climate education, involving policymakers, educators, and community stakeholders (Schipper, Dubash & Mulugetta, 2021). This approach can bridge the gap between knowledge and action, fostering a culture of awareness and responsibility (Stoliarchuk et al., 2023).

Community-based education and participatory approaches have proven effective in enhancing climate change awareness (Buriro et al., 2024; Usman et al., 2023). The success of grassroots initiatives in rural Pakistan, where local communities were engaged in educational workshops and awareness campaigns (Rasool et al., 2024). These efforts not only improved knowledge but also empowered communities to adopt adaptive strategies and advocate for policy changes. The climate change study underscores the importance of culturally relevant and accessible education programs that resonate with local populations and address their specific vulnerabilities (Buriro et al., 2024).

The critical role of education in addressing climate change impacts in Pakistan highlight the need for a multi-faceted approach that combines formal education, community engagement, and policy support to enhance awareness and build resilience in the face of growing climate challenges (Dushkova & Ivlieva, 2024).

Methods and Procedure

This study employs a qualitative research design to explore the impacts of climate change and the role of education in enhancing awareness in Pakistan. Thematic analysis is used as the primary method to identify, analyze, and interpret patterns (themes) within the data. This approach allows for an in-depth understanding of the perceptions, experiences, and suggestions of various stakeholders regarding climate change and educational interventions in Pakistan.

The study focused on representatives from agricultural areas of Pakistan, employing a heterogeneous sample to ensure a comprehensive analysis. To collect primary data, the Multistage Random Sampling (MSRS) technique was adopted. Participants aged 35 to 50 years, actively engaged in agriculture-related activities such as farming and agribusiness, were selected across the provinces of Sindh, Balochistan, Punjab, and Khyber Pakhtunkhwa during the initial stage.

In the second stage, two primary cropping systems—the rice-wheat cropping system (RWCS) and the cotton-wheat cropping system (CWCS)—were purposefully chosen for their critical roles in ensuring food security and contributing to Pakistan's economy. The third stage involved selecting specific districts within the RWCS and CWCS regions.

Finally, 20 farmers from each selected district, involved in crop production and livestock rearing, were randomly chosen for interviews. This systematic approach ensured that the study captured diverse perspectives and provided a robust dataset for analyzing the impacts of climate change on agriculture and related livelihoods.

Data Collection Procedure

Data for this research were collected through semi-structured interviews and focus group discussions. The participants included educators, environmental experts, policymakers, students, and members of local communities from both urban and rural areas in Pakistan. Purposive sampling was employed to ensure the inclusion of diverse perspectives, particularly those from regions most affected by climate change. A total of 30 participants were interviewed individually, and 5 focus group discussions were conducted, each consisting of 6–8 participants.

The interview and discussion guides were designed to explore participants' knowledge of climate change, their awareness of its impacts, and their opinions on the role of education in addressing the issue. Open-ended questions allowed participants to share their insights freely, fostering a comprehensive understanding of the subject.

Data Analysis Procedure

The data collected were transcribed verbatim and analyzed using thematic analysis. The analysis followed Braun and Clarke's six-step framework:

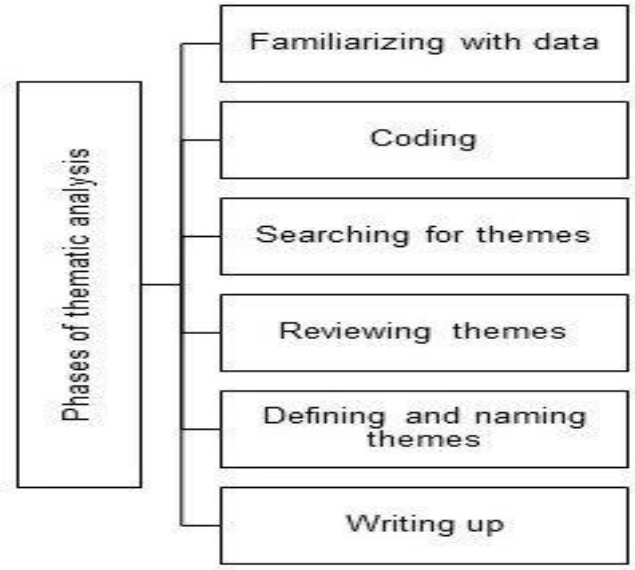

Fig 1. Brown and Clark (2006) Method of Thematic Analysis

Familiarization: Transcripts were read multiple times to gain an overall understanding of the content.

Coding: Key ideas and recurring concepts were identified and coded systematically across the dataset.

Searching for Themes: Codes were grouped to identify overarching themes that addressed the research objectives.

Reviewing Themes: Themes were reviewed to ensure they accurately represented the data and were coherent and distinct.

Defining and Naming Themes: Themes were clearly defined, and descriptive labels were assigned to represent their core essence.

Writing Up: The findings were organized into a narrative, illustrating the themes with relevant excerpts from the data.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review board. Participants were informed about the purpose of the study, and their consent was obtained before participation. Confidentiality and anonymity were maintained throughout the research process to ensure participants' privacy.

This thematic approach provides a nuanced understanding of the intersection between climate change impacts and education in Pakistan, offering actionable insights for improving climate change education and awareness in the country.

Results

Keeping in view of the nature of the study, semi structured interviews were conducted with the participants for the study. The results of the study show interesting findings and are important for the study.

Environmental Impacts

Climate change has significantly disrupted Pakistan's natural environment, manifesting through rising temperatures, glacial melting, and shifting precipitation patterns. The country is home to over 7,200 glaciers, and accelerated glacial melting in the northern regions has led to an increased frequency of glacial lake outburst floods (GLOFs), threatening downstream communities and ecosystems. Erratic rainfall and prolonged droughts have resulted in water scarcity, severely affecting agricultural productivity in arid and semi-arid regions. Biodiversity is also at risk, with ecosystems like mangroves and wetlands facing degradation due to rising sea levels and changing climatic conditions. These environmental changes not only threaten the natural landscape but also amplify the challenges of managing natural resources sustainably.

R1: Climate change in Pakistan has led to significant environmental issues, such as rising temperatures, erratic rainfall, and glacial melting. One of the most severe consequences is the increased frequency of natural disasters, such as floods and droughts, which are devastating for vulnerable communities. For instance, floods displace thousands of families every year, destroying homes, crops, and infrastructure. On the other hand, prolonged droughts in arid regions like Balochistan deplete water resources, making it difficult for people to sustain agriculture or even access clean drinking water. Vulnerable communities, especially in rural areas, lack the resources to recover from these events, leaving them trapped in cycles of poverty and displacement.

R3: As a farmer in Punjab, we are directly affected by changing weather patterns. The biggest challenge is the unpredictability of rain; sometimes, we get heavy rains that flood our fields, and other times, there is no rain when we need it most. This uncertainty has reduced crop yields and even led to complete crop failures in some years. For vulnerable communities like ours, these changes mean losing our primary source of income. Additionally, the extreme weather also affects our health, with more cases of heatstroke and waterborne diseases after floods. Climate change has made life much harder for us, and we feel helpless in dealing with its impacts.

Social and Economic Impacts

The social and economic repercussions of climate change in Pakistan are profound, disproportionately affecting vulnerable communities. Displacement due to floods and droughts have led to a rise in climate refugees, particularly in rural areas, where livelihoods depend heavily on agriculture. The economic burden of climate-related disasters is immense; damages from floods alone are estimated to cost billions of dollars annually, straining an already fragile economy. Moreover, food insecurity is escalating as extreme weather events disrupt crop cycles, while water scarcity exacerbates conflicts over access to this vital resource. On a social level, these challenges deepen inequalities, leaving marginalized groups such as women, children, and the poor with limited resources to adapt. The intersection of environmental, social, and economic impacts underscores the need for integrated strategies to build resilience and address these interconnected challenges.

R4: Climate change has profound social and economic consequences in Pakistan. Economically, sectors like agriculture and fisheries, which many vulnerable communities depend on, are heavily impacted by extreme weather events.

Furthermore another respondent has expressed that

R7: Droughts and floods destroy crops, leading to food shortages and increased poverty. This loss of

livelihood forces many families to migrate to urban areas in search of work, creating social challenges such as overcrowding and inadequate housing in cities. Socially, the displacement caused by climate-related disasters often breaks down community structures and disrupts education and healthcare services. Vulnerable groups, including women and children, bear the brunt of these impacts, as they have fewer resources and limited access to support systems.

R11: Socially, floods and droughts displace thousands of people every year, disrupting their lives and creating long-term instability. Families are often separated, and children lose access to education, which hampers their future opportunities. Economically, these communities face immense challenges in rebuilding their lives. Farmers lose their crops and livestock, while laborers find it harder to secure jobs in disaster-affected areas. The lack of economic stability exacerbates poverty, leaving families with little to invest in rebuilding or adapting to future risks. Without targeted support, these communities remain trapped in a cycle of vulnerability.

Climate change Affects Vulnerable Communities in Pakistan

Climate change disproportionately affects vulnerable communities in Pakistan, amplifying existing social and economic inequalities. Rural populations, particularly those reliant on agriculture and livestock, face devastating losses due to erratic rainfall, prolonged droughts, and floods that destroy crops and deplete water resources. These challenges are compounded for marginalized groups such as women, children, and low-income households, who often have limited access to resources, education, and adaptive technologies. Coastal communities are at risk from rising sea levels and saline intrusion, which threaten their homes and livelihoods. Additionally, the displacement caused by extreme weather events often forces these communities into overcrowded urban areas, where they struggle with inadequate infrastructure and limited employment opportunities. The cascading effects of climate change on these populations highlight the urgent need for targeted interventions to build resilience and ensure equitable adaptation strategies.

R13: Climate change is altering Pakistan's environment significantly. Rising temperatures are accelerating glacial melting, leading to frequent glacial lake outburst floods in northern regions. In addition, erratic rainfall patterns result in devastating floods during monsoons and prolonged droughts in other seasons. Vulnerable communities, especially those in rural areas, are directly impacted as they lose their homes, farmlands, and livelihoods. The lack of resources to adapt to these changes forces many to migrate, often to urban slums, where they face new challenges like overcrowding and limited access to basic services.

R15: In Sindh, we have seen more frequent floods that destroy our crops and make it impossible to farm. At other times, droughts last for months, leaving us without water for irrigation. These climate changes directly impact farmers like us who depend on agriculture for survival. Vulnerable communities, including small-scale farmers, are the hardest hit because we have no savings or alternative sources of income. After a flood or drought, it takes years to recover, and some people are never able to return to farming.

R18: Climate change in Balochistan is mostly visible through droughts and water scarcity. These changes have made it difficult for families to sustain their livelihoods, especially those who rely on farming or livestock. Children are affected as well because when families lose income, education becomes a lower priority, and many students drop out of school. Vulnerable communities here face a constant struggle to access clean drinking water and food, which not only affects their physical health but also their ability to adapt to the changing climate. The lack of government support makes these challenges even worse.

Formal Educational Initiatives

In Pakistan, formal education systems have begun to incorporate climate change topics into school and university curricula, but these efforts remain limited and inconsistent. Environmental studies have been introduced as part of science curricula in some schools, while universities offer specialized programs in environmental science and climate change studies. However, these initiatives often lack depth and fail to connect theoretical knowledge with practical applications, particularly in addressing

local climate challenges. Teacher training programs on climate change are also insufficient, leaving educators ill-equipped to convey the complexity and urgency of the issue. Moreover, the reach of formal education is constrained in rural and marginalized areas, where access to quality education remains a significant barrier.

R20: Formal education in Pakistan has made some progress in introducing climate change topics into the curriculum, particularly at the university level. However, these efforts are still in their infancy. While environmental science programs offer specialized courses, they often lack practical applications that connect students with real-world climate issues in Pakistan. At the school level, awareness is limited, as climate change is either not addressed comprehensively or included as a small part of general science courses. Moreover, teacher training on this topic is insufficient, resulting in a lack of depth in classroom discussions. To truly raise awareness, there needs to be a more focused and integrated approach across all educational levels.

R15: In high schools, climate change is only briefly covered in science textbooks, which isn't enough to create meaningful awareness. Many students don't fully understand how climate change affects their lives or communities. Teachers like me try to explain the importance of this topic, but we don't always have the resources or training to make lessons engaging or relevant. Most students see it as a distant issue, rather than something they need to act on. Formal education could be much more effective if it included practical examples, fieldwork, and discussions on local climate challenges.

R13: Formal education initiatives have potential, but their effectiveness is currently limited. The primary issue is the lack of a cohesive national strategy to integrate climate change education into school and college curricula. While some institutions have taken steps to include environmental topics, the content often lacks depth and fails to reflect the unique climate challenges of Pakistan. Furthermore, rural schools, where climate awareness is most needed, are often left out of these initiatives due to resource constraints. Until the government prioritizes climate education with a tailored and inclusive approach, the impact of formal education on raising awareness will remain inadequate.

Informal Educational Initiatives

Informal educational efforts in Pakistan, such as community awareness campaigns and workshops organized by non-governmental organizations (NGOs) and environmental advocacy groups, play a critical role in raising climate change awareness. These initiatives often focus on grassroots engagement, targeting communities most affected by climate change through culturally relevant and accessible formats. Programs such as training sessions on sustainable farming practices, water conservation, and disaster preparedness have proven effective in building resilience at the local level. Media platforms, including television, radio, and social media, are also utilized to disseminate information on climate change, although their outreach varies across demographics. While these informal initiatives contribute significantly to public awareness, their scope and sustainability are often limited by funding constraints and lack of coordination with formal education systems.

R8: Informal educational initiatives, such as workshops, community training, and media campaigns, have proven to be quite effective in raising awareness, especially in rural and marginalized areas. These programs are more accessible and often tailor the message to the specific challenges that communities face, like water scarcity or agricultural loss due to changing weather patterns. For example, in Balochistan, we have conducted training on water conservation techniques, which has had a positive impact on local farmers. However, these initiatives often face challenges with limited funding and reach, meaning that while they are impactful, their influence is restricted to certain regions or groups.

R7: Informal education plays a crucial role in raising climate change awareness, especially among communities who may not have access to formal education. NGOs and local organizations often run awareness campaigns, using tools like radio programs, social media, and street plays to engage with the public. These initiatives are effective in breaking down complex climate change concepts into simpler messages that resonate with people's everyday lives. For instance, we've seen success in

educating women and farmers in Sindh on sustainable agricultural practices. The challenge is that these programs are typically short-term and lack long-term sustainability.

R9: In rural areas, informal educational initiatives have been vital in spreading awareness about climate change. Community gatherings, local seminars, and field demonstrations have proven to be effective, as they provide hands-on knowledge. For example, one NGO helped us understand how changing rainfall patterns affect our crops, and how we can adapt by planting drought-resistant varieties. These initiatives are much more accessible than formal education, especially for those who can't afford to attend schools or universities. However, the main issue is the inconsistent reach and the need for continuous engagement to ensure long-lasting impact.

Context-Specific Curriculum Development

Improving climate change education in Pakistan requires developing curricula tailored to the country's unique environmental and socio-economic challenges. Educational programs should emphasize local climate impacts, such as glacial melting in the north, floods in the plains, and droughts in arid regions, making the content relatable and actionable for learners. Collaborating with climate scientists, educators, and policymakers can ensure the inclusion of accurate and practical knowledge in school and university syllabi. Additionally, introducing hands-on learning opportunities, such as field trips to affected areas and community-based projects, can enhance students' understanding of climate change while equipping them with problem-solving skills. Integrating traditional ecological knowledge, especially from indigenous and rural communities, can further enrich the curriculum, ensuring it reflects Pakistan's diverse cultural and environmental contexts.

R14: Absolutely. Context-specific curriculum development is crucial because it tailors the learning experience to the unique cultural, economic, and social needs of a community. A one-size-fits-all approach often overlooks local challenges and resources. For instance, in rural areas, incorporating agricultural practices into science lessons can make the curriculum more relatable and practical for students.

R5: One major challenge is the lack of resources. Customizing a curriculum requires thorough research and stakeholder involvement, which can be resource-intensive. Another issue is resistance to change, especially from educators who are accustomed to standardized curricula. Training and capacity-building are critical to overcoming this.

R9: I see it as a game-changer. When the curriculum reflects the students' environment and experiences, they engage more actively. For example, in our region, we've integrated lessons about local industries like textile manufacturing into business studies. It helps students see real-world applications of what they're learning.

R5: One issue is the lack of standardized materials. I often have to create my own resources, which is time-consuming. Another challenge is aligning these context-specific lessons with national exams, which tend to focus on standardized content.

R4: Access to localized teaching resources and professional development programs would be immensely helpful. Also, flexibility in assessment methods would allow us to evaluate students based on both national standards and local context.

R2: It can bridge the gap between education and our daily lives. For example, if schools teach children about sustainable farming practices relevant to our region, they can bring that knowledge back home and improve agricultural productivity. It also fosters a sense of cultural pride and identity.

R2: The community should have a voice in identifying what's important for our children to learn. Parents, local leaders, and even small business owners can contribute insights about skills and knowledge that are most valuable locally. This ensures the curriculum aligns with real-life needs.

R6: One barrier is the gap between educators and the community. Sometimes, we feel our input isn't taken seriously. There should be structured platforms for ongoing dialogue and collaboration between schools and the community.

Strengthening Informal Education and Community Engagement

Complementing formal education with robust informal initiatives is vital to foster widespread awareness and action. Strategies should include

community-based workshops, led by local leaders and NGOs, to educate vulnerable populations on sustainable practices such as water conservation, disaster preparedness, and renewable energy adoption. Media campaigns, utilizing television, radio, and social media, can amplify climate messages, tailored to resonate with different demographics and linguistic groups. Youth engagement is crucial; programs that empower students to act as climate ambassadors in their communities can drive grassroots change. To ensure these efforts are sustainable, partnerships between government bodies, educational institutions, and non-governmental organizations are essential. Such collaborations can provide resources, expertise, and outreach capabilities to embed climate resilience deeply across all sectors of society.

R8: One key strategy would be to integrate climate change education into the core curriculum at all educational levels, from schools to universities. The content must be context-specific, focusing on Pakistan's unique environmental challenges, such as water scarcity, flooding, and agricultural disruptions. Additionally, curricula should include practical solutions for local issues, like water conservation techniques, sustainable farming practices, and disaster preparedness. Involving local communities in the development of these educational materials can ensure cultural relevance, while partnerships with NGOs and government agencies can help provide real-world examples and foster resilience in vulnerable areas.

R13: To improve climate change education, we need to tailor lessons to the local context. For instance, in rural areas like Punjab, lessons should emphasize agriculture-focused solutions, such as climate-resilient crops, organic farming, and water-saving irrigation methods. Teachers also need training on how to deliver climate change lessons effectively and with cultural sensitivity. Involving local leaders and using storytelling techniques can make the subject matter more engaging. Hands-on activities, like field visits and local climate action projects, will further enhance the learning experience by showing students how they can directly contribute to sustainability in their communities.

R14: A crucial strategy would be to focus on community-based education programs that address the needs of vulnerable groups. In regions prone to floods or droughts, education should not just raise awareness but also equip people with the knowledge to adapt to changing conditions. Training programs that teach sustainable farming, renewable energy solutions, and efficient water management practices can be designed in collaboration with local experts and community leaders to ensure that the content is culturally appropriate. In addition, integrating technology like mobile apps and online platforms can help spread knowledge to remote areas and engage youth in climate action initiatives.

R16: To make climate change education more effective in Pakistan, we should adopt an interdisciplinary approach that links climate science with other subjects like economics, sociology, and engineering. This would help students understand both the environmental and socio-economic dimensions of climate change. Courses should also incorporate indigenous knowledge and practices that have long been used by rural communities to cope with environmental changes. In addition, teacher training programs should be implemented nationwide to ensure that educators have the tools and knowledge to teach climate change in a way that is engaging and locally relevant.

R20: Education in rural communities must involve local experiences and practical solutions. Climate change education should focus on issues like water management, soil conservation, and local crop variations that are more resistant to changing weather patterns. It's essential to work with community elders and respected leaders to design the education programs so they align with cultural values. This could include integrating traditional practices, like rainwater harvesting or eco-friendly construction techniques, into the curriculum. Additionally, local media campaigns and community outreach programs can complement formal education and help spread important climate change messages to even the most remote areas.

Discussion

Climate change is increasingly recognized as a major threat to Pakistan, with its impacts being felt across environmental, social, and economic sectors. The country has already experienced severe consequences, including rising temperatures, glacial melt, erratic rainfall, and more frequent floods and

droughts. These environmental disruptions have led to widespread damage to agriculture, water resources, and infrastructure, with rural and marginalized communities bearing the brunt of the crisis. These communities, already vulnerable due to limited access to resources, are left even more exposed to climate-related risks. Addressing the wide-ranging impacts of climate change requires both systemic policy changes and a shift in public awareness to ensure that individuals and communities understand the risks they face and are equipped with the knowledge to adapt and mitigate these effects.

Education plays a critical role in enhancing climate change awareness in Pakistan, especially given the low level of public understanding about the issue. Despite some progress in integrating climate change topics into the national curriculum, much remains to be done, particularly in rural and underprivileged areas where the effects of climate change are most severe. Educational programs need to be context-specific, incorporating local knowledge and addressing the unique challenges faced by different regions. By making climate change education more culturally relevant and accessible, particularly in communities most affected by environmental changes, it can help foster resilience and sustainable practices that are crucial for adapting to climate impacts.

One of the most effective ways to improve climate change education in Pakistan is through a combination of formal and informal strategies. While formal education at schools and universities must integrate climate science with practical applications, informal education initiatives, such as community workshops, media campaigns, and NGO-led projects, can reach wider populations, including those in rural areas. These informal initiatives allow for a more hands-on approach, where people learn about climate change through direct engagement, using local examples and solutions. This dual approach can empower communities to take proactive steps toward sustainability and climate resilience, ensuring that future generations are better prepared to cope with the challenges posed by climate change.

Conclusion

Climate change presents a significant and growing threat to Pakistan, particularly affecting its environment, economy, and vulnerable communities. The country faces a range of challenges, including rising temperatures, extreme weather events, and disruptions to agriculture and water resources. These impacts disproportionately affect rural and marginalized populations, who often lack the resources and knowledge to adapt to these changes. Effective education is essential in raising awareness about climate change and equipping individuals with the knowledge and skills to mitigate and adapt to its effects. While formal education systems have made strides in addressing climate change, they still fall short in delivering context-specific, localized, and actionable knowledge to communities most at risk.

To address these gaps, it is crucial to implement both formal and informal educational initiatives that are culturally relevant and tailored to the unique challenges faced by different regions in Pakistan. Formal education can provide the foundational scientific knowledge needed for understanding climate change, while informal programs, such as community workshops and outreach efforts, can offer practical, localized solutions. A collaborative approach involving the government, educational institutions, NGOs, and local communities is essential to fostering climate literacy and building resilience. By prioritizing climate change education across all sectors, Pakistan can better equip its population to face the challenges of a changing climate, ultimately ensuring a more sustainable and resilient future.

Reforms in the agricultural extension systems are essential to ensure farmers have better access to critical agricultural information. Policymakers and government officials must facilitate the dissemination of knowledge by developing accessible education programs on climate change and its impacts. The government also bears the responsibility of sharing the findings of this research with local farmers and providing both institutional and financial support, particularly to disadvantaged smallholder farmers.

Introducing sustainable and modern farming practices into agricultural livelihoods can play a pivotal role in addressing climate challenges. Short-term strategies, such as improving access to

essential resources and providing information on adaptive techniques, can significantly enhance agricultural productivity and net income. By leveraging the potential of climate change adaptation, farmers can improve their financial stability and overall quality of life while contributing to increased yields of key crops such as cotton-wheat and rice-wheat at the national level.

To fully realize these benefits, region-specific strategies tailored to the unique climate risks and needs of each farming region are necessary. These outcomes highlight the importance of integrating targeted, sustainable approaches into agricultural practices to secure long-term productivity and resilience.

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