

A Snapshot of Climate Change Education Initiatives in Europe

**Initial findings and implications
for future Climate Change Education**

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This ALLEA report has been prepared by the ALLEA Science Education Working Group, whose members are listed at the end of the report. Through its Working Groups, ALLEA provides input on behalf of European academies into pressing societal, scientific and science-policy debates and their underlying legislations. With its work, ALLEA seeks to ensure that science and research in Europe can excel and serve the interests of society.

A subgroup comprising four members of the working group, two invited experts and a post-doctoral researcher with expertise in climate change education was convened to conduct this work. ALLEA is especially thankful to the members of the drafting subgroup:

Dr Cliona Murphy (chair)

Dr Gabriela Martínez Sainz

Prof. Maija Aksela

Prof. Gerd Bergman

Prof. Michael Jones

Prof. Pierre Léna

Dr David Wilgenbus

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Executive Summary

UNESCO acknowledges “Climate change as a real and rapidly-evolving threat for humanity” and “strives to ensure that all generations understand the impact of climate change and are better equipped to take action to protect resources, the environment and the planet that sustains life, as enshrined in SDG 13” and advocates “the importance of education as a key element of the response to climate change” (UNESCO 2019).

There is a dearth of research that provides an overview of different climate change education (CCE) initiatives currently available throughout Europe. This scoping review maps a sample of current CCE initiatives in a non-exhaustive way, to identify commonalities, gaps, and best practices in CCE. It is intended that the findings from this scoping survey would inform a more representative large-scale survey of CCE initiatives throughout Europe. While the sample in the current study is relatively small, it yielded informative and relevant findings that are particularly timely taking cognisance that climate change is one of the key challenges identified by the European Commission in their 2020 Work Plan (EU 2020).

To gain an insight into CCE in Europe an online survey was developed and administered to ALLEA’s more than 50 science academies requesting that the survey be shared with relevant universities, education providers and outreach organisations that address climate change education in their work. The survey gathered 67 responses from 14 countries (11 from the European Union). Responses were compiled and collected for analysis. Descriptive statistics were used to analyse the responses from the survey to identify patterns and averages in the types of initiatives, scope, content, and age groups each initiative targets. In addition, content analysis was used to explore main themes across the open-ended responses related to the aims and descriptions of the initiatives.

Taking cognisance of the small sample the survey nevertheless provides a snapshot of existing CCE initiatives in Europe and identifies types, scope, content, and age groups each initiative targets which revealed some informative and timely findings.



Summary of Findings

- » Out of the 67 responses 20 and 19 of these respectively were from Higher Education Institutions and non-governmental organisations. Only nine and seven of the responses respectively came from governmental organisations and national academies.
- » More than half of the initiatives self-identified as national in terms of scope (38/67) or having a multi-level scope (16/67), that is local, regional and/or national.
- » Nearly three quarters of the initiatives referred to in the survey include primary school children in their target audience, over half of them include secondary-school students while almost half of the initiatives include high-school students.
- » Of the initiatives that involve participants in Higher Education, there was an equitable distribution between undergraduate and graduate programmes.
- » While very high percentages of the initiatives offer resources for students, low percentages of the initiatives offer professional development for teachers. Only 14 of the initiatives offer professional development at Initial-Teacher Education level whilst 17 offer professional development for practising (in-service) teachers.
- » The professional development programmes are being delivered in a variety of formats: face-to-face; blended as a mix of online and face-to-face components or completely online.
- » The length of the professional development programmes varies significantly between the different initiatives. Some are less than 2 hours in length (11), nearly half are more than 2 hours but less than 10 hours, while only a quarter of the programmes are longer than 20 hours.
- » Almost all of the initiatives focus on developing knowledge and understanding about climate change. However, only a third of the initiatives also provide support for design and implementation of climate action projects.
- » The majority of the initiatives address the causes of climate change but fewer of the initiatives tend to focus on issues regarding climate change mitigation, climate change adaptation and impact reduction.
- » Interestingly nearly half of the initiatives mentioned climate change technologies as one of their focuses.

Recommendations



The recommendations herewith are based on the survey findings and complemented by the educational research literature and by the expertise of the sub-group that was convened to conduct this work.

- 1.** We suggest that existing high-quality examples of CCE resources for different age groups should be collated so that educators throughout Europe could avail of them and use them in different educational settings. An important first step would be to assess the quality of existing CCE resources and then to develop a set of criteria or a framework that would inform the development of future resources.
- 2.** It would appear that there is a tendency for the different initiatives to focus on more grass-root approaches to climate change rather than focusing on climate change at a more local level. It is necessary to incentivise the development of local initiatives that are fully contextualised and address the needs of communities. One way of progressing this might be that the emphasis of programmes could shift from local, at primary and middle school levels to more global at high school and third levels.
- 3.** The aims of the CCE initiatives in addition to looking at causes of climate change need to expand to focus more on mitigation and adaptation. CCE initiatives should consult the successive Intergovernmental Panel on Climate Change (IPCC) summary reports that provide regular updates on the most recent developments in climate science. These reports also outline potential solutions for adaptation and mitigation.
- 4.** Further information is required to examine the extent to which ‘climate justice’ is addressed in the different educational resources. Students have to understand that mitigation is not only crucial for future generations but is also essential for current disadvantaged populations on whom climate change is having the biggest impact resulting in these populations having to deal with significantly bigger challenges.
- 5.** It is important that CCE resources and programmes adopt more solution-oriented and collective action approaches to climate change that would be a means of decreasing eco-anxiety but also in fostering a sense of agency.
- 6.** There are gaps in the age ranges of which the initiatives target. High percentages of the initiatives appear to target upper primary and post primary school students for example, however, very few target lower primary school students. It would be important to develop educational resources and programmes related to climate change for early years’ education.
- 7.** There appears to be a dearth of initiatives that offer professional development for teachers to support them in teaching climate change. A greater focus needs to be placed on the development, implementation and assessment of high-quality professional development programmes for teachers and on the impact of these professional development programmes on the teaching and learning about climate change.
- 8.** CPD programmes must move away from ‘once size fit all’ type models, towards more long term programmes, that are differentiated, hands-on and that support teachers in developing their Pedagogical Content Knowledge (PCK) (Shulman 1986) in CCE. Future CCE modules should therefore include content that will support teachers in: developing their scientific understanding of climate science; and, implementing Inquiry-Based Science Education (IBSE), Nature of Science (NoS) and Project-Based pedagogies while teaching about climate change.
- 9.** Primary and post primary curricula throughout Europe are being reviewed and revised and Education for Sustainable Development and Climate Change are being included as content in many of these revised curricula. Further research needs to be conducted to establish whether or to what extent existing CCE resources and initiatives (including Initial Teacher Education and Continuing Professional Development for teachers) are linked with National curricula.

The survey provides a snapshot, some initial insights, into CCE initiatives in Europe. However, a more in-depth examination of a wider range of CCE initiatives is warranted to ascertain a more thorough account of the status of CCE resources. The recommendations outline actions that are needed to achieve the necessary changes, actions that will require significant financial support. It is recommended that a funding framework should be established to support research in and the development of effective approaches for teaching and learning about Climate Change Education.

Setting the Context

The UN Global Action Programme (GAP) on Education for Sustainable Development (ESD) that started in 2015 and finished in 2019, was aimed at scaling up action on sustainable development through education beyond 2019. Subsequently UNESCO developed a draft framework entitled Education for Sustainable Development: Towards achieving the SDGs (ESD for 2030) (UNESCO 2019). This framework focuses on strengthening ESD's contribution to the achievement of all 17 Sustainable Development Goals (SDGs), focusing on policies, learning environments, teachers and educators, youth as well as communities.

In this draft Framework UNESCO explicitly acknowledges “*Climate change as a real and rapidly-evolving threat for humanity*” and specifies “*Climate Change as a particular focus area of ESD, which UNESCO strives to ensure that all generations understand the impact of climate change and are better equipped to take action to protect resources, the environment and the planet that sustains life, as enshrined in SDG 13*” (UNESCO 2019). Furthermore, UNESCO states that these actions “*also support Member States in meeting their obligations under the United Nations Framework Convention on Climate Change and 2015 Paris Agreement by advocating on the importance of education as a key element of the response to climate change; producing and sharing knowledge and policy guidance on climate change education; and providing country support and in the implementation of projects on the ground*” (UNESCO 2019).

The obligations towards climate change education (CCE) acquired by Member States in addition to the urgency of climate change makes it necessary to take a closer examination of different educational responses that address the climate crisis specifically and not only as an element embedded in ESD. To this extent the ALLEA Science Education Working group elected to focus specifically on gathering information on CCE initiatives throughout Europe rather than looking into broader educational initiatives or programmes that focus on sustainable development. The survey therefore asked respondents to report on those initiatives that specifically targeted CCE. By narrowing the focus of the survey to CCE, it was possible to gain a deeper insight into the aspects of climate change that are currently being addressed through education across Europe.

It is important to note at the outset that the findings reported in this report are from a relatively small sample of initiatives (67) from 14 countries throughout Europe. Generalisations therefore cannot and are not drawn. However, in the absence of any other published comprehensive review of CCE initiatives in Europe, this scoping review of existing CCE initiatives maps a sample of the existing initiatives in the field of CCE, in a non-exhaustive way, to identify commonalities, gaps and best practices in CCE. It is intended that the findings from this scoping survey, would inform a more representative large-scale survey of CCE initiatives throughout Europe. While the sample in the current study is relatively small, nevertheless, it yielded some informative and relevant results that are particularly timely taking cognisance that climate change is one of the key challenges identified by the European Commission in their 2020 Work Plan (EU 2020).

The recommendations put forward in this report are based on the findings of the scoping survey, a review of educational and CCE research literature and also draw from the expertise of the members of the subgroup that was convened to carry out this work.

1. Introduction

For the remainder of the 21st century and beyond, climate change poses an existential threat to humanity (IPCC 2014) as it has caused, and it will continue to, damage human and natural systems around the world (IPCC 2019; UN 2019). The complexities of the issues surrounding climate change pose important challenges for education (Mallon 2015; Lena, Lescamontier, Wilgenbus 2019). However, learning about climate change can also provide opportunities for students to develop their knowledge and a range of inquiry, problem solving and critical thinking skills (Burke et al. 2018; IAP 2017; Tolppanen & Aksela 2018). It is also apparent that students have a high level of consideration towards the scientific, societal, and ethical aspects of climate change and that their questions regarding climate change are multidisciplinary and complex in nature (Tolppanen & Aksela 2018). Recent research also reveals that teachers are among the many ‘messengers of knowledge’ present in the society of information, the most trusted by the youth (Corner et al. 2015).



This report calls for the inclusion of climate issues, adopting inquiry-based pedagogies in primary and secondary schools worldwide

Currently, CCE is placed at the core of strategic targets of the Sustainable Development Goals (SDGs) not only as a means to improve awareness and capacity on climate change mitigation, adaptation and impact reduction (SDG 13) but also as an approach to education that ensures that all learners acquire the knowledge and skills needed to promote sustainable development (SDG 4).

The Paris Agreement (UN 2015) recognises the significant role CCE has to play in ensuring young people develop the requisite knowledge and skills to understand the complex issues around climate change. Article 12 of this Agreement requires all signatories to recognise and address the importance of climate change in education.

“Parties shall cooperate in taking measures, as appropriate, to enhance climate change education, training, public awareness, public participation and public access to information, recognizing the importance of these steps with respect to enhancing actions under this Agreement.” (Paris Agreement, Art. 12)

Education for people and the planet (UNESCO 2016) analyses the considerable steps required in virtually all education systems in the world (both developing and developed education systems) to prepare young people for the difficult decades ahead.

On these premises the Inter Academy Partnership (IAP) for Science, led by the Académie des sciences from France, drawing on the expertise of 29 experts from 25 academies, prepared a declaration on climate change and education that was endorsed by a large majority of the 113 academies and promulgated by IAP in December 2017 (IAP 2017)

This report contains a number of recommendations largely concerning primary and secondary education, with some reference to higher education, and calls for the inclusion of climate issues, adopting inquiry-based pedagogies in primary and secondary schools worldwide. Some of the recommendations in this report include:

- » An extension in the direction of social sciences in addressing climate change education;
- » A greater emphasis on the essential role of teachers in educating children in climate issues;
- » The development of teacher professional development programmes and educational resources to support teachers in teaching about the content and issues raised in the regular IPCC reports.

As mentioned earlier, UNESCO's 2019 draft framework highlights the importance of ensuring that all generations understand the impact of climate change and are better equipped to take action to protect resources, the environment and the planet is articulated. The document further articulates that the framework corresponds to Member States' obligations towards CCE (UNESCO 2019). These obligations towards CCE in addition to the urgency of climate action provide a robust justification for a closer examination of educational initiatives that address climate change specifically not only as an aspect of ESD.


The ALLEA Science Education Working Group, as part of the Inter Academy Partnership (IAP) Science Education Network, recognises the importance of CCE in preparing our young people to face future challenges in our rapidly changing world and recognises that there are numerous international educational initiatives that address climate change currently being rolled out throughout Europe. Such initiatives include the development of educational resources to support teaching about climate change education, professional development for teachers and regional conferences bringing together scientists, climatologists and educators. Although science and education in science should remain separated from politics, the recent interest expressed by the new President of the European Commission, Ursula von der Leyen, may indicate that some initiatives within the Union may become possible, similar to those triggered by the Rocard Report '*Science Education, Now!*' in 2007. Furthermore, with the ratification of the Paris Agreement by the European Union, there are now legally binding commitments for governments to work in strengthening the capacities to deal with the impacts of climate change, a task in which the role of CCE is essential.

While anecdotally it would appear that there are a plethora of initiatives supporting CCE throughout Europe there is a dearth of documentation detailing these initiatives in terms of:

- » Their overall aims and content;
- » Their target audiences;
- » Supports that are available to teachers for teaching about climate change;
- » Whether they are led by government or non-government organisations;
- » Whether they are targeted at a European, National or local level.

To this extent the Science Education Working Group (under the aegis of ALLEA and part of the IAP Science Education Network¹) developed, piloted and administered an online survey gathering information regarding different CCE initiatives currently available throughout Europe. This report provides an overview of the findings from this scoping survey, identifies overlaps and gaps in the educational initiatives and puts forward a number of recommendations for progressing climate education throughout Europe.

¹ Read more: <https://allea.org/science-education/> and <https://www.interacademies.org/12250/IAP-Science-Education-Programme>



The ALLEA Science Education Working Group developed, piloted and administered a large-scale survey gathering information regarding different Climate Change Education initiatives currently available throughout Europe

2. Methodology



A subgroup comprising four members of the ALLEA Science Education Working Group, with expertise in CCE, two invited experts and a post-doctoral researcher also with expertise in CCE was convened to conduct this work. A European survey was developed and piloted in four European countries (Denmark, France, Ireland and Sweden). After piloting, minor changes were made to the survey prior to administering the survey throughout Europe at the beginning of June 2019. The survey can be found on the following [link](#).

With regard to dissemination of the survey, ALLEA sent the survey to more than 50 science academies requesting that the survey be forwarded to relevant units in their academies as well as to relevant universities, education providers and other outreach organisations that address climate change in their work. ALLEA informed the academies that the survey was seeking information from local, regional, and national climate change education initiatives. The science academies were not specifically asked to target public or private institutions, or a particular target age level (primary, post primary or tertiary levels). Rather it was left to the discretion of the individual academies to circulate the survey to organisations that were addressing climate education.

ALLEA also included information regarding the survey in their newsletter and ALLEA posted several tweets regarding the survey between July and September 2019. The survey had a continuous presence on the ALLEA website.

The response rate to the survey, however, was low, gathering only 67 responses from 14 countries (11 from the European Union). Generalisations therefore cannot be drawn from the survey results. Rather the report provides a scoping review of existing CCE initiatives and identifies types, scope, content and age groups each initiative targets. As mentioned earlier, it is intended that the findings from this survey would inform a more representative large-scale survey of CCE initiatives throughout Europe. Despite the small sample, however, the survey yielded some informative and relevant results.

The data from the survey were compiled and collected for analysis. Descriptive statistics were used to analyse the responses from the survey to identify patterns and averages in the types of initiatives, scope, content and age groups each initiative targets. In addition, content analysis was used to explore main themes across the open-ended responses related to the aims and descriptions of the initiatives.

3. Summary of Findings

3.1 Organisations

A total of 67 responses from 14 countries (Austria, Croatia, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Norway, Poland, Spain, Sweden, and Switzerland) were received. Table 1 shows the participating countries in the survey, the total number of responses received from each country and the distribution of institutions that responded to the survey.

Table 1 | Participating countries and distribution of institutions that completed the survey

	Governmental Organisation	Higher Education Institution (HEI)	International Organisation	National Academy	Non-Governmental Organisation	Hybrid (NGO + HEI)	Private Organisation	Schools
Austria					1			
Croatia				1				
Denmark		1			1			
Finland		6						1
France	2				5			
Germany	1	1						
Ireland	1	5	1				1	
Israel		1						
Italy			1	1	2			2
Norway	2	1						
Poland				3				
Spain				1				
Sweden	3	5			10	3	2	1
Switzerland				1				

The survey revealed that all of the initiatives are offered in the national languages of the participating countries. However, some of the initiatives have multiple working languages (6/67), either because the institutions are bilingual - as it is the case of the Royal Academy of Sciences and Arts of Barcelona that offers the courses in Spanish and Catalan - or because the initiatives are part of international projects - for instance, the *Oxford Debates for Youth in Science Education (ODYSSEY)* in which schools from Poland, Estonia, Serbia and Greece participate. There are also some initiatives (8/67) that have translated their resources into other languages such as English, German, French, Spanish and Swedish. For example, the resources developed by Fondation La main à la pâte / Office for Climate Education in France have German, Spanish and English translations available and the initiative 'Earthshape-EarthSurface Shaping by Biota' developed by GeoForschungsZentrum Potsdam in Germany offers English, German and Spanish versions.

Out of the 67 responses 20 and 19 of these respectively were from Higher Education Institutions and non-governmental organisations. Only nine and seven of the responses respectively came from governmental organisations and national academies and only two of the responses came from international organisations. Four schools completed the survey, one for Early Years (1 to 6 years-old) in Finland, one Primary School in Sweden, one Secondary School and one High School both in Italy.

3.2 Scope of Initiatives

Figure 1 outlines the scope of the different initiatives. In relation to the scope, more than half of the initiatives were self-identified as national in terms of scope (38/67) or having a multi-level scope (16/67), that is local, regional and/or national. For example, the Science Education for Action and Engagement towards Sustainability (SEAS) in Norway works at a community level developing models, tools and resources that contribute to community well-being while also creating regional and national networks that support engagement with science for action. In a similar manner, the Young Environmentalist Awards in Ireland empower young people to take action at the local level to protect the environment and to raise awareness among their communities but the different projects are disseminated at a regional and national level.

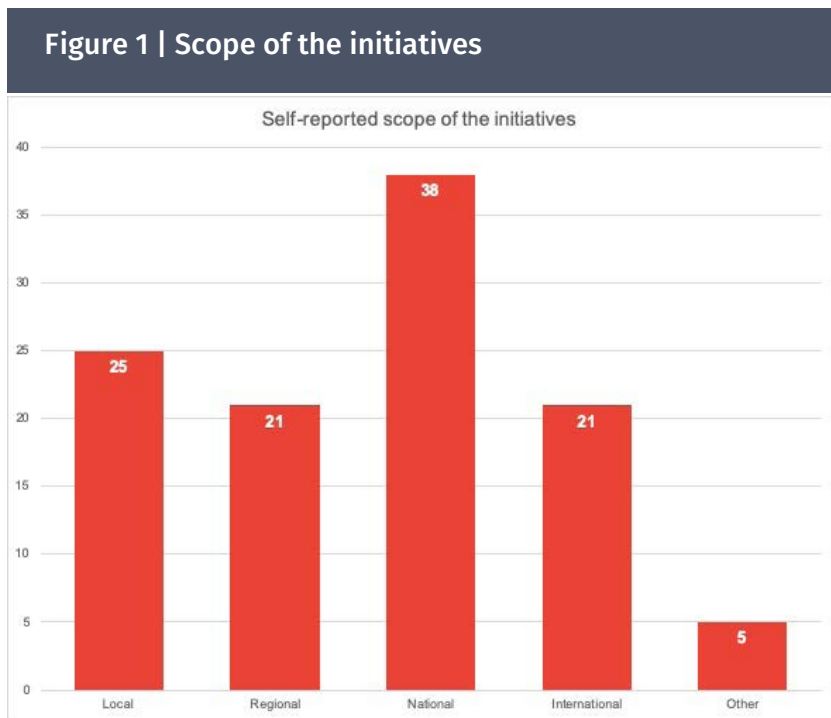
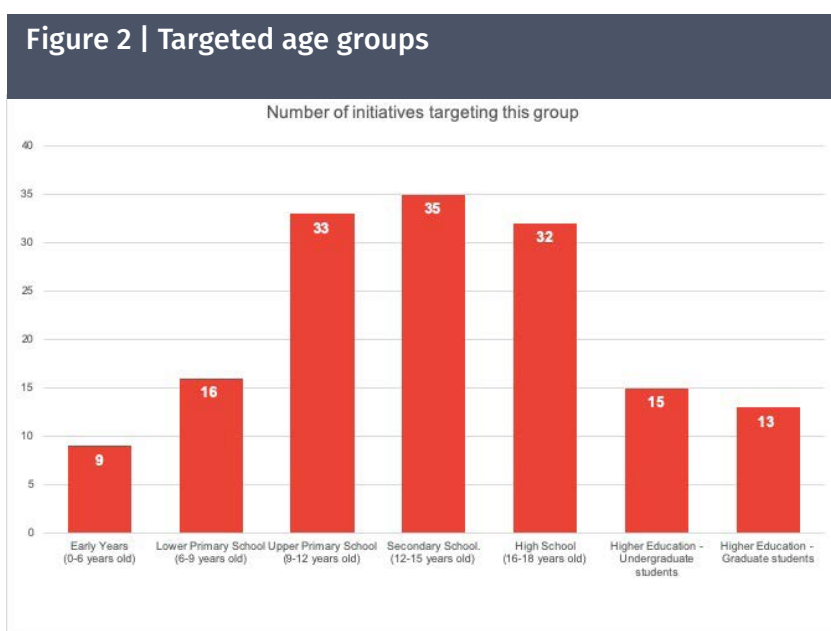


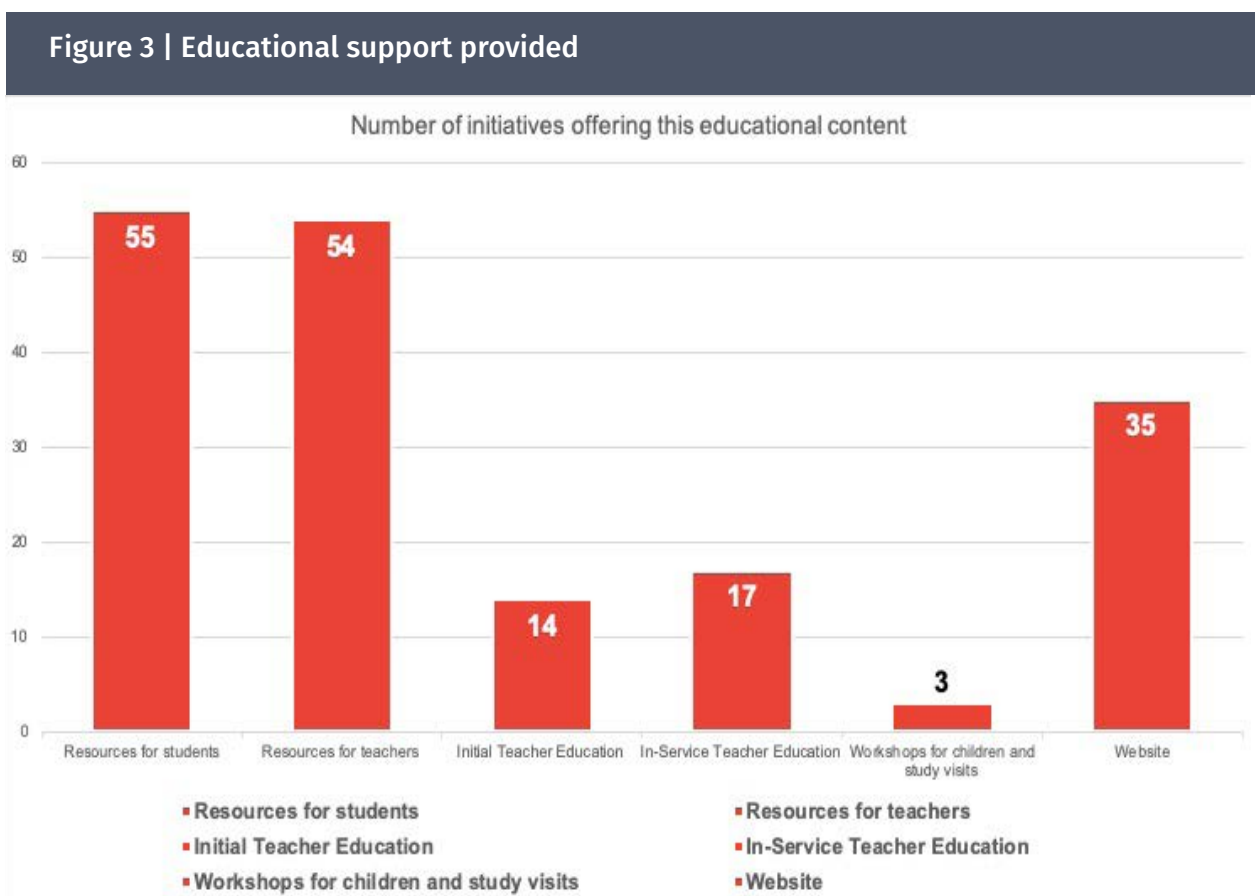
Figure 2 provides an overview of the age-groups the different initiatives reported in the survey target.



As can be seen from Figure 2, a high percentage of the initiatives outlined in the survey are aimed at children and young people. Nearly 75% of the initiatives referred to in the survey include primary-school children in their target audience (49/67), over half of them include secondary-school students (35/67) while almost half of the initiatives include high-school students (32/67). Of the initiatives that involve participants in Higher Education (28/67), there is an equitable distribution between undergraduate (15/67) and graduate programmes (13/67).

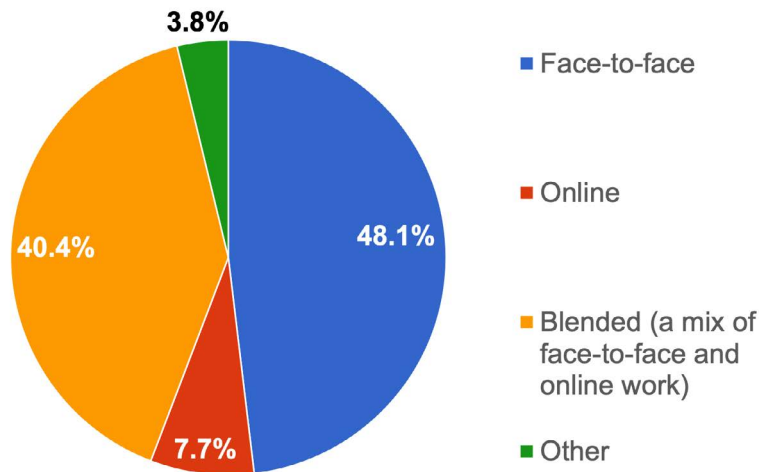
3.3 Educational Support

As indicated in Figure 3 below, a very high number of the initiatives offer resources for students (55/67) or teachers (54/67). However, few of the initiatives offer professional development (PD) for teachers. Only 14 of them offer PD at Initial-Teacher Education level and 17 offer PD for practising (in-service) teachers. Out of the 67 responses in the survey, six of the educational initiatives referred to resources and professional development modules specifically designed for educators providing professional development support for practising teachers.



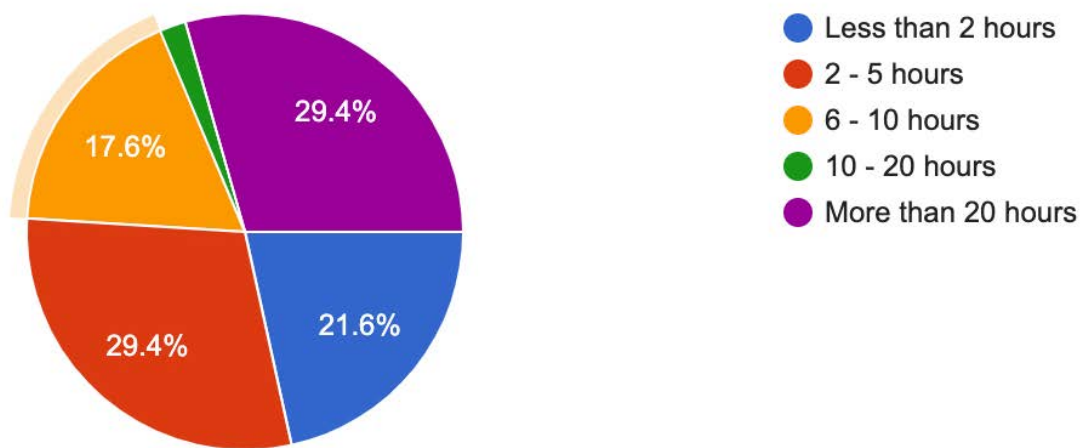
While further exploration is required to understand the nature, content, implementation and impact of the professional development programmes, the variety of formats in which the professional development programmes are being delivered is worth noting. Figure 4 provides an overview of the different formats in which the PD is being provided. These include face-to-face (25/52); blended as a mix of online and face-to-face components (21/52); or completely online (4/52).

Figure 4 | Delivery of Professional Development Programmes



The length of the professional development (PD) programmes vary significantly between the different initiatives (Figure 5).

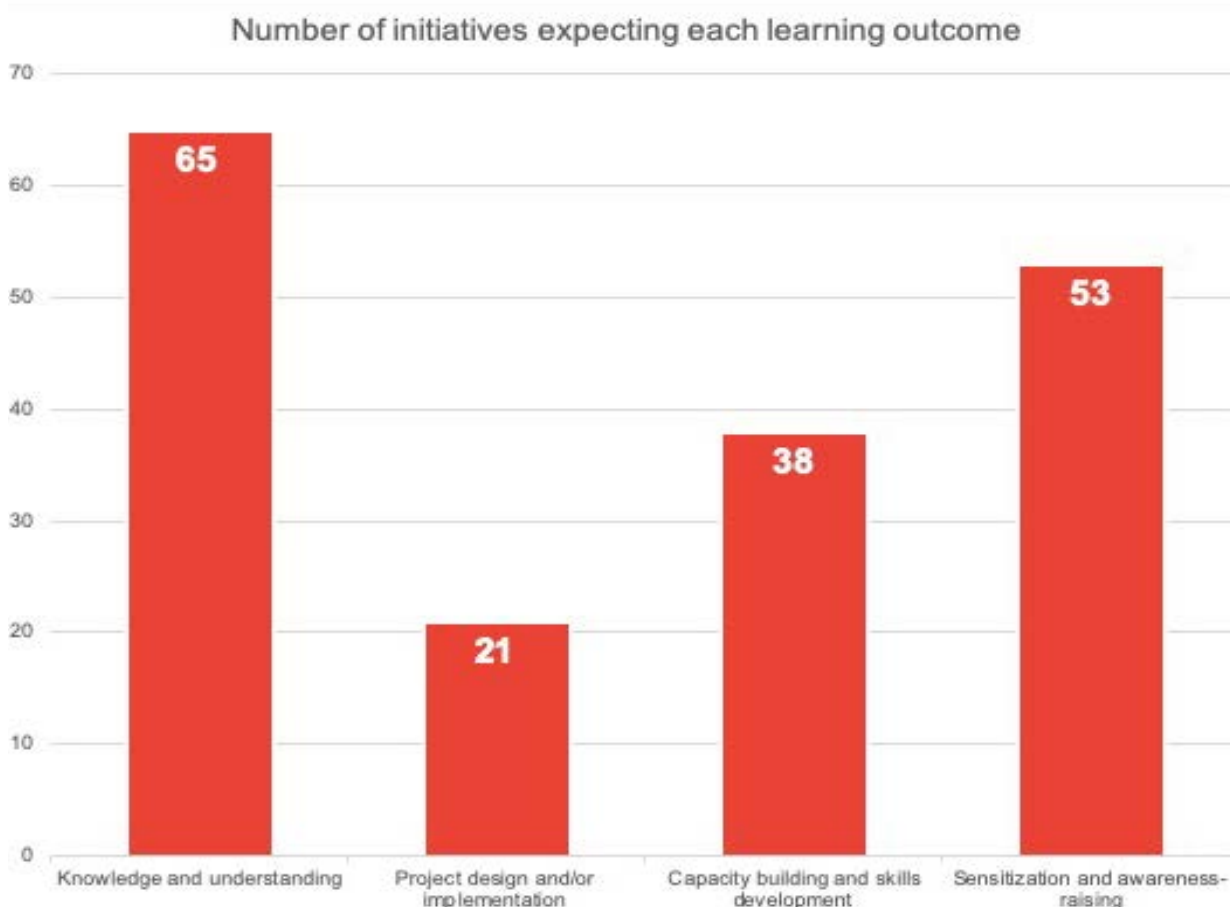
Figure 5 | Length of CPD programmes



As can be seen from Figure 5, some of the PD programmes are less than 2 hours in length (11/52), others are more than 2 hours but less than 10 hours (24/52), while relatively low numbers of the PD programmes are longer than 20 hours (14/52). Examples of the 14 programmes that are longer than 20 hours include the *Course on Climate Change* offered at the Weizmann Institute of Science in Israel, the undergraduate module on *Climate Change Education* offered at Dublin City University in Ireland and the Initial Teacher Education programme on *Sustainable Education* delivered by the University of Eastern Finland.

Almost all of the initiatives (resources and professional development programmes) (65/67) focus on developing knowledge and understanding about climate change (Figure 6).

Figure 6 | Expected learning outcomes

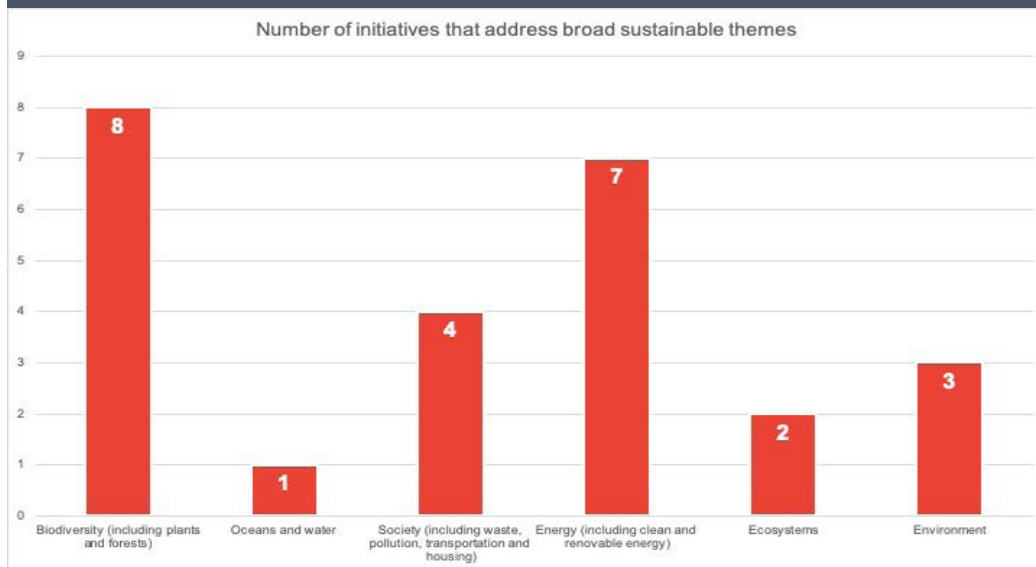


However, only a third of the initiatives also provide support for design and implementation of climate action projects (21/67). Interestingly, of the 41 respondents that made concrete suggestions for Climate Change Education, 12 commented on the need to foster climate action among children and to help them develop suitable solutions.

3.4 Content and Focus of Initiatives

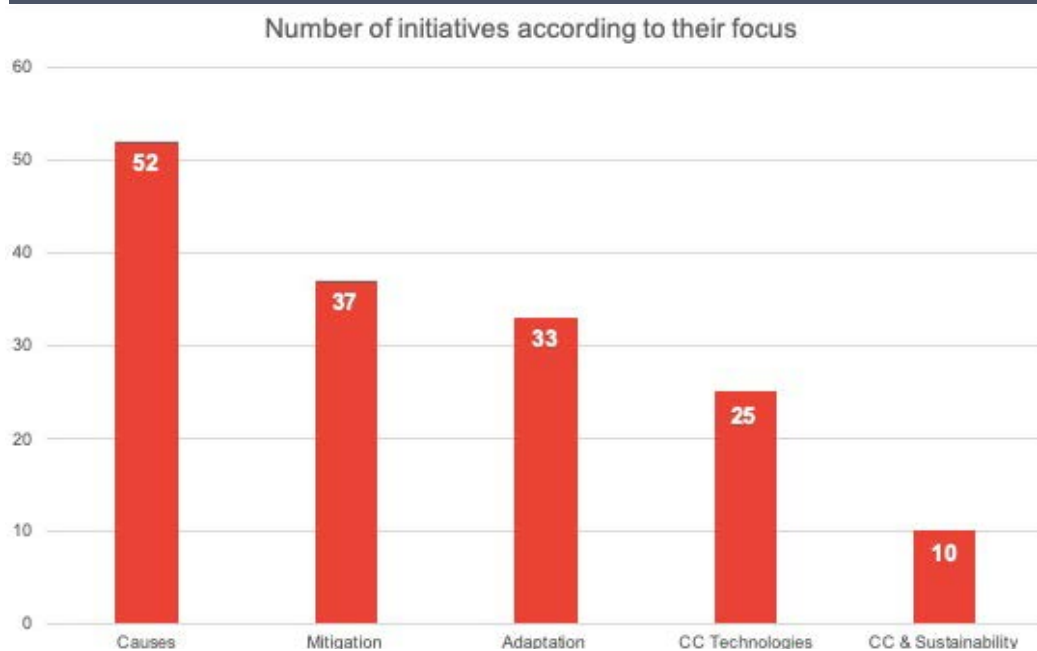
Figure 7 provides an overview of the content in the various initiatives. More than half of the initiatives' content relates to climate change (51/67) although the specific approach of the content varies from one to another. Some initiatives address climate science (25/67), a few focus primarily on the relationship between climate change, STEM, scientific knowledge and reasoning (9/67). Although the survey explicitly looked for information on climate change some of the responses referred to initiatives on Education for Sustainable Development (ESD) and the SDGs (25/67). The variety of topics presented in the ESD related initiatives demonstrates how the scope of sustainable development has widened significantly as a result of a more complex and comprehensive understanding of what it entails. A sustainable future requires focusing not only on the responsible use of natural resources but also on the social, economic and cultural challenges we face as a global society.

Figure 7 | Content of the initiatives



Other initiatives focus on mitigation, adaptation and risks (4/67), climate action and implementation of solutions (5/67), while others focus on climate policy and politics (3/67). Figure 8 provides an overview of the focus of the different initiatives.

Figure 8 | Focus of the initiatives



The majority of them (52/67) address the causes of climate change. However, fewer of the initiatives tend to focus on issues regarding climate change mitigation (37/67), climate change adaptation (33/67) and impact reduction (32/67). Interestingly 25 of the initiatives mentioned climate change technologies as one of their focuses, while some of them (10/67) explicitly link climate change with sustainable development.



4. Recommendations

The recommendations put forward in this section are based on the survey findings, the educational and climate change education research literature and on the expertise of the sub-group that was convened to conduct this work.

1.

It is apparent that there is a myriad of resources available throughout Europe to support teaching and learning about climate change. Of the initiatives identified in the survey, many of them (43/67) have content and materials that are available to the general public and have open access. It is important to collate good examples of CCE resources for different age groups (primary / post primary / tertiary levels), so that educators throughout Europe could avail of them and use them in different educational settings. The first step should be to assess the quality of these resources and the extent to which they adopt more inquiry-based and problem-based pedagogies. Good exemplars of CCE resources could then be identified. A set of criteria or a framework for effective CCE could be created that would support the development of future CCE resources.

2.

It would appear that there is a tendency for the different initiatives to focus on more grass-root approaches to climate change rather than focusing on climate change at a more local level. In terms of scope, therefore, it is necessary to incentivise the development of local initiatives that are fully contextualised and address the needs of communities. These contexts could also be used when discussing and considering climate change issues at a global level. One way of progressing this might be that the emphasis of programmes could shift from local, at primary and middle school levels to more global at high school and third levels.

3.

The aims of the CCE initiatives need to expand to focus more on mitigation and adaptation. We found that a high percentage of the initiatives focus on the causes of climate change and the science behind it while very few address issues of mitigation and adaptation, the use of technology or the implementation of actions and solutions. CCE initiatives should consult the successive Intergovernmental Panel on Climate Change (IPCC) summary reports that provide regular updates on the most recent developments in climate science. These reports also outline potential solutions for adaptation and mitigation.

The aims of the Climate Change Education initiatives need to expand to focus more on mitigation and adaptation- a high percentage of the initiatives focus on the causes of climate change and the science behind it while very few address issues of mitigation and adaptation, the use of technology or the implementation of actions and solutions.

4.


Further information is required to examine the extent to which 'climate justice' is addressed in the different educational resources / projects. The question arises, for example, in the context of when mitigation is being addressed in developed countries, to what extent students are being supported in their understanding about the role society today has to play in acting not only on their own interests but in the interest of others. Students have to understand that mitigation is not only crucial for future generations but is also essential for current disadvantaged populations on whom climate change is having the biggest impact resulting in these populations having to deal with significantly bigger challenges. Stapleton (2015) highlights that a climate justice approach to climate change education is also pragmatic, as many learners are motivated more by 'justice' concerns than by the 'ecological' concerns with which climate change has traditionally been associated.

5.

Considering the emotional responses that climate change might elicit, particularly amongst young people, it is necessary that CCE resources and programmes advance solution-oriented approaches to climate change. Initiatives that solely focus on the scientific knowledge of climate change run the risk of overlooking the complex social, historic, economic, political and psychological factors involved which determine how we are and might respond to the challenges it poses (Burke, Sanson and Hoorn, 2018; Martinez Sainz, Oberman and Mallon, 2019). Evidence suggests that the overwhelming nature of climate change can provoke a sense of helplessness among children (Waldron et al. 2016) which can be addressed through initiatives that focus on solutions and collective actions as a means to decrease eco-anxiety while fostering a sense of agency. There is also a need for promoting CCE amongst teachers, in particular two themes have been identified as critical: capacity building for teachers to convey climate change in a personally relevant and meaningful way, and development of skills to use active and engaging methodologies for climate change education (Monroe et al. 2019).

6.

There are gaps in the age ranges that the initiatives target. High percentages of the initiatives appear to target primary and post primary school students for example, however, very few target early years' education. As recent literature shows (Rooney 2018; Do Nascimento 2019), it is important to develop educational resources and programmes related to climate change for early years' education. Such programmes would not necessarily start with details of climate change, rather they could focus on more concrete topics related to climate change. For example, waste, biodiversity, fair usage of materials etc. In terms of climate change early years' education could focus on the differences between climate and weather initially, rather than focussing on climate change as such.

The image shows two young girls from behind, painting large green leaves on a white wall. The girl on the left is wearing a white long-sleeved shirt, and the girl on the right is wearing a light-colored, textured dress. The wall is decorated with various green leaves of different shapes and sizes, some of which are being painted by the girls. A semi-transparent dark grey box with white text is overlaid on the left side of the image.

There are gaps in the age ranges that the initiatives target. High percentages of the initiatives appear to target primary and post primary school students for example, however, very few target early years' education.

7.

Almost all of the initiatives reported in the survey offer educational resources to support teaching and learning about climate change. However, in contrast, there appears to be a dearth of initiatives that offer professional development for teachers to support them in teaching climate change. It would appear therefore that a greater focus needs to be placed on the development and implementation of high-quality professional development programmes for teachers. Further research is required to assess the targeted age group (primary / post-primary teachers, teacher educators) quality, type (face to face, online, blended), duration, pedagogies underpinning and impact of the current professional development education programmes in climate change on teachers' confidence and competence in teaching about climate change. Such research should also assess the extent to which teachers are implementing the professional development methodologies in their classrooms and the impact on their students' understanding of and attitudes towards climate change. The findings from this research could inform the development and rollout of effective professional development programmes on climate change education throughout Europe.

8.

Educational research indicates that effective Continuing Professional Development (CPD) programmes are ones that improve teachers' confidence, subject and pedagogical knowledge and classroom practice (Darling-Hammond et al. 2017; Desimone 2009). Furthermore, the evidence suggests that effective models of CPD for teachers adopt longer more sustained approaches that are relevant, differentiated, interactive and support teachers in implementing new ideas into the classroom (Coe et al. 2014; Guskey 2000; Monroe et al. 2019; Smith 2015; Whitehouse 2011). Over the last decade, professional development projects in the area of ESD have been the focus of a number of research projects throughout Europe (Mader et al. 2014; Redman et al. 2018). However, these projects have tended to focus more on ESD in general rather than specifically focusing on CCE. Taking cognisance of the research literature for effective professional development, future CCE CPD programmes should move away from 'once size fit all' type models, towards more longer term programmes, that are differentiated, hands-on and that support teachers in developing their Pedagogical Content Knowledge (PCK) (Shulman 1986) in CCE.

It is also recommended that the content of future CCE modules should include:

- » *Climate Science Overviews*: Accurate scientific overviews of different aspects of climate change. These overviews should be informed by the latest IPCC reports (2014; 2019) that provide accurate scientific accounts of how our planet is being impacted by climate change. These reports provide regular updates on the most recent developments in climate science and also suggest potential solutions for adaptation and mitigation.
- » *Inquiry-Based Science Education (IBSE) pedagogy*: The importance of IBSE methodologies in developing young people's scientific literacy is well documented (Artigue et al. 2012; Harlen 2012; Rocard et al. 2007). Research indicates that IBSE methodologies support the development of young people's scientific content knowledge and skills; increases interest and motivation in science; supports collaboration; promotes critical thinking and scientific reasoning skills (including the ability to provide evidence-based arguments) – and promotes problem solving skills (Artigue et al. 2012; Harlen 2012; Murphy et al. 2019). These skills are essential in enabling young people to understand issues around climate change, which is critical considering younger generations will be the most affected by climate change and facing the environmental, social and economic consequences (Corner et al. 2015; Ojala 2012; Ojala & Lakew 2017)
- » *Nature of Science (NoS) pedagogy*: Accepting the facts and projections on climate change requires more than acquiring some basic knowledge. It also requires establishing a relationship of trust with science, in order to understand how science works and how its conclusions are validated within the scientific community, including and understanding the concepts of uncertainty (IPCC 2014; 2019). NoS pedagogy supports students in developing their understanding about the epistemology of science (Lederman 2001; Murphy et al. 2011). For example, if young people were afforded opportunities to learn about what climate


scientists do (observe patterns, gather data, measure and interpret data, develop climate models), they would value the work of climate scientists and would understand how they have gathered information and evidence about climate change. Such knowledge would support young people in understanding the scientific ‘facts’ around climate change and the principle of uncertainty (IPCC 2014; 2019) but would also enable them to distinguish facts from opinions.

» *Project-based pedagogy (PBP)*: Project-based pedagogy adopts hands-on inquiry based methodologies and addresses core content via rigorous, relevant and hands-on learning. Projects are typically framed with open-ended questions that encourage investigation, research and construction of solutions (Liescarmontier et al. 2020). Through PBP teachers can support their students in the design and implementation of projects and solutions for climate change adaptation and mitigation.

9.

Primary and post-primary curricula throughout Europe are being reviewed and revised and ESD and Climate Change are being included as content in many of these revised curricula (For example: Austria, France, Finland, Ireland, Norway, Sweden). In the current survey participants were not asked to indicate whether or to what extent national curricula were embedded in the various initiatives. Further research needs to be conducted to establish whether or to what extent existing climate education resources and initiatives (including Initial Teacher Education and Continuing Professional Development for teachers) are linked with national curricula.

The findings from this survey provide a snapshot, some initial insights into CCE initiatives in Europe. However, a more in-depth examination of a wider range of climate change education initiatives is warranted to ascertain a more thorough account of the status of climate change education resources, particularly with regard to their content, scope, quality and impact on teaching and learning at primary, secondary and tertiary levels. The recommendations provided above outline a large number of actions that are required to achieve the necessary changes. However, these actions will require significant financial support in order to support the research and implementation of effective CCE throughout Europe. Cognisance should be taken of the 2007 EU decisive Rocard report, followed by the highly successful FP6 and FP7 EU funding calls that supported a vast range of Inquiry-Based Science Education projects throughout Europe. It is therefore proposed here that the Climate Strategy of the Union considers the connection between science, societal issues and education to be a vital sector for the future of the youth. After a thorough review of the recommendations of this survey and a more detailed follow-up, it is recommended that a similar funding framework should be established to support research in and the development of effective approaches for teaching and learning about Climate Change Education.

A photograph of a female teacher with long brown hair, wearing a white shirt, smiling and high-fiving a young boy with short blonde hair, wearing a blue and white striped shirt. They are standing in front of a green chalkboard. On the chalkboard, there are some faint chalk drawings, including a large number '2' and a simple drawing of a person or object. The teacher's hand is raised to high-five the boy's hand.

Professional development programmes should support teachers in developing the requisite knowledge and skills to effectively teach about climate change. Two themes have been identified that are common to many environmental education initiatives, namely, focusing on personally relevant and meaningful information; and, using active and engaging teaching methodologies.

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About the ALLEA Science Education Working Group

Education policies across Europe highlight the importance of the role science education plays in ensuring citizens have the requisite knowledge and skills to enable them to become ‘informed critical consumers of scientific knowledge’, according to the OECD. Today, society faces numerous global challenges, from climate change, pollution to malnourishment and hunger. Science is embedded in these challenges and science education has a crucial role in ensuring our students -future decision makers- have the necessary knowledge and skills to make sense of and address them.

For the past thirty years or so the focus of science education throughout Europe has moved from an emphasis on teaching and assessing science content towards the development of students’ scientific literacy. This shift in science education has led to an increase in the number of students leaving formal education with science qualifications.

The ALLEA Science Education Working Group is committed to supporting the further progression of science education throughout Europe to ensure our students develop the necessary knowledge, skills and motivation to participate as active citizens and to pursue careers in science.

Central themes of the group include:

- » Global Influences on Science Education
- » Development of students’ scientific literacy
- » Effective Continuing Professional Development (CPD) for teachers
- » Climate Change Education
- » Education for Sustainable Development

Members of the ALLEA Science Education Working Group

- » Cliona Murphy (Chair) – Royal Irish Academy
- » Nils O. Andersen – Royal Danish Academy of Sciences and Letters
- » Benő Csapó – Hungarian Academy of Sciences
- » Maksym Galchenko – National Academy of Sciences of Ukraine
- » Stefan Jokic – Institute of Nuclear Sciences, Serbia
- » Lena Kjellen – Royal Swedish Academy of Sciences
- » Pierre Léna – Académie des Sciences, France (honorary chair)
- » Jan Lundell – LUMA Centre Finland
- » Odile Macchi – Académie des Sciences, France (past chair)
- » Pia Norrthon – Science and Technology for All Programme (NTA), Sweden
- » Svein Sjoberg – Norwegian Academy of Science and Letters
- » Petra Skiebe-Corrette – Free University Berlin, Germany

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About ALLEA

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Academies are self-governing bodies of distinguished scientists drawn from all fields of scholarly inquiry. They contain a unique human resource of intellectual excellence, experience and multidisciplinary knowledge dedicated to the advancement of science and scholarship in Europe and the world.

Jointly with its members, ALLEA seeks to improve the conditions for research, to provide the best independent and interdisciplinary science advice available, and to strengthen the role of science in society. In doing so, ALLEA channels the expertise of European academies for the benefit of the research community, decision-makers and the public. Outputs include science-based advice in response to societally relevant topics, as well as activities to encourage scientific cooperation, scientific reasoning and values through public engagement.

ALLEA is constituted as a non-for-profit association and remains fully independent from political, religious, commercial or ideological interests.





CONTACT US

ALLEA | All European Academies
Jägerstraße 22/23
10117 Berlin
Germany

☎ +49 (0)30-3259873-72
✉ secretariat@allea.org
🌐 www.allea.org
🐦 @ALLEA_academies