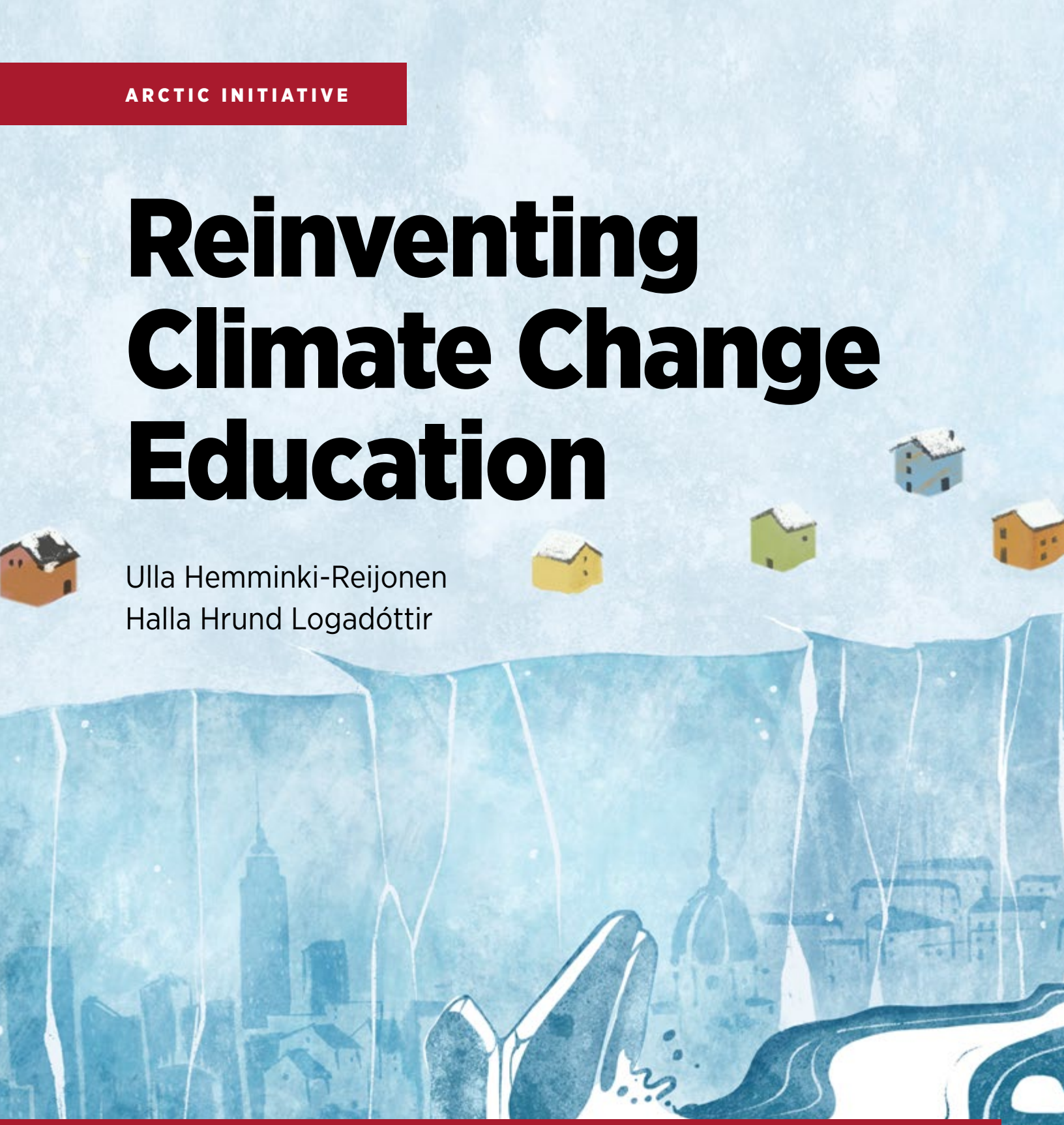
ARCTIC INITIATIVE

Reinventing Climate Change Education

Ulla Hemminki-Reijonen
Halla Hrund Logadóttir



HARVARD Kennedy School
BELFER CENTER
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About the Project

The Arctic is changing. It's warming more than twice as fast as the rest of the globe. Ultimately, what happens in the Arctic does not stay in the Arctic. As the top of the world melts, the impacts are felt by everyone.

The Belfer Center's Arctic Initiative seeks to develop new insights and collaborations that bring together science, technology, and policy to address the environmental, economic and social challenges facing the Arctic. At the Arctic Initiative we are initiating new research; convening stakeholders like policymakers, scientists, and Arctic residents; and training a new generation of public and private experts to understand and address the factors driving change and risk in the region.

The Arctic Initiative is a joint project of the Environment and Natural Resources Program and the Science, Technology, and Public Policy Program at the Belfer Center.

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Introduction

This paper will review the changing world of climate change education and opportunities for adopting innovative pedagogical approaches such as immersive technologies, participatory methods, and art-based learning. It will also point out examples of how institutional collaboration and support from policymakers can facilitate climate change education and make a great impact. It concludes with a pilot project on increasing engagement in climate change education at Harvard Kennedy School. The lessons learned offer three main considerations when designing climate change education.

1. The Growing Climate Challenge

The Arctic is changing. It is warming at least twice as fast as the rest of the globe, seeing some of the world's first climate-displaced communities. Ultimately, what happens in the Arctic does not stay in the Arctic. As the top of the world melts, everyone feels the impacts. The phenomenon of climate change is complex and cross-curricular by nature – it is one of the wicked problems of our times (Incropera, 2016).

The nature of climate change also poses a challenge to educators: How can we raise awareness of the urgency of this issue and all the effects that will follow? How can we become better at responding and adapting to climate change in an uncertain future?

The first challenge for climate change education is the complexity of the topic. Climate change involves addressing not simply scientific and environmental issues but also social, cultural, and political issues (Gibb, 2016). Our understanding and response to climate change is socially constructed, with each person having their own perspective (Lehtonen et al., 2019). Students need to interpret numerical data, links, connections, and consequences, and educators need to find effective ways to support their learning.

The second challenge is the long time horizon. For other environmental problems, the effects are sometimes near-term, if not immediate. In contrast, the effects of today's emissions are not felt today, but over time, taking decades before they are revealed (Incropera 2016). Today, communities experience the consequences of historic emissions. Therefore, it might be difficult for students to understand the urgency and the impact of climate change on their own lives, especially in regard to their own contributions.

The third challenge is that climate change is neither a regional nor a national problem – it is global (Incropera, 2016). Often, heavily impacted regions, such as the Arctic region, may feel far removed from a student's own location if they are not in the Arctic. That is why building empathy for the transformations occurring in other communities impacted by climate

change can be difficult. In fact, climate apathy may cause students to be less likely to take a course on climate change in the first place (Reimers, 2021).

Finally, students might also feel that there is no hope or that they are powerless to help the situation with their own actions. More than two-thirds of the US adults have at least a little "eco-anxiety" or worry about climate change and its effects, and nearly half of 18-34-year-olds say that their lives are affected by the stress caused by climate change (APA, 2020). People say they would do more to reduce their contribution to climate change, but they feel they don't have enough resources or skills to make necessary changes (APA, 2020).

To learn to mitigate and adapt to climate change, people need to navigate through these challenges. Therefore, there is a great need to improve the skills that are required on this journey. Impactful and innovative climate change education can help narrow this learning gap.

2. The Importance of Systemic Support for Climate Change Education

2.1 A Need for Institutional Action

UNESCO's work on Climate Change Education (CCE) aims to make education a more central part of the international response to climate change globally. Key recommendations for policymakers include education policy development; increased investment in high-level support and resources for climate change education in member states; curriculum development; capacity-building of teachers; raising public awareness; and improving communication-related to CCE. Innovative teaching and learning approaches—especially active and participatory methods designed to develop critical thinking and problem-solving skills–are needed to help a broad audience understand, address, mitigate, and adapt to the impacts of climate change. (UNESCO, 2015).

Yet, studies show a lack of creative, participatory, and interdisciplinary approaches to climate change education (Rousell&Cutter-Mackenzie-Knowles, 2019). There is a need to rethink traditional knowledge-based climate change education and introduce more experimental methods for students.

Universities can play a critical part in this process as they are already concerned with climate change and advancing a range of actions to address it. Academic institutions have a distinct role in CCE, for example, in deepening knowledge (Reimers, 2021). However, a survey of university leaders working on sustainability in 51 countries reveals a gap between the priority universities attach to climate change and the opportunities given for all students to learn about climate change (Leal Filho et al. 2019 in Reimers 2021). If universities can recognize this gap between their expressed commitment to sustainability and the reality of their educational programming, then universities can offer opportunities for innovation and collaboration.

2.2 Systemic Educational Support at the Municipal, National and Global Levels in Action

Municipal Level: Ii, Finland

The small *Municipality of Ii* in Finland provides an example of climate action at the municipal level. Ii demonstrates that when participatory climate-aware methods are built into the school system and are developed with municipal governments, children can grow up to become environmentally aware citizens. Sustainable lifestyle - including teaching, everyday life, and taking action - is defined as a key part of the Finnish Core Curriculum covering all the subjects. Therefore, Ii has innovated a so-called 50/50 method for schools: if children in comprehensive schools succeed in saving water, heating, or electricity, they can get half of the saved money back from the municipality and use it how they like. The 50/50 method has activated and empowered children and strengthened their initiative around sustainability. Children have seen in their daily life how acting sustainably is possible and economically a wise thing to do.

The sustainability message also has reached the families. Parents have reported with a smile on their face that they are not allowed to take long showers anymore because their children are actively observing the water consumption at home. One school even needed to intervene when children didn't flush the toilets anymore due to the water saving goals. (Vuotovesi&Paaso, 2021).

> "This all is building inclusivity – we are working for climate together, as a municipality. We have proved that there can be local solutions for global problems."(Vuotovesi&Paaso, 2021)

For its efforts, the small municipality of Ii in Northern Finland has been awarded as the most environmentally friendly municipality in Europe.

National Level: Climate University

Climate University is an example of what possibilities lay in national support and how institutions can collaborate in the field of CCE. Climate University is a network of 12 universities and six universities of applied sciences in Finland that develops climate change and sustainability teaching in higher education. The network has co-created a set of nine online courses freely available for everyone, funded by the Ministry of Education and Culture of Finland and the Finnish Innovation Fund, Sitra. Courses include climate change and sustainability basics, leadership for sustainable change, systems thinking in climate challenges, and climate communication. This network supports co-teaching and does close collaboration with schools and companies. (Riuttanen, 2021). The university students have overall responsibility for their learning in these cross-curricular courses. A teacher is not expected to be a subject matter expert but more a co-learner. The goal is to accomplish a shared learning process. (Climate University, 2021).

Global Level: Climate Action Project

On the other hand, Climate Action Project offers possibilities for global collaboration in CCE with support from renowned experts and international organizations from the UN and WWF to His Holiness the Dalai Lama and Dr. Jane Goodall. Climate Action Project is the world's largest environmental education organization, which already has educated more than 2,500,000 students aged 6-22 across 130 countries in climate change. During the 6-week program, students from all over the world explore together the effects of climate change, brainstorm solutions, have fun, and share their findings via weekly videos. Expert webinars are provided as part of the program. (Climate Action Project, 2021).

2.3 **Climate Interactive: Practicing Sustainable Decision-making**

Group role play games can educate students and provide better systemic support as future decision-makers. The MIT Sloan Sustainability Initiative, a nonprofit think tank, developed Climate Interactive to build awareness on issues of sustainability and climate change. The game simulates an emergency climate summit organized by the UN. The players explore key technologies and policy solutions for addressing global warming through the game and use the En-ROADS simulator to analyze the effects of different policy and technology decisions in real-time. The ambassador program helps interested individuals become facilitators of the game, helping to spread awareness and change. Climate Interactive is an excellent example of using games and technology to help increase understanding of different stakeholder's perspectives on a systems level. (Climate University, 2021).

3. Responding to the Climate Change with Education

3.1 The Nature of Climate Change Education (CCE)

The goal of climate change education (CCE) can be described as: "to fully realize our humanity–a person, who thinks critically with rich information about a wide range of global situations" (Lehtonen et al., 2019). Even though the climate change education field still is said to lack the scientific consensus on specific learning pedagogies suitable for CCE, there are efforts to synthesize ideas about what works in practice (Reimers, 2021). Studies have identified some principles for excellent climate change education. These include, for example, pedagogies that promote exchange with scientists, focusing on solutions more than problems, building better learner agency of students, and emphasizing cross-curricular approaches (Alberta Council for Environmental Education, 2017). Studies show that interdisciplinarity promotes the ability of learners to understand complex problems and act on them (Annan-Diab and Molinari, 2017 in Reimers 2021). Without building deep connections between different subject-silos, the critical linkages in climate change might be missed (Lehtonen et al., 2019).

3.2 Opportunities through Learning Transformation with Online Environments

The COVID 19 pandemic has accelerated an already existing trend towards online learning. This online learning trend has demonstrated a need for rapid innovation in climate change education too. The artificial, residential, and temporal constraints on courses need to be removed even faster, and instructional platforms that achieve immersion and enable student agency need to be utilized (Dede&Richards, 2020). Also, a variety of new tools and technologies are available for more engaging climate change education.

When moving into the world of online learning, lecturers need to start by developing their own professional skills and by transforming their old teaching methods. Besides having the knowledge of the content on the subject area and the pedagogical knowledge on how to teach, teachers now need the Technological Pedagogical Content Knowledge (TPACK), which involves how to integrate technology for learning (Mishra, 2021). Educators need to move to a more constructivist role of a teacher and think of themselves as facilitators of students' own inquiry. If technology is used to automate teaching-by-telling and learning-by-listening, it can bore and disengage students (Fishman&Dede, 2016).

There are certain development stages which teachers usually take on their path to digital pedagogies. Teachers may start by substituting the old learning materials with digital ones. Ideally for online learning to fully take advantage of the new medium, their teaching must ultimately evolve to redefine their teaching methods by offering rich virtual learning environments. Puentedura (2013), who developed the SAMR model, states that the first two steps (Substitution and Augmentation) enhance learning while the last two (Modification and Redefinition) transform learning.

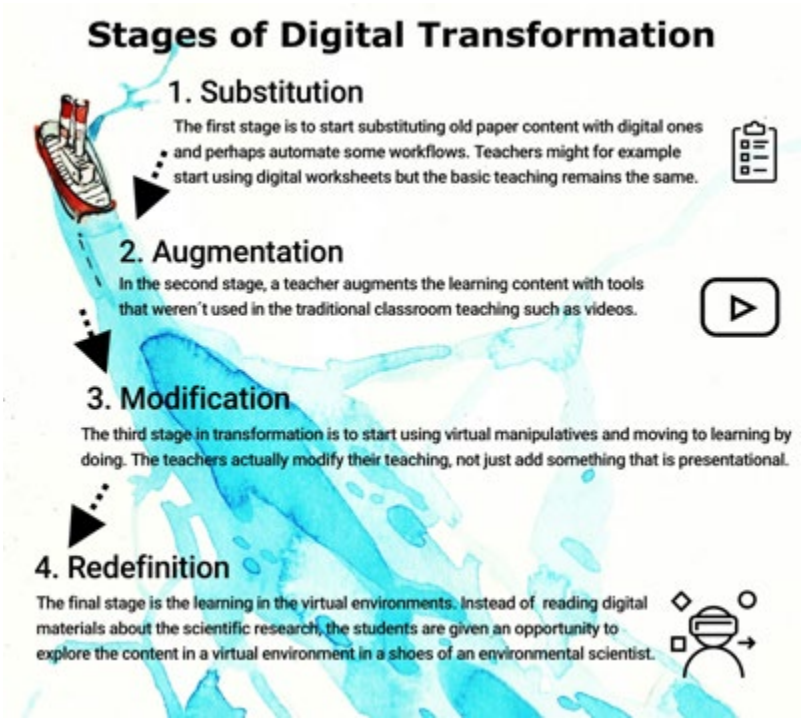

Figure 1. Puentedura (2013). SAMR model. Edited by Ulla Hemminki-Reijonen. Artwork by Xin Ma.

One suggestion for CCE is a flipped classroom method. The instructor provides pre-recorded lectures and other resources that students work through and explore prior to coming to class. The lesson time can be dedicated to deepening the topic, class discussions, and group work (Contact North, 2020). For example, on a climate change course, students could first explore the effects of climate change on their own before joining deeper discussions in class. This approach also requires a different kind of responsibility from students than what they are used to. However, moving to a more learner-centered approach does not mean students would automatically have high self-regulation skills. Therefore, flipped classrooms can be seen as a means to build better self-regulation in students and a strategy to improve learner agency (Toivola, 2020).

4. Approaches for Climate Change Education

4.1 Participatory and Student-Led Methods

Designing climate change education with more collaborative methods may produce effective outcomes. One suggestion is to build a more cooperative relationship between faculty and students (Van der Leeuw et al., 2012). There is a need to move beyond top-down versus bottom-up participation and embrace a participatory democracy where everyone is involved and held responsible (Fadeeva et al., 2014). A collaborative process in which all ideas are held important can enrich the collective understanding of the issue (Lehtonen et al., 2019). Dialogical learning situations where adults and young people learn from each other can also strengthen hope, courage, and trust (Lehtonen et al., 2019).

A recent Harvard Graduate School of Education (HGSE) project, Education for Sustainable Earth, serves as an example of a participatory method. HGSE students created this project to engage students as partners in the creation of climate change education (Nam&Lee, 2021). The group increased awareness of sustainability by hosting the Climate Interactive simulation, publishing a climate change book with Ford Foundation Professor Fernando Reimers, corresponding with HGSE faculty to develop a climate change curriculum, and working on a school-wide climate change conference. One of the key goals was to develop specific skills that foster sustainable actions after studies, too. The student members highlight this approach's focus on system change and a shared responsibility to promote action:

> "For a successful blend of bottom-up and top-down interaction, multiple components must come together under mutual respect, common understanding, and shared responsibility. Learner agency, increased satisfaction with the academy, and heightened engagement came with the author's participation of a curriculum design."(Nam&Lee, 2021)

4.2 **Immersive Technologies**

When moving towards the redefinition of the learning, there comes the need to redesign the entire learning environment and consider immersive tools as a learning medium. It is recommended to considerably augment the intensity of climate change education efforts (Reimers, 2021). Studies show that immersive virtual reality solutions can deliver meaningful climate change content and test how people think, feel, and respond to the issues. Virtual reality tools can increase participant interest, concern, or knowledge about the issues and expose users to new experiences that would otherwise be impossible. In a virtual world, for example, people can accelerate time to see climate change effects or travel to an area affected by climate change (Markowitz et al., 2021). The long horizon of the phenomenon is easier to understand when experiencing the effects right now – virtually. Creating immersive learning environments can also help to build better learner agency (OECD, 2018).

Teachers who have used virtual reality solutions in their class have even reported that the students were so engaged in what they were doing that they did not realize they were learning (Jeon, S. et al., 2020). These technologies offer a way to increase student's learning motivation significantly. When a learner is truly immersed, they might have reached the flow—they can lose everything else around, even their sense of time (Csikszenthmihalyi, 2014). The EcoMOD (2021), a 3D research project by the Harvard Graduate School of Education (HGSE) on environmental education and curriculum development for K-12 education, explores these effects for learning and the possibilities to understand the complexity better in a virtual environment:

> "EcoMOD is a great example of how students can experience meaningful engagement in a virtual world that they normally wouldn't be able to experience in a regular classroom. Through this process, one area that was particularly interesting was students' realization about misconceptions; students were initially certain that the cause of the change in the ecosystem was simply food chains, but through further exploration, they learn that the ecosystem is much more complex and that there are various casual relationships that affect an ecosystem."
> (Jeon, 2021)

Virtual reality can help with learning about ocean acidification. Ocean acidification can be challenging to teach; there is often a lack of scientific literacy and ocean acidification is complex and largely invisible to the human eye. Virtual reality as a tool can mitigate the challenges to teaching by increasing empowerment, perspective-taking, and visualization (Fauville et al., 2020). Studies (Bailenson, 2018) also show how after using VR application showing the importance of eco-friendliness, people were more likely to behave in a more environmentally conscious way in real life after the experiment in a lab environment. Not only did a virtual reality solution produce larger changes than other media like educational videos or texts, but those changes in behavior also lasted longer (Bailenson, 2018).

The makers of one immersive climate change solution, Sea level rise, reflect the meaning that they see in their work:

> "As my colleague Aleksis Karme aptly says, we are not putting anyone in other peoples' shoes but filling their own boots with water. It's amazingly powerful to bring catastrophic future scenarios for people to experience them in environments familiar to them. You can't escape the unpleasant feeling that "this is really happening". We have shown the experience to hundreds of people, and it made an impact to all of them."(Teronen, 2021)

Name	Description
Stanford Ocean Acidification Experience (SOAE)	Stanford Ocean Acidification Experience (SOAE) is an educational experience of a virtual underwater ecosystem that allows observations of what rocky reefs are expected to look like by the end of the century if we do not curb our CO_2 emissions. It was part of one of the largest-scale virtual reality studies (Virtual Human Interaction Lab, 2021) ever, which shows how VR as a tool can empower learners and give an opportunity to create a personal connection with the ocean (Fauville et al., 2020).
Sea level rise	Sea level rise is a virtual reality experience that illustrates various potential futures for the city center of Helsinki from the effects of 1.5 ºC warming to a worst-case scenario. All scenarios are based on IPCC climate reports and data (Teatime Research, 2021).
Greenland Melting	Greenland Melting is offering an insight into the world of glaciers in Greenland. The melting process is explained by two NASA scientists in a virtual reality experience.
Immerse	Immerse by Hydrous offers viewers a way to get immersed in a 360-degree view of the coral reefs, guided by a marine biologist. It raises awareness of the underwater effects of global warming

Table Examples of Immersive Solutions

The first step into the immersive world can be the usage of 360-degree images and videos. For example, zooming in and out in a landscape is possible with 360-degree videos, something that is not possible for a human eye otherwise. When using these tools, the users can experience the full location and engage further with the material presented. The users can also decide where they look and when. The immersion with 360-degree videos can connect the viewers with the content in a more meaningful and emotional way. (Reyna, 2018).

One way to think about a course is as an ecosystem of media, allowing instructors to use transmedia storytelling to engage students in content using multiple methods, thereby engaging multiples senses and learning styles. This kind of pedagogy utilizes multiple media platforms where each piece – whether it's a comic, novel, video game, mobile app, or film – functions as a standalone story experience, but, like a giant puzzle, each piece also contributes to a larger narrative (Rutledge, 2021). This approach can show the big picture of a complex phenomenon like climate change but still allow students to deep dive into the different perspectives and details.

4.3 **Art-based Learning**

The literature review on CCE (Rousell&Cutter-Mackenzie-Knowles, 2019) also calls for approaches that can make climate change meaningful for young people through participatory and arts-based methods. Art has the ability to transform apathy and grief into joy and empowerment and bridge the gap which can be found between theory and practice. When watching art, not only the artist but also the spectator participates actively, and transformative learning can take place on many levels during artistic processes. Therefore, to deepen the insights traditionally approached only with scientific knowledge, arts should be used alongside natural and social sciences (Lehtonen et al., 2019). According to Lehtonen et al. (2019), nature and culture should be seen as one entity and people should think about climate change education from a socio-ecological perspective. People who are educated eco-socially understand better that they are part of a fragile planetary entity (Lehtonen et al., 2019).

4.4 **Arctic Initiative's Pilot Project**

The Arctic Initiative at Harvard Kennedy School wanted to take a step into more cross-curricular, participatory, and immersive learning experience. Harvard Kennedy School offers a course *Policy and Social Innovations for the Changing Arctic* created and taught by Halla Hrund Logadóttir, Co-Founder and former Co-Director of the Harvard Kennedy School's Arctic Initiative. The COVID-19 pandemic moved the course online in 2020. This offered the opportunity to rethink the course and its content.

The transformation was based on the idea of "online yet onsite" learning. The lecturer filmed videos and provided digital materials to go along with the online classes. The lecturer even held a lesson straight from glacier roots since she was in Iceland due to the pandemic. The success of this pilot inspired the teaching team to seek to transform the content of the course for future purposes with the same idea – into more engaging learning experience.

The goal was to create an environment with a flipped classroom practice, where students could explore rich learning content on their own before coming to class to discuss. By introducing 360-images, videos, 3D models, music, unique art, and quizzes, the aim was to increase the learning motivation through a transmedia narrative. A semi-immersive 360-degree interface was chosen as the basis of the learning environment.

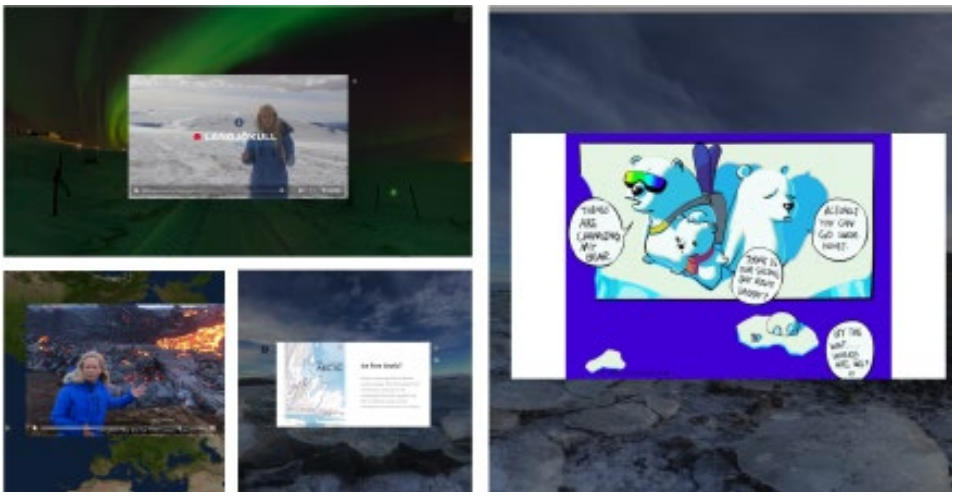

Figure 2. Arctic Initiative's Learning Environment created with Thinglink

The participatory methods and student-led curriculum development were core to this project. New ways of using arts were tested with the contribution of lots of climate-related artwork submitted from around the world, ranging from songs to comics, to be included in the learning environment. This proved the power of global collaboration and the opportunity to have more channels contributing to the climate change education platform from different fields of expertise. Boyu Guo, who coordinated the artist work, reflected on this collaboration project (2021):

> "When artists see the deteriorating environment of the Arctic, they are shocked by how such an urgent issue is widely neglected. Because their expertise is visual communication, they start to use powerful images to engage people to care about what is going on in the Arctic. Now more than ever, we need artists to collaborate with scientists and researchers, entrepreneurs, and technology experts to raise awareness of the precarious environment of Arctic."(Guo, 2021)

The content was designed to be accessible to all students around the world at any time of the day, and the key goal was to create culturally relevant material for students from different countries. In the same course, there can be students who have never seen snow in real life, and on the other hand, there can be an Indigenous student from an Arctic country who knows 1000 lexemes for snow and ice, so the content needed to work for different situations and with students who had varying levels of background information on the topic. The learning environment will be used in the next course cohort in January 2022 and developed further according to the student feedback.

5. The Next Steps for Climate Change Education

Climate change is a complex phenomenon, cross-curricular by nature, and affects everyone's lives, so there is an urgent global need to build better skills to understand, mitigate and adapt to climate change. Many promising projects are already in place, and more are coming to the field continuously. Systemic support can make a difference. To succeed in mitigating the climate crisis, the need for involving all levels of the society in CCE exists:

> "Climate change education needs to involve school-based and university-based programs, as well as non-formal and informal education. It needs to educate old and young, the employed and the un-employed, leaders and followers, business owners and workers." (Reimers, 2021)

Policymakers need to be aware of this opportunity and integrate it strategically, with funding, into national and global policies to accelerate the impact it can bring to the world. The good news is that policymakers are already acknowledging this trend and committing more resources for climate change education. According to a UNESCO (2019) report, 95% of the 194 reporting countries are identifying some aspect of climate change education as part of their national action on climate change. The study shows, however, that these countries mostly focus on raising public awareness. This means that it will be necessary for countries to expand their climate change education activities to address more systematically the other elements of climate change education, especially formal education and training (UNESCO, 2019).

With the learning transforming increasingly into the virtual world and the redefinition of pedagogies, we can hope to see more engaging learning experiences and new innovations in the field of climate change education that will help to address this big challenge more impactfully than imagined before. The below checklist will help educators and policymakers take the next steps in reinventing climate change education.

Climate Change Education Checklist

☐ **Allow students to experience climate change instead of just asking them to read about it**

- Create an ecosystem of media
- Be open for the opportunities with new technologies such as virtual reality
- Instead of substituting old content with digital workflows, try to redefine the teaching

☐ **Prioritize creative, cross-curricular, and participatory methods**

- Encourage cooperative relationships between faculty and students, and student-led curriculum design, promote exchange with scientists
- Be open for unexpected collaboration; leave room for new innovations
- Try flipped classroom method and encourage students' own explorations
- Consider arts-based education as an approach

☐ **Improve the systemic support and involve policymakers and educational institutions to collaborate**

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