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Three roles for education in climate change adaptation

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ABSTRACT

Education, appropriately conceived, can be a powerful tool in enabling effective adaptation to climate change. In this article, we identify three distinct but overlapping policy uses. First, protecting and deploying education infrastructure, the social and material resources on which education depends, can reduce vulnerability and build resilience. Second, improving general education, measured in terms of literacy, school attendance, and overall academic attainment, can enhance adaptive capacity. Third, research-based adaptation learning support can accelerate social and policy change by maximizing learning before and during adaptive decision-making. Although all three are important, the unique and transformative contribution of education lies in adaptation learning support: curricular, pedagogical, and technological resources that prepare people for complex adaptive decision-making and help them solidify learning during that work. As human societies seek to balance the old social mechanisms that ensure stability with new ones that facilitate change, our capacity to systematically support the learning that undergirds adaptation may be the limiting factor.

Key policy insights

- The value of education for climate change adaptation policy has been limited by vague definitions and poor cross-field communication.
- Education supports climate change adaptation through three distinct but overlapping pathways, each offering concrete policy options: education infrastructure, general education, and adaptation learning support.
- The greatest value of education lies in the transformative potential of adaptation learning support: curricular, pedagogical, and technological resources that prepare people for complex adaptive decision-making and help them solidify learning during that work.

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Introduction

Education can be a powerful tool in enabling effective adaptation to climate change (IPCC, 2014), but its policy value has been limited by vague definitions of education and by poor cross-field communication that prevents important ideas from one discipline or policy domain from reaching another. This article builds on a more precise and pragmatic conceptualization of education and synthesizes research from multiple fields to identify three different policy uses of education in adaptation.¹ Two of these, education infrastructure and general education, correspond to well-defined policy domains. The third, adaptation learning support, cuts across policy domains. Although applications will vary across contexts, each of these uses of education offers actionable targets for research and policy. Together, they offer a menu of education-based strategies that range from long-term, nation-scale investment to immediately applicable community-scale learning support. All three provide concrete benefits, but we believe that adaptation learning support has the greatest potential for transformative impact.

What is education?

In climate policy discourse, education is often tacitly interpreted as a synonym either for school or for learning. The first interpretation ignores other important forms of education, while the second is too nebulous for useful policy action. We suggest a pragmatic middle ground: Education is systematic support for learning. Education is systematic in the sense that it is methodical, but also in the sense that it relies on systems: interconnected cultural and institutional resources including networks of people (e.g. families, teachers, professional organizations) and materials (e.g. buildings, books, computers) (NASEM, 2018). By specifying that education is support for learning, we emphasize that learning is an active process involving changes in knowledge, skills, identity, and socio-cultural roles, rather than the transmission of information to a passive recipient (NASEM, 2018). Education takes place in schools ('formal education'), but also in organized non-school programmes such as agricultural extension and professional certification ('non-formal education'), and in more improvised, situation-specific activities in the home, workplace, and civic environment ('informal education') (Coombs, Prosser, & Ahmed, 1973).

Three roles for education

Protecting and deploying education infrastructure to reduce vulnerability and build resilience

Education infrastructure – the people and materials that education depends on – is a major societal investment that can exaggerate vulnerability or increase resilience, defined here as a socio-ecological system's capacity to bounce back or reorganize after a disturbance, while maintaining its core functions and capacity for future transformation. For example, the decision to build a new school in a low-lying coastal area or flood plain exposes students to flood risk, whereas building that same school on easily accessible higher ground both protects students and provides a safe community shelter during floods. Research on resilient infrastructure and disaster management emphasizes the importance of protecting physical infrastructure, including the physical infrastructure of education, from climate-related hazards (Godschalk, 2003; Sakurai et al., 2018). Countries that already have extensive education infrastructure can reduce their exposure to climate-related hazards through renovation (e.g. installing critical equipment such as boilers or generators above ground level), interconnection with other systems (e.g. improving communications networks that enable schools to respond quickly to changing conditions), or relocation (e.g. moving out of floodplains) (UNICEF, 2012). Countries that are expanding their education infrastructure have a cost-effective opportunity to expand with resilience in mind. For example, schools might be proactively designed to serve disaster relief functions (e.g. emergency shelter and resource distribution) that they often fill sub-optimally and by default.

Focusing on physical infrastructure is important, but can also distract from the profound risk that climate change poses to the humans – and human systems – that support education. Educators face elevated risks of disease and injury while caring for others in hazardous conditions such as flooding or extreme heat; they also suffer if climate-related impacts destabilize their livelihoods by making it impossible to go to work, or by draining scarce resources from salary and training (UNICEF, 2012). For example, when schools are repeatedly closed for extended periods of time following climate-related flooding, educators may be deprived of income, forcing them to move or seek other employment and making it harder to re-open those same schools later. Protecting the human infrastructure of education requires protecting the health and safety of educators but also finding ways to stabilize their livelihoods in the face of disruption.

The human systems that support education can also strengthen the social infrastructure that makes communities resilient – a topic of increasing interest among adaptation researchers and practitioners. Educators who are appropriately trained, resourced, and empowered can facilitate the functional, trusting relationships that reduce damage and speed up recovery (Klinenberg, 2015; UNICEF, 2012). Initiatives that integrate schooling with social services (Whitehurst & Croft, 2010) could also boost resilience.

Improving general education to enhance adaptive capacity

Although education and school are not synonymous, schools are the most visible form of education. Research on sustainable development indicates that improving schools also improves adaptive capacity and the ability to

adjust to climate impacts by moderating damages, taking advantage of opportunities, and coping with consequences (IPCC, 2014). These analyses focus on the adaptation-related benefits of improving *general education*, measured in terms of basic literacy and total years of schooling, rather than education that specifically focuses on climate change (Lutz, Muttarak, & Striessnig, 2014). On shorter timescales, improving general education directly reduces multi-dimensional vulnerability and facilitates proactive risk reduction and disaster recovery (Frankenberg, Sikoki, Sumantri, Suriastini, & Thomas, 2013; UNICEF, 2012). Although the mechanisms are unclear, general education may improve awareness and disaster response by accelerating the flow of information through society, facilitating economic diversification away from climate-sensitive sectors, and reducing inequity, which itself magnifies societal vulnerability. There is particularly strong evidence that enhancing general education among women and marginalized groups reduces individual and communal vulnerability over relatively short time spans (Lutz et al., 2014). On longer timescales, general education indirectly contributes to adaptive capacity by advancing economic growth, health, democratic governance, and collaborative resource management (Lutz et al., 2014; Marshall & Duram, 2017).

Although these overall correlations are widely recognized in both research and policy, making effective use of general education in adaptation policy will require clarifying both how and when it contributes to adaptive capacity. Expanding access to general education may be counterproductive if the quality of educational services declines (Bangay & Blum, 2010). Furthermore, policy makers who wish to build adaptive capacity by improving general education must account for timing and path dependency. Many of the positive consequences of general education – consequences that are crucial to addressing the inequities of climate change impacts – play out over decades. Where general education is concerned, the key adaptation decision point is now.

Using adaptation learning support to prepare for, and maximize learning in, adaptation practice

Education's greatest potential contribution to effective climate change adaptation lies in its capacity to help people prepare for and learn from climate impacts. Learning is often understood as an outcome of adaptation or disaster response work – and societies do, indeed, learn from their experiences of climate change impacts (e.g. Albright & Crow, 2015; Chaffin, Gosnell, & Cosens, 2016; Sakurai et al., 2018). But learning can also be a transformative input for adaptation and disaster response work: well-designed resources that support learning before and during adaptation can increase the chance of success (Cornell et al., 2013). Research on education and learning (e.g. NASEM, 2018) and public engagement with science (e.g. Stilgoe, Lock, & Wilsdon, 2014) offers an under-exploited knowledge base for developing effective *adaptation learning support*: tools and strategies that either prepare people to participate in adaptation or support them during adaptation as they develop new skills, knowledge, and social roles.

Adaptation learning support can take a wide variety of forms. For example, technological tools such as computer-based simulations can provide low-stakes opportunities to practice important disaster response tasks (Wu & Lee, 2015). Pedagogical strategies, including new teaching techniques and facilitation tools, can improve the quality of democratic dialogue (Hess & McAvoy, 2014) and encourage information exchange among experts and stakeholders (Burgess, 2014). Curricular resources such as field manuals or structured workshops can build capacity in community and professional settings (Mitchell et al., 2010; Rumore, Schenk, & Susskind, 2016). The role of formal education in adaptation learning support is a large and complex topic that we plan to examine in detail in a forthcoming article; here, we focus on informal and non-formal mechanisms of adaptation learning support.

Different types of adaptation learning support are useful when climate-related uncertainty is low and when it is high. When climate impacts are clearly mapped out and policy choices are well-defined, uncertainty is relatively low. In these circumstances, curricular resources like field manuals and structured workshops can raise awareness of known climate impacts and policy options (IPCC, 2014) or directly empower stakeholders to reduce vulnerability by building knowledge, developing skills, and shifting attitudes toward well-defined challenges (Stern, Sovacool, & Dietz, 2016). For example, agricultural extension programmes (a well-established system of non-formal education) can change farming practices by encouraging farmers to adopt new cultivation and conservation techniques and by introducing drought – or disease-tolerant crop varieties (Di Falco, Veronesi, & Yesuf, 2011; Prokopy et al., 2015).

Often, however, climate change adaptation must take place in circumstances where climate impacts are uncertain and policy options are unclear, untested, and rapidly evolving. For example, coastal communities planning for sea level rise in the second half of the century must respond to changing scientific projections while simultaneously accounting for economic, demographic, and political trends. They face a bewildering array of inter-connected questions, none of which can be answered definitively with available expertise. Will our seawall or flood barrier be high enough? How will rising seas affect tourism and fishing? What will our tax base look like in fifty years? What sort of federal support for adaptation (or disaster recovery) might be available? How do new zoning or insurance regulations affect low-income residents?

In conditions like this, when no field manual or workshop can provide clear guidance, adaptation learning support can improve the *processes* of adaptation by preparing and supporting the people who participate. Stakeholders who are faced with questions like the ones listed above must repeatedly collaborate to define and re-define their goals, shifting adaptation strategies as natural and social conditions change (Albright & Crow, 2015; Chaffin et al., 2016). This sort of sustained collaboration is notoriously difficult: the combination of high stakes, uncertainty, and limited trust can lead to attrition and disengagement (Chaffin et al., 2016; Cvitanovic et al., 2019; Stringer et al., 2006). Fortunately, a growing body of research offers concrete tools and practical guidance in the development of educational programmes that build collaborative skills, offer strategies for managing complexity, and prepare participants to bridge cultural and professional disconnects (Krasny, Lundholm, & Plummer, 2010). Adaptation learning support can help through simulations (Wu & Lee, 2015), role-playing scenarios (Rumore et al., 2016), and exercises in democratic dialogue (Burgess, 2014; Hess & McAvoy, 2014) that prepare diverse stakeholders to participate in iterative, collaborative decision-making.

On the other hand, there is an urgent need for research-based adaptation learning support that provides just-in-time assistance for stakeholders and decision-makers when advance preparation is impractical, or when adaptation processes are already well underway (Cvitanovic et al., 2019). Climate services, decision support, and sustained assessment processes are being developed and deployed for climate change adaptation (Moss et al., 2019), but insufficient support for learning before and during adaptive decision-making limits their effectiveness (Albright & Crow, 2015). What sorts of facilitation and technological support can maximize learning and minimize burnout during participation in adaptation processes (e.g. Selin et al., 2017)? How can adaptation professionals help maintain a learning orientation in high-stakes decision-making contexts? Education that supports learning *during* adaptation can have a multiplicative effect by making ongoing adaptation projects more effective while simultaneously building capacity for future projects (Eakin, Lemos, & Nelson, 2014). Developing new, research-based adaptation learning support should be a high priority for adaptation policy.

Conclusions

The value of education for adaptation policy goes far beyond boosting awareness and disseminating information. Our framework draws attention to the important roles of education – systematic support for learning – in climate change adaptation, encouraging a subtle but profound shift in emphasis from adaptation decision-making to adaptation *learning* (e.g. Lumosi, Pahl-Wostl, & Scholz, 2019). The three strategies we have identified here unquestionably overlap. For example, improving general education often requires changes to education infrastructure, while both general education and education infrastructure are useful inputs for adaptation learning support. Although each strategy has independent value, work in these domains should be coordinated to maximize returns and prevent perverse consequences.

Education infrastructure, with its vast scale and potential to enhance resilience, deserves greater attention in adaptation policy. The delayed benefits of general education, which can enhance adaptive capacity in both the short and long term (Frankenberg et al., 2013; IPCC, 2014; Lutz et al., 2014), make large-scale decisions around educational investment more urgent. When considering how to invest in general education, policy-makers must account for the tendency of education to both reflect and magnify societal inequities. General education may improve awareness and disaster response by accelerating the flow of information through society, facilitating economic diversification away from climate-sensitive sectors, and reducing inequity (Lutz et al., 2014; UNICEF, 2012), yet schools cannot enhance community resilience or build adaptive capacity when they are hostile territory for vulnerable students and their families.

The most profound implications of our framework concern adaptation learning support. Education and adaptation researchers must collaborate in developing, testing, and deploying learning supports that serve the functions discussed above. How might we re-conceptualize and re-design adaptive decision-making situations to support learning among new and experienced participants? What sorts of curricular resources, technological tools, and pedagogical strategies help people learn while engaging in adaptive decision-making across diverse contexts and scales? Answering these questions could have a transformational impact on societies' ability to adapt effectively as the climate continues to change.

Note

1. In practice, adaptation and mitigation must be pursued together: adaptation that does not account for broader socio-ecological consequences can have perverse outcomes, and mitigation activities often represent the most efficient long-term adaptation strategies. We isolate adaptation here to clarify the distinct roles of education in adjusting to the current and anticipated outcomes of climate change.

Declaration of interest statement

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