

Climate change competencies from perspective of Finnish Youth

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Abstract

Climate change (CC) is causing distress and worry in today's young people, who are inheriting CC-related problems from previous generations. To equip young people with the necessary CC mitigation and adaptation skills, we need a detailed description of CC competencies. A framework of CC competencies describes sets of knowledge, skills, values, and attitudes required to tackle climate change. Young people are the next generation of leaders, and it is particularly important to listen to their hopes and demands. To create a CC competency framework from the perspective of Finnish young people, we surveyed 43 young respondents using an open-ended questionnaire. All respondents were participants in a climate change summit for young people. Based on the responses, we compiled a framework of six climate change competencies: CC systems thinking, CC science orientation, CC leadership, CC justice and collaboration, CC implementation, and CC well-being. The results provide insight into the qualities that were emphasized by the young people, such as urgency of action, the need for solidarity, and science-based knowledge. We conclude that this framework can serve as an opening for a discussion on climate change competencies, which can eventually be utilized as a basis for learning outcomes in CC education.

Keywords: *climate change, young people's perspective, climate change education, climate change competencies*

Introduction

Climate change is causing increasing distress and concern among today's young people (Ojala 2015; Fløttum, Dahl and Rivenes 2016; Myllyniemi and Kiilakoski 2019 and Marks et al., 2021). Young people have a strong sense of uncertainty about their future and feel both betrayed and abandoned by governments and adults because climate change issues have not been adequately addressed (Marks et al., 2021; Hickman et al., 2021; Myllyniemi and Kiilakoski 2019). Intergenerational climate change injustice has even been recognized as young people are inheriting social and ecological problems (Piispa and Kiilakoski 2022; Cutter-Mackenzie and Rousell 2019). Young people have openly criticized climate change policies for not conforming with climate science recommendations (Piispa and Kiilakoski 2022).

Tackling and coping with climate change requires quick (re)action, strong climate change expertise and interdisciplinary work (Riuttanen et al., 2019; Kelly et al., 2019; Lehtonen et al., 2018; Perry 2015). Climate change has been repeatedly recognized as a wicked problem (Head 2008; Incropera 2016; Perry 2015), meaning that there are no clear or easy solutions for how to mitigate anthropogenic greenhouse gas emissions around the globe, or how to adapt to the rapid changes observed in the climate and nature (Masson-Delmotte 2021; Perry 2015). Even though global warming, the key aspect of climate change, can be described as a physical phenomenon, it has causes in societal development and implications for biology, sociology, well-being, and many other fields. An understanding of all these fields, as well as the ability to take effective action in collaboration and from local to international levels is necessary to mitigate climate change and to adapt to the changes.

Climate change education has been recognized as playing a key role in achieving mitigation and adaptation goals (Masson-Delmotte 2021; Bangay and Blum 2010). To make climate change education coherent and meaningful for young students, it is crucial to identify and specify the necessary competencies. Competencies are seen as a set of knowledge, skills, values, and attitudes which together form a functionally linked complex for performing a certain task or, above all, for problem solving (Wiek, Withycombe, and Redman, 2011). A set of individual competencies form a framework of competencies. In education, competencies serve as the basis for learning outcomes, but they are too broad and abstract in nature to be used directly as such (Brundiers et al., 2021; Wiek, Withycombe, and Redman, 2011).

The concepts of sustainability, sustainability education and sustainability competencies have been under development for decades (Wiek, Withycombe, and Redman, 2011; Brundiers et al., 2021; Bianchi, Ulrike, and Marcelino, 2022). Since climate change is one of the consequences of unsustainable practices in society (Lehtonen et al., 2018), sustainability competences can be seen as a key to effective mitigation and adaptation. However, in a recent study, Riuttanen et al. (2019) suggest that climate change competencies would differ from sustainability competencies. It has also been noted that in education, broad sustainability models do not capture the needs of specific issues such as climate change (Cantell et al., 2019).

This paper focuses purely on identifying and describing the climate change competencies needed by society from the perspective of young Finns. Piispa and Kiilakoski (2022) showed that Finnish young people have a critical and active interest in the climate crisis. In their study, young climate activists express disappointment with the slow implementation of climate science recommendations in national and global policies, and demanded urgent and just climate action. Research has proved that engaging students as co-researchers in investigating young people's

voices on climate change can be insightful (Cutter-Mackenzie and Rousell, 2019). Listening to young people can also lead to new perspectives when it comes to their demands and hopes for climate change education (Girard et al., 2015). Therefore, instead of the more common top-down method, we used a bottom-up approach and asked young people for their opinions on the required climate change competencies. We agreed with Cutter-Mackenzie and Rousell's (2019) proposal that young people should be considered legitimate participants and collaborators in research, rather than objects of investigation. Indeed, young people are experts on their own lives and perspectives (Cutter-Mackenzie and Rousell, 2019).

This study duly provides insights into a group of young Finns engaged in climate action. We describe their views on the knowledge, skills, values, and attitudes that society needs in order to achieve climate change mitigation and adaptation goals. Our aim is to put together a framework that serves as a descriptive model presenting the competencies that climate aware Finnish young people believe society needs to tackle climate change.

Data collection

We collected young people's views on the knowledge, skills, values, and attitudes that are needed by our society. To begin with, young people were asked to describe the climate change goals and the mitigation and adaptation action that they considered important. They were then asked to separately list the knowledge, skills, values, and attitudes that society needs to reach these goals. Responding to the survey was voluntary and participants received a link so that they could reply using a phone or computer. The survey was introduced at a stand in a climate change-related event

for young people. In addition, an email was sent to all event participants asking them to respond to the survey and to complete their responses within seven days of the event.

According to Jackson and Trochim (2002), open-ended questions can elicit honest and current thoughts and experiences from participants, although, there is also a possibility that answers will be brief and minimal. Incomplete and vague answers can be avoided by using a purposeful sampling technique whereby the group of participants is intentionally limited (Harsh, 2011). Hence, we chose a group of young people that had a pre-existing interest in the topic of climate change, allowing us to receive information-rich answers. The survey was distributed to participants aged 16 to 27 at the *Climate and nature summit for young people* in Helsinki, in October 2019, which was attended by nearly 200 people from different parts of Finland. The national event was organized by young people for young climate-active Finns to learn about and discuss the current climate crisis, nature loss, and the Mock COP26 –agreement. Mock COP is an internationally youth-led organization working to raise the topic of the climate crisis in decision-making.

The survey, which included 23 questions in total [Appendix 1], was created using Qualtrics, and the form was compatible with both computer and smartphone. There were six background questions on items such as age and educational background, and ten open-ended questions, including one on the identification of climate change goals and the rest on identifying the (1) knowledge, (2) skills, and (3) values and attitudes required at a societal level and by a climate change leader to achieve the above goals. The questions on needed knowledge, skills, values and attitudes were asked separately for a climate change leader and collectively for the whole society, to receive descriptions from different perspectives. At the end of the survey, there

were five multiple choice questions and two open-ended questions on climate change-related education.

A total of 43 participants completed the questionnaire, either during or within seven days of the event. Both the event and the survey were conducted in Finnish. For the purposes of this article, all survey questions and 19 quoted responses were translated into English after the analysis phase. The survey was anonymized, and the young respondents could not be identified at any stage during the analysis. Respondents' ages ranged from 16 to 27 years (mean = ~21, SD = ~3, mode = 26). Most of them (85%) identified themselves as women, 8% as men and the rest either as other or did chose not to answer. There was a notable gender imbalance, and we cannot exclude its influences on the outcome. Most of the young respondents were either upper secondary school graduates (31%) or had a lower academic degree (31%). The rest had either finished comprehensive school (23%) or had a higher academic degree (15%). At the time of the research, half of the young respondents were studying at an upper secondary school and the other half at university.

When participants were asked where they have learned about climate change, some reported that they had studied climate change independently and formal education was mentioned in all answers. In a national survey about climate responsibility, 94% answered that they had learned about climate change in schools (Opetushallitus, 2019). The topics of sustainability and explicitly climate change topics have been increasingly included in the Finnish curricula (EDUFI, 2014; EDUFI, 2019).

Analysis

Utilizing computer-assisted (ATLAS.ti) content coding, the responses were typologized into a more generalized and coherent list [Figure 1]. Code-based analysis was used as part of the inductive content analysis research method, in which textual data is summarized into content-related categories (Elo and Kyngäs, 2008). The purpose of forming these categories was to develop a conceptual framework or map, in this case a framework of young people's climate change competencies. Jackson and Trochim (2002) criticize the technique because it relies on the researchers' classification and may allow interdependence between coders. This bias could be avoided by using a word-based analysis, where words are used as the units of analysis. However, a word-based analysis did not suit our responses, as they were written in Finnish, a language in which grammatical cases change the phrasing of words. In addition, it was meaningful to analyze the words and phrases while keeping the context in mind in a content-sensitive way (Elo and Kyngäs, 2008). To assess whether the results of the analysis were coherent and comparable with previous literature, the results were actively compared with the learning models of Tolppanen et al. (2017) and Cantell et al. (2019), and the frameworks of sustainability competencies by Brundiers et al. (2021) and Bianchi, Ulrike, and Marcelino (2022) while completing the analysis.

The inductive research method proceeds from the specific to the general (Elo and Kyngäs, 2008). First, the qualitative data was organized using open coding. In other words, notes were written next to the open-ended textual data while reading it through (Elo and Kyngäs, 2008). At this stage, the answers related to the needed competencies of a climate change leader and the society were kept separately. Every feature mentioned in the responses was coded using the same words as the participant where possible, leading in total of 116 codes [Figure 1, *1st section*]. Some words were used to describe multiple themes and resulted in several codes. For example, empathy

was part of three different codes: one in the context of listening and leading others with empathy, the second in considering and treating others with empathy, and the third in feeling empathy for oneself and others. After the first author had coded all the responses, the process and the codes were discussed with the other authors. The first author then went through all the answers again to ensure that they were coded consistently. Codes supporting the same theme or meaning were grouped by the first author into sub-categories, which eventually numbered 40 [Figure 1, 2nd section]. Each sub-category described one piece of knowledge, skill, or value and attitude [Figure 1, 3rd section]. The final combinations of climate change competencies were formed by grouping the sub-categories of knowledge, skills, and values and attitudes that all seemed to support the same topic [Figure 1, 4th section]. The competency subcategories of the needs of a climate change leader and the whole society, emerging from the answers, pointed out towards very similar themes, and were therefore combined. Thus, the young people's point of view was that similar climate change competencies are needed by an individual climate change leader and society. The initial grouping was carried out by the first author and checked in discussions with the other authors. Each of the competencies was formed based on several answers, but there was no requirement for a certain percentage of the responses to contribute to a competency, for example. Each sub-category was included in only one competency with the aim of constructing competencies that both work independently and that complement each other. Each climate change competency was named using a content-characteristic heading. The framework consisted of six climate change (CC) competencies, namely: CC systems thinking, CC science orientation, CC leadership, CC justice and collaboration, CC implementation and CC well-being.

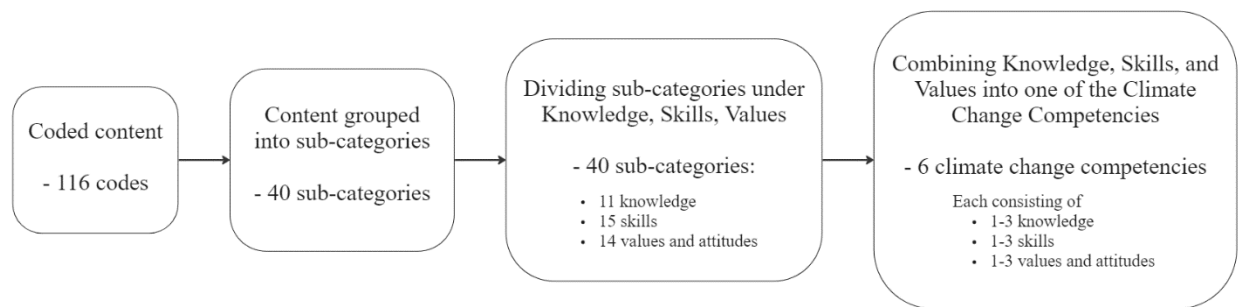


Figure 1. Illustrative image of the competency formation (analysis) process starting from the content of the open-ended responses.

Both the coding and the resulting climate change competencies framework were discussed by the research group and co-authors and presented at multidisciplinary national and international research meetings and seminars. The framework was also presented to five willing young respondents who had answered the first questionnaire. All five interviewees approved the framework and none of them had any amendments or suggestions related to the framework or to the specific competencies. Two of the interviewees were willing to discuss the competencies in more depth, and how they related to their responses in the survey. These two participants emphasized, among others thing, the various scales of implementation, the importance of justice and collaboration in everyday life, and the role of politics in climate change-related issues.

Results and discussion

Description of the competencies

The contents of the six climate change competencies, based solely on the young people's responses, have been aggregated in Table 1. The description of each competency is divided into knowledge (K), skills (S) and values and attitudes (A) related to either mitigation of, or adaptation to, climate change. The climate aware young people did not describe competencies in their answers, but the competencies comprise the different attributes they listed for a climate leader and society. The climate change competencies framework is also presented as a flower model, with each petal representing one of the competencies [Figure 2]. The resulting climate change competencies are presented one by one below. Each competency identified based on young people's responses is discussed and compared with similar competencies presented in the literature. All articles in the comparison have been carefully selected and are either similar in terms of the general topic, concept, or content to the climate change competencies defined in this study.

Table 1. Six climate change competencies based solely on the young people's responses. Each competency includes a short, general description followed by a more detailed description of the related knowledge (K), skills (S), and values and attitudes (A).

Climate Change (CC) Competency	Description
CC systems thinking	<i>Understanding the climate system, the structures of the society, effects of actions, ability to discuss the climate system, sustainable way of thinking</i>
K	Familiar with climate system (present state, factors/variables affecting the climate, climate scenarios/future), knows the structures of the society and effects that (climate) actions have on people and nature
S	Able to comprehend entities, consider and renew structures, comprehend, discuss, and explain the climate system
A	Sustainable way of thinking, highlights sustainable solutions, (systemic) understanding, interest and care for the effects of the (climate) actions
CC science orientation	<i>Orientation to seek scientific information, critical information literacy, curiosity as a learner, futures thinking, innovative attitude</i>
K	Bases knowledge on scientific information, understands scientific CC related information: i.e., the state of the Earth and climate, knows the factors that led to the present state and the effects of (climate) actions on future
S	Able to look for, learn and even create new knowledge, is innovative, has critical information literacy, and studying skills
A	Goal-directed, curious as a learner and doer, futures thinking, realism, ambitious
CC leadership	<i>Understanding the realistic solution possibilities, ability to make quick and rational decisions, skills of performing, speaking, writing, boldness, ambition</i>
K	Recognizes the urgency of climate change, acknowledges realistic solution possibilities and their effects on, i.e., the well-being of humans and nature, understands the structures of society and ways to affect people in an equitable way
S	Able to make quick and rational decisions, able to act as a leader, if necessary, possesses skills of performing, speaking publicly and writing
A	Open, bold, ambitious, realistic
CC justice & collaboration	<i>Understanding and aiming for equality, equity, and justice, ability to cooperate and work in collaboration, aim for justice, appreciate nature, people, and oneself</i>
K	Understands equality, equity, and justice related to the unequal nature of climate change
S	Able to cooperate and work in collaboration, make compromises, listen and treat people and nature in an equal and caring way
A	Aims for justice and equality/equity, caring, appreciates nature, people and themselves, open, direct, courage to change and take responsibility
CC implementation	<i>Understanding the structures within society and its ability to change, ability to put action into practice, willingness to end unsustainable practice</i>
K	Knows the structures within the society, its functionalities and capability/possibilities to change in practice
S	Able to put mitigation and adaptation action into practice and articulate directions in a clear, simple, and easy to understand manner
A	Willingness to discontinue unsustainable practices and try alternative solutions
CC well-being	<i>Ability and knowledge on how to take care of one's well-being (mentally and physically) in a changing climate and uncertainty, valuing one's and other's limits</i>
K	Knows one's own limits and ways to take care of oneself (both mentally and physically)
S	Able to take care of one's well-being, comprehend, handle, understand and control various emotions, take and share responsibility, has tolerance for pressure and uncertainty
A	Values one's own limits and well-being, in addition to nature and other people



Figure 2. Illustrative flower model of the climate change competencies framework. Each of the six petals depicts one of the competencies.

Climate change systems thinking competency

Understanding the climate as a system that is changing due to various cause-and-effect relations was the core idea that emerged from the young people’s responses related to the competency we called CC systems thinking [Table 1, 1st competency; Figure 2, top petal]. The young respondents

said that understanding the climate system requires knowledge about climate changes in the past, the present state of the climate, factors affecting the climate, and future climate scenarios. The need for information about both biophysical and societal processes and their connections emerged in quotation (1): *'Information on emissions sources (and on the scales between each source), information on ways the sources could be mitigated, information on carbon sinks, on ways to increase the number of sinks, information on the cooperative consequences of a decrease in emissions and an increase in carbon sinks for other biophysical parts of the system, as well as, for the well-being of people and the functionality of societies.'* The young respondents were aware that humans play an inevitable role in climate change, and they duly emphasized this point. In addition to climate knowledge, one needs to be familiar with the structures of society and the effects that climate action has had, and will have, on people and nature.

The ability to comprehend entities and both consider and renew existing structures is a CC system thinking skill, demonstrated in quotation (2): *'Understanding entities. Consideration and perception of long timescales.'* These CC systems thinking skills and knowledge together lead to the ability to explain and discuss complex climate systems. Of the values listed by the young respondents, a more sustainable way of thinking in general and a constant effort to highlight sustainable solutions were included in this competency. An interest in and concern about the effects of climate action were also categorized as a part of this competency's values.

The definition of systems thinking has been under discussion for decades (Amissah, Gannon, and Monat, 2020) and the concept can also be found in sustainability competency frameworks (Wiek, Withycombe, and Redman, 2011, Brundiers et al., 2021; Bianchi, Ulrike, and Marcelino 2022). Climate change systems thinking, based on the young people's answers, has a lot in common with the systems thinking of sustainability competencies. For example, according

to both our young respondents and Bianchi, Ulrike, and Marcelino's (2022) GreenComp, systems thinking competency aims to equip learners with the necessary understanding of complex problems. Systems thinking can be used to consider different levels (e.g., local, global), fields (e.g., environmental, economic) and times (e.g., past, present, future). Systems thinking is regarded by Brundiers et al. (2021) as cascading effects, inertia, and feedback loops related to sustainability issues and problem-solving, among other things. The young respondents in our study indicated that understanding these concepts is also necessary for understanding climate change.

Holism, complexity, relationships, causal loops, and structural consideration are concepts that appeared in the young people's responses and are mentioned, for example, by Amissah, Gannon, and Monat (2020) in an article compiling definitions of systems thinking in general. According to the young respondents, understanding of ill-structured problems and related scenarios requires a strong ability to find out-of-the-box solutions.

Climate change science orientation competency

The importance of using science-based information as a basis for knowledge and action, as highlighted by the young respondents, was included in the competency called CC science orientation [Table 1, 2nd competency; Figure 2, 1st petal on the right]. According to the young respondents, this means possessing knowledge about the state of the Earth and its' climate, about the variables and factors affecting it, and about the effects of current climate actions. Some examples are seen in quotation (3): '*Calculating greenhouse gas emissions, climate modelling, data-analysis...*'. In addition to knowledge, respondents highlighted the importance of being able to read and search for information in a critical way (quotation 4): '*Knowledge gained from real*

scientific information. Skills to distinguish between scientific and unscientific sources of information.'

However, rather than knowing everything about climate change, the young respondents were more concerned with scientific thinking and reasoning and making an effort to find reliable knowledge. Seeking, learning, and even creating knowledge requires skills (quotation 5): '*... First of all, skills, and willingness to gather more information and apply it in decision making...*'. These skills include academic learning skills, such as critical information literacy and ways to study efficiently (DiPerna and Elliott, 1999). Maintaining learning skills after leaving schools demands curiosity as a learner. Futures thinking, realism and ambitiousness, as listed by the young respondents, were seen as values and attitudes that supported CC science orientation.

As CC science orientation was defined by the young people's answers as an orientation toward the search for scientific knowledge and curiosity as a learner, it came close to some of the academic learning competences described by DiPerna and Elliott (1999). Academic learning competences consist of five main topics: academic skills, study skills, academic motivation, participation, and interpersonal skills (DiPerna and Elliott, 1999).

The young respondents recognized that topical knowledge of climate change played an essential role in climate change competencies. The more general academic learning competences presented by DiPerna and Elliott (1999) also have a lot in common with CC science orientation. Academic skills include, among others, vocabulary, problem solving and critical thinking skills (DiPerna and Elliott, 1999), which were all part of CC science orientation. Study skills are important in terms of the orientation toward seeking and creating new information and the ability to use it as a basis for one's actions and opinions. According to DiPerna and Elliott (1999), study

skills include the attitude or willingness to learn more and curiosity as a learner, which were also mentioned by the young respondents.

Academic motivation includes responsibility, initiative, challenge preference, and goal-directed behavior (DiPerna and Elliott, 1999). In particular, initiative and a goal-oriented attitude emerged from the young people's responses. Enthusiasm and motivation, together with the previously mentioned curiosity and willingness to learn more, were interrelated and served as an attitude and value base for CC science orientation.

Climate change leadership competency

In the young people's responses, CC leadership was about having a leader-like attitude rather than being a leader per se [Table 1, 3rd competency; Figure 2, 2nd petal on the right]. Consequently, CC leadership did not necessarily imply the competencies of a leader in a high-level organization or even a leader of a certain group. However, CC leadership competency can support being a climate change leader in areas such as one's family or hobbies.

The urgency of addressing climate change and the need for climate change action were one of the most highlighted features in the young people's responses and they formed the basis of CC leadership, as exemplified in quotation (6): *'Belief in the urgency of climate change.'* According to the young respondents, realistic solutions and their effects on people and nature should be identified. To know what can be done in society, one needs to familiarize oneself with the structures and different aspects of society. This was reflected in quotation (7): *'Information about factors affecting the climate and about possible solutions, understanding how to influence others and how to communicate about it with various target groups.'* In addition, the young respondents

discussed ways to influence people and emphasized that these means should be considered in an equitable way.

The skills addressed by the young people, which were grouped under CC leadership, were the ability to make quick and rational decisions and to be willing to act as a leader when necessary. Presentation skills, public speaking, and writing were also considered as necessary when certain messages or guidelines had to be conveyed (quotation 8): *'Speaking skills, charisma, trustworthiness, logical and rational actions'*. Values and attitudes pertaining to CC leadership included being open-minded, bold, ambitious, realistic, and willing to set an example (quotation 9): *'The courage to take on challenges even if they question common perceptions and habits...'*

Leadership competency is rarely addressed in education, although its importance has been perceived by UNESCO, for example (Wu and Otsuka, 2021). In an article about climate change leadership, Wu and Otsuka (2021) define leadership competence as 'An individual's insightful readiness to act on the climate change challenges, through personal efforts and interpersonal influences.' This description compasses many of the views raised by the young respondents in our study. They highlighted the readiness and willingness to act, even if it was not the easiest path and required personal effort. In addition, Wu and Otsuka (2021) state the importance of collective action. The young respondents also noted that even though CC leadership required personal effort, it should be aimed at collective action and influence.

The three main aspects of leadership competence described by Wu and Otsuka (2021) are (1) climate (change) activism, (2) the importance of leadership pertaining to climate change policy and the fact that (3) lack of leadership may prevent the adoption of new technological solutions, for example. These three aspects were not directly addressed in the young people's responses, but similar themes and meanings emerged. Climate change activism calls for presentation skills,

personal effort and advocacy goals. Climate change-related policies or politics were rarely brought up by the young respondents as many of them were under 18, and too young to vote, for example. However, in several responses the young respondents pondered how to bring climate change issues to the decision-making tables.

Both the leadership perspective by Wu and Otsuka (2021) and the concept of CC leadership as perceived by the young people do not necessarily require someone to have formal leadership status. The young respondents addressed the skills, aims, and values of a leader-like actor in everyday life. Such qualities mentioned in the literature by Wu and Otsuka (2021) and Jokinen (2005), and in the answers of the young people's responses, include social skills, networking skills, empathy, optimism, and engagement.

Climate change justice and collaboration competency

Climate justice, or climate injustice, has turned out to be particularly important for young people (Piipasa and Kiilakoski, 2022; Vogel et al., 2022), and the issue of justice and equality was also referred to extensively by the respondents in our study. They recognized that effective climate change action needs collaboration in which different perspectives are valued. In terms of CC justice and collaboration [Table 1, 4th competency; Figure 2, lowest petal], knowledge about equality, equity, and justice, together with an understanding of the unequal nature of climate change, were mentioned by the young people. They described the ability to cooperate and work in collaboration with others, even if they did not share the same opinion (quotations 10, 11): (10) *'Dialog skills (listening, speaking, pausing, respect). Skills to work together...'*, (11) *'... moderation, solidarity, willing to engage in dialog, a sense of community, equality (global,*

between generations).’ They stressed the importance of listening and treating people and nature as equals and of caring and being able to compromise.

Based on the young respondents’ answers, the values needed for the CC justice and collaboration competency include striving for fairness and respect for others and nature, as well as caring, openness, directness, and solidarity. In addition, the courage to change and to take responsibility are values and attitudes pertaining to this competency. Quotation (12) aptly summarizes the idea of CC justice and collaboration: *’Promoting the development of justice, protecting humanity, solidarity between species, sustaining and protecting life, living in harmony with nature and animals. Empathy and solidarity in discussions, belief in love. Determination and bravery, the courage to depart from the known. Respecting nature and its intrinsic value.’*

Svarstad (2021), who considers climate justice in time and space, suggests that climate change education is needed to tackle the climate crisis through responsible action. Responsible action is approached from three perspectives: insight into injustice and oppression, political ecology, and environmental justice (Svarstad, 2021). The first perspective of Svarstad (2021) leans on building competence with regard to how to work for change, suggesting that acknowledging the current structures and identifying those parts that are not working in an equal manner is required. Understanding the unequal nature of climate change was also repeatedly raised in the young people’s responses. They considered that climate change affects people and areas of the world in different ways and believed that the most vulnerable are often the ones most affected by the changes. The young respondents noted that it was important to keep in mind what kind of impact the current system was having on people and nature, and what had happened when new actions had been taken previously. Empathy, solidarity, and cooperation skills were placed at the heart of CC justice and collaboration.

The second perspective, political ecology, described by Svarstad (2021) was not addressed directly by the young people. Decision-making was mentioned in some responses, but not in connection with ecology, as described by Svarstad (2021). However, the human-environmental relationship and respect for nature was evident throughout the young respondents' answers. Political agency, on the other hand, was probably a relatively unfamiliar topic for young respondents under 18 years old. The aspect of political ecology and the opportunities for young people to engage in the field of politics would be something to explore in the future.

The third perspective, environmental justice, is considered in both time and space, for example, from the perspective of future generations and taking into account all parts of the world (Svarstad, 2021). Inheriting ecological problems came up in some of the young people's responses, but their thoughts and concerns were more about the future aspects of climate change than its past; what could be done to secure their future and that of their children? Justice in space, described by Svarstad (2021) as drawing attention to spatial dimensions and burden-sharing around the world, was often partly or indirectly covered in the young people's responses. Justice in space was seen, for example, in the above-mentioned quotations: (11) '*...equality (global, between generations) ...*' and (12) '*Promoting the development of justice, protecting humanity, solidarity between species...*'. Space was not singled out or named in the answers, but neither was the attention focused only onto people the respondent knew or on nature close to them. In many cases the message was that the key to tackling climate change lies in striving for solidarity everywhere.

Climate change implementation competency

The CC implementation [Table 1, 5th competency; Figure 2, 2nd petal on the left] came close to CC leadership as both promote awareness of the urgency of climate change and demonstrate a strong attitude toward change. In this competency, however, the focus was on actual climate change action and ways to turn plans into reality.

According to the young respondents, understanding the structures within society and its ability to change were important when it came to putting planned action into practice (quotation 13): ‘... *Knowing how to get society to act according to climate targets in practice (transition/sustainability transformation, how does it happen?)*’. Other aspects included the skills of executing (mitigation and adaptation) actions in practice and articulating directions in a clear, simple, and easy to understand manner (quotation 14): ‘*Implementation skills. It is not enough to decide to decrease emissions it must also be made simple for actors and citizens....*’ The young respondents articulated that one should be willing to end any unsustainable practices and to seek alternative solutions. Creativity was mentioned as a key factor for this respect (quotation 15): ‘... *Creativity in problem solving and inventing new ideas. Perseverance, the ability to compromise.*’

Implementation competency is discussed in the framework of sustainability competencies on the recommendation of experts (Brundiers et al., 2021). Brundiers et al. (2021) describe implementation competency as being about taking conscious action. Similarly, from our respondent’s perspective, implementation was seen as a way to put plans into action. Teaching implementation competency should allow students to learn how stakeholders implement change and practice implementation themselves (Brundiers et al., 2021). In addition to doing something concrete oneself, the young respondents suggested that the ability to get other people and society to act in practice would be needed.

Brundiers et al. (2021) cover values and attitudes separately from all sustainability competencies, and they do not have a description of the value base for their implementation competency. In our classification, competency-specific values and attitudes were included in the definition of each competency. The core values underlying CC implementation were the aim and willingness to end unsustainable actions and to seek alternative ways of doing things. In order to find such alternatives, the young respondents underlined the importance of problem solving. Translating changes into actions refers both to the choices made by individuals in their own lives and by society overall.

Climate change well-being competency

CC well-being competency [Table 1, 6th competency; Figure 2, 1st petal on the left] was characterized by consideration of and respect for the limits of one's own well-being, as well as that of others and nature. The young respondents suggested that people need to recognize the limits of their own well-being and to have the necessary adaptation and coping skills to take care of themselves both mentally and physically, as mentioned, for example, in quotation (16): '*... Knowledge of what is necessary for our well-being...*'

According to the young respondents, the ability to handle, understand and sometimes control various emotions was needed when considering climate change-related topics and threats. Climate change was seen as creating pressure and uncertainty, which needed to be coped with while living with the changing climate (quotation 17): '*... Ability to endure pressure and stress...*' It was not seen as the responsibility of the individual to act and cope with climate change (quotation 18): '*... Mental health skills to support one's ability to cope, as the question is huge,*

distressing and there is an endless amount of work for just one person.’ The young respondents emphasized that the burden can be, and needs to be, shared and that the sharing of action and responsibility should happen in a way that values one’s own well-being in addition to that of nature and other people. The main values pertaining to CC well-being competency were summarized in the following quotation (19): *’Empathy, responsibility, considering and respecting others.’*

Patrick et al. (2012) describes the core competencies of health promotion, which are required for climate change action and are similar to the content of well-being competency. The core values and attitudes they describe, such as ‘socio-ecological health’ and ‘equity and social justice,’ are particularly in line with CC well-being. More specifically, these values and attitudes include empathy, resilience, a positive attitude, respect for different perspectives, social justice, and human rights (Patrick et al., 2012). In our framework, social justice and human rights were considered under CC justice and collaboration, but they were also mentioned in the young people’s responses when talking about well-being. The young respondents thought that everybody should take care of their own health and consider the well-being of others and nature. According to their view, there should be a balance between personal responsibility and the responsibility of others. The ability to respect different perspectives was a key value related to CC well-being.

Some of the knowledge and skills presented by Patrick et al. (2012) were similar to the young people’s CC well-being competency. One of the main aspects entails understanding climate change as a crucial factor affecting health (Patrick et al., 2012). The need to understand how climate change affects one’s and others’ health was rising from the youth’s answers. Patrick et al. (2012) describes this as recognizing the impacts on physiological, social, emotional, spiritual, and psychological health.

Comparison to other competency frameworks

The young people's perspectives on climate change competencies were grouped similarly to the sustainability competencies framework presented by Wiek, Withycombe, and Redman (2011), for example. Some aspects presented in the sustainability competence literature were not fully reflected in the young people's answers. For example, motives, decisions, and regulations, stated by Wiek, Withycombe, and Redman (2011) were not entirely covered by the young respondents. In addition, the mental models, and the role of learning, mentioned by Amissah et al. (2020), for example, did not come up directly in the young people's answers. Comments and concerns about the culture of overconsumption were the only business and economic aspects in the responses.

The main difference between the existing sustainability competency frameworks and the new climate change competency framework was the context of the problem. In sustainability competencies the focus is more diversified across all sustainability problems (Bianchi, Ulrike, and Marcelino, 2022). There is a need to address sustainability problems in different fields, whereas there is one problem that applies to all fields when it comes to climate change competencies. The young people's responses focused on one well-defined problem, climate change, with the complex climate system at the heart of their understanding.

The CC competencies in the framework overlapped, but there was no layered structure between each competency. In the sustainability framework by Brundiers et al. (2021), topical knowledge and basic academic competencies work beneath all the other competencies. In addition, integrated problem solving and both interpersonal and intrapersonal competencies cross over the other competencies. Instead of this type of layering, the CC competencies presented in this article work at the same level and are equally important. This comes closer to the earlier division carried out by Wiek, Withycombe, and Redman (2011), where five competencies act as key competencies

side by side. However, both Brundiers et al. (2021) and Wiek, Withycombe, and Redman (2011) describe basic competencies, such as critical thinking and communication, working behind the key competencies. In the GreenComp framework by Bianchi, Ulrike, and Marcelino (2022), the division is made in a detailed manner that leads to 12 competencies. The number of GreenComp competencies is considerably higher than in the young people's CC competency framework, but the way that the competencies work together is similar. They are on an equal footing and support each other, even if they are considered separate competencies.

Amissah, Gannon, and Monat (2020) argue that a system needs to be taken as a whole, in order to understand it. They suggest that, according to holistic thinking perspectives, understanding a system requires consideration of different levels and perspectives. These perspectives apply when considering the whole CC competencies framework. Having an idea of the overall framework and its purpose provides a broader view of the necessary capabilities. The framework has its functional side, as it aims to provide a concrete means of mastering the skills with the help of education. However, even if the framework's competencies are equally important, they cannot be learned at the same time. The knowledge, skills, and values are built over time and are emphasized according to one's interests. Learning different competencies and how they work together takes time, requiring temporal and scientific approaches, and both formal and in-formal learning opportunities (Barth et al., 2007).

The bicycle model designed for climate change education, presented by Cantell et al. (2019), has much in common with the idea of competencies. In a way, the bicycle model could be integrated into each of the CC competencies and support the learning of competencies. All six competencies had their specific thinking skills and knowledge. Action came from execution of the skills. The bicycle frame describes the identity, values, and worldview, and hence the values and

attitudes of a competency. Motivation, participation, hopes, and emotions are close to intrapersonal skills, which were not separately defined in this paper. However, they did exist beneath the values and some of the skills. The future orientation emerged naturally from a temporal perspective of climate change. History was seen as important, but in our study the young people were more focused on the future. The competencies were aimed at overcoming operational barriers to meeting climate targets. By mastering some of the competencies one should duly be able to tackle topic-related barriers.

Conclusions

This qualitative research about climate change related knowledge, skills, and attitudes from the perspective of young climate aware Finns, resulted in a framework encompassing six climate change (CC) competencies: CC systems thinking, CC science orientation, CC leadership, CC justice and collaboration, CC implementation, and CC well-being. Climate change competencies have been suggested to differ from sustainability competencies (Riuttanen et al., 2019), and indeed, according to our study, the climate change competencies defined by the young respondents are not identical to the suggested sustainability competencies (Brundiers et al., 2021; Bianchi, Ulrike, and Marcelino 2022). There are notable similarities, such as the importance of systems thinking and of valuing nature, but the context of climate change means that the content and division of the competencies is different. Instead of addressing all the various sustainability problems, the focus is on the changing climate, its impacts on people and nature, and the need for adaptation and mitigation action.

The climate aware young respondents were able to identify the competencies in an all-encompassing way. The main themes in their responses were the urgency for concrete climate change action, the need for solidarity, and the fact that knowledge should be based on reliable sources and science. Together with solidarity, the young respondents emphasized the importance of justice and collaboration in tackling climate change. Similar themes were raised by young South-Africans in a study by Vogel et al. (2022). Despite the likely cultural differences between Finland and South Africa, young people in both studies expressed a strong sense of justice, urgency for climate action, and a demand for reliable information that is based on reliable climate science.

In addition to the themes highlighted above, some of the young respondents considered the structural side of climate change, its cause-and-effect relations, and the perspectives of nature and other people. Local and global perspectives were mentioned, as well as working together in a way that respects all points of view. However, aspects such as regulations (Wiek, Withycombe, and Redman, 2011), and the role of learning (Amissah et al., 2020), which were recognized in the sustainability competence literature, did not appear in young people's responses. In this paper, we did not focus on the qualities that the young respondents omitted. Rather, the findings described the first and most urgent issues that the young climate active Finns had in mind. Fully considering why and which perspectives were excluded would require more in-depth follow-up interviews and discussions.

In Finland, climate responsibility is taught in schools (Opetushallitus, 2019). This was present in the respondents' answers related to where they had learned about climate change. In Finnish education the topics of sustainability and climate change are integrated into the education system starting from the primary school (EDUFI, 2014; Tani et al., 2020). The results presented in this paper support integrating climate change in the education system. Scaffolding (Vygotsky,

1976) of climate change competence in a systematic way could be done implementing the suggestions of the bicycle model by Cantell et al. (2019). We recommend that similarly to the Finnish comprehensive (EDUFI, 2014) and upper secondary school (EDUFI, 2019) curricula, the learning aims of climate change competencies should be defined for different age levels and be built through various school subjects according to the level of knowledge and skills. It is not necessary to consider all aspects at once but to scaffold learning of the competence step-by-step or, according to the flower model, perhaps petal-by-petal. We should not underestimate young people's capacity to learn complex systemic topics like climate change. As Svarstad (2019) suggests climate change and climate justice need to be considered in time and space. She calls for critical climate education where students investigate specific climate mitigation options and their outcomes on both reduction of greenhouse gas emissions and climate justice (Svarstad, 2019). The flower model presented here offers the young people's point-of-view on the needed competencies, and we recommend implementing the framework when designing climate change education.

The respondents were voluntary participants in the *Climate and nature summit for young people*, and hence it was assumed that they had a higher pre-existing interest in climate-related topics than an average young person. The interest was reflected in their information rich answers used to compile a framework of the competencies needed by society. Since most of the respondents were females, there is clearly a gender bias in the data. In order to validate and evaluate the full functionality of the youth climate change competency framework, the next step would be to test it in a quantitative way with a larger number of respondents. Defining young people's perception of their own climate change competency, as articulated in their own words, can help today's young people, tomorrow's experts, to identify their interests, strengths, and weaknesses. Further research and development of the climate change framework through young people's own perspectives will

also support the field of education. Students are more likely to find and take up climate change education where the learning goals are described in a way that young people recognize and that responds to their needs. This, in turn, will support young people in developing the competencies that society needs to solve wicked problems in the climate-changing world.

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