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Primary school students and climate change—an interview study in Finland and Tanzania

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ABSTRACT

Climate change is a complex and wicked problem, which needs to be addressed through relevant climate change education. However, the preconditions for combatting climate change differ in different parts of the world, depending on physical, cultural and social circumstances. The diversity of circumstances also influences the implementation of climate change in education. Therefore, in this article we have chosen to examine climate change education (CCE) based on an interview study in two distinct school contexts. More specifically, the cases aim to explore Finnish and Tanzanian primary students' views on climate change. A hermeneutical approach guided the analysis, and a significant result was that most of the students understood the severity of climate change. Nevertheless, some misconceptions regarding both causes, consequences and mitigation of climate change were also obvious. In addition, the analysis revealed interesting variations in the students' reasoning, which relate to their different contexts. Unquestionably, the sample size in this study is limited, and further research is needed for a more detailed picture of Finnish and Tanzanian students' views.

1. Introduction

Human-caused climate change is one of the largest problems faced by the world today. However, the consequences of this change vary substantially in different parts of the world (e.g., Holmes, 2020). Human activities have changed the Earth's physical, chemical, and biological circumstances, which has caused the unpredictable and complex climate change phenomenon. In turn, this has caused ecological and social disasters, resulting in local and global economic breakdowns (Karimi et al., 2022; Tol, 2009). Many climate scientists have published papers and tried to highlight the gravity of the quandary, a trend that already started in the 19th century (Holmes, 2020). The Intergovernmental Panel on Climate Change (IPCC) is a scientific body set up by the United Nations, representing the largest organization responsible for providing information about the climate change dilemma. In addition, the media has tried to report about the consequences of climate change. However, despite the political, economic, and social importance of this subject, these messages have not translated into sufficiently pervasive and collective actions (UNEP, 2021).

With young activists around the world regarding political processes as being too slow, they are becoming increasingly active in addressing climate change through demonstrations and other tools (e.g., Zummo et al., 2020). This immense dilemma has an influence on all human life,

requiring knowledge, understanding, and changes on both social and individual levels. Therefore, a quest for climate change education (CCE) has emerged, and it is regarded as increasingly urgent. Interest in CCE is growing in formal and informal education, and in educational research. To contribute to this research field, this study examines primary school students' views on climate change through two cases from two continents and discusses their similarities and differences.

The aim of the empirical study is to explore Finnish and Tanzanian primary students' views on climate change. The research questions are:

How do students describe: a) the concept of climate change; b) the causes of climate change; c) the consequences of climate change; and d) climate change mitigation?

Children and adolescents are underrepresented in the research literature on climate change perceptions. Additionally, Lee et al. (2020) and Ahmed et al. (2021) claim that most of the research conducted on perceptions of climate change is from high-income countries. Obviously, there is a call for more research from other than high-income countries on this topic, and with this study we respond to that call. The discussion in this article also includes a comparison, which focuses on the views of students living in different parts of the world with widely different school circumstances. Even though the sample is limited (negating far-reaching generalizations), this study can provide valuable insights into CCE for researchers and educators in various parts of the world.

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The two countries used as contexts in the empirical study, Finland and Tanzania, are located in two vastly different parts of the world. Hence, they differ significantly in terms of both physical and cultural geography, creating contrasting prerequisites for mitigating climate change. The main part of Finland is located in Northern Europe in the subarctic climate zone with coniferous forests. By comparison, the climate of the East African country of Tanzania is mainly tropical savanna climate. According to the IPCC's (2021) climate report, extremely hot periods and other signs of climate change have increased remarkably in Tanzania and nearby regions. The consequences of the changing climate have a negative impact on food security, water resources, and human health, causing extreme weather events, biodiversity decline, and food shortages (Apollo and Mbah, 2021). East Africa is a region where these consequences are particularly problematic, since the economy largely relies on climate-dependent activities such as agriculture (Apollo and Mbah, 2021; Nnko et al., 2021). Consequently, the situation in Tanzania is more vulnerable than in Finland. According to a ranking of climate change vulnerability in 180 countries, Finland was the 5th least vulnerable, while Tanzania was the 145th (University of Notre Dame, 2021). Although vulnerability can be measured in various ways, the prerequisites for combatting and adapting to climate change are vastly different in the two countries. Hence, the consequences and tangibility of climate change appear differently for the two populations. In Tanzania, extreme weather events with droughts, floods and wildfire are frequently affecting human health (Apollo and Mbah, 2021). Therefore, children in Tanzania are at much greater risk because of climate change (Nyasimi et al., 2018). Besides direct health problems, weather disasters also damage vital infrastructures and cause increased poverty (Karimi et al., 2022), which may lead to nutrient insecurity (Sheffield and Landrigan, 2011).

Economic resources also affect adaptation to climate change. Finland is classified as a high-income economy while Tanzania is classified as a lower-middle income economy (World Bank, 2021). Accordingly, there are big differences between the two countries regarding the length of teacher education, and availability of economical school supplies and resources (e.g., Simola, 2014; Roberts et al., 2015). In addition, the teaching methods and the background of the students vary between the countries. The geographical location is also relevant in this case because it is related to the causes, consequences and mitigation of climate change (Bofferding and Kloser, 2015).

2. Literature review

A considerable problem with CCE in primary schools is that the students do not understand the processes that cause climate change. Similarly, it is difficult for students in secondary school to understand the issue, and many teachers find the topic challenging. Moreover, the usual misconceptions about climate change among students in schools as well as student teachers are similar to those found in studies among the public (Fleming et al., 2021).

Many studies have identified that the misconceptions among students are due to errors in how they understand climate change before entering instruction in CCE (Chang et al., 2018; Ratinen et al., 2013). Unfortunately, such misconceptions are often very hard to correct (Chang and Pascua, 2015). Generally, students tend to confuse climate change and ozone depletion and misunderstand the basics of the solar radiation process (Chang et al., 2018; Hermans, 2015; Ratinen et al., 2013). However, according to a meta-analysis by Lee et al. (2020), this misconception has decreased in newer studies. Students also think that daily weather is an indicator of climate change (Chang et al., 2018), and they confuse climate change with other environmental problems, such as acid rain, radioactivity, all kinds of pollution, volcanic eruptions, and tsunamis (Chang and Pascua, 2015; Truelove and Parks, 2012). An example of this confusion is littering, which does not result in greater emissions of greenhouse gases (Truelove and Parks, 2012). Even if students understand what personal-level actions can mitigate climate

change, they often over- or underestimate the impact of actions on one's personal carbon footprint (Lehnert et al., 2020; Tolppanen et al., 2021). Jurek et al. (2022) indicated that students with a deeper understanding of climate change issues also have greater trust in the efficacy of climate change mitigation.

Chang and Pascua (2015) found that when ninth-grade students described climate change, they could not distinguish the human-caused greenhouse effect from the natural greenhouse effect, which is a prerequisite for life on Earth. However, even if students construct and describe incorrect mental models, they may sound logical and well defined, rendering them more stable and very problematic to revise. Ratinen et al. (2013) studied primary school student teachers' basic scientific understanding of the reasons for climate change. According to their study, the students lacked the necessary fundamental knowledge to understand the topic in all its complexity. However, the students' knowledge increased after a period of purposeful instruction, including group work, lab work, demonstrations, and discussions. Yet, several gaps remained in their knowledge, and they retained many of their initial misconceptions. The causes of misconceptions related to gaps in their chemistry, physics, and biology knowledge. Seroussi et al. (2019) also found misconceptions about climate change issues among teachers. However, difficulties when making cognitive leaps between different magnitudes of time, space and multitude may also aggravate the understanding (Skarstein and Wolff, 2020). Similarly, it can be difficult to grasp the combination of physical, geographical, economic, and social factors in the climate change dilemma.

The correct understanding of climate change is fundamental. Nevertheless, the path from knowledge and action is all but strait, and do not apply to any linear models. However, Kolenatý et al. (2022) showed that knowledge about climate change is a 'key initial driver for climate action' (p. 1) for young people to develop a willingness to act, which often results in climate actions. This is in line with Ratinen and Uusautti (2020), who found that climate change knowledge significantly predicts climate change mitigation. Climate change knowledge also predicts constructive hope, and constructive hope predicts climate change mitigation (Ratinen, 2021). Ojala (2012) identified two kinds of hope: 'constructive hope', which is connected to pro-environmental behaviour, and 'hope based on denial of climate change', which does not motivate people to act pro-environmentally. Although Kovács et al. (2020) reported a positive connection between students' knowledge and self-reported behaviour, the connection between knowledge and actual behaviour was unclear. Interestingly, they found a connection between school and behaviour, which the researchers explained by suggesting that school-level socialisation can impact on environmental behaviour.

Climate change is deeply related to the norms and values in students' societal and daily contexts (Monroe et al., 2019; Nnko et al., 2021). However, a study on students aged 9–10 years understandably indicated that opinions on what constitutes "normal" in relation to climate change vary significantly, even if the frame of reference is their daily life (Byrne et al., 2014). The students constructively suggested various solutions, negotiating and arguing about the concept of normality. Here, their own health was often employed as a powerful negotiation argument to legitimate non-climate-friendly solutions. Other useful arguments related to self-interest and justice. Even if successful implementation of CCE requires scientific knowledge about climate change, teachers also need understanding of how norms and ideologies influence teaching and learning. In addition, they need the ability to deliberate on values and norms (see Byrne et al., 2014; Guy et al., 2014).

Another problem occurs when students do not regard themselves as capable of modifying or changing the course of climate change, which causes negative emotions and feelings of hopelessness (Pihkala, 2020). Here, Pihkala refers to "eco-anxiety" (specifically, "climate-anxiety"), which relates to diverse negative emotions such as grief, guilt, anger, and despair. However, anxiety also has an adaptive dimension that Pihkala calls "practical anxiety," which includes expectation, motivation, and hope (see also, Cantell et al., 2019). Unfortunately, studies

ignore the negative emotions that the subject of climate change can embed in the minds of young people (Pihkala, 2020). Further, few studies include the concept of hope. The research by Ojala (2012) on hope indicates that young people cope with climate change in various ways. In her study, children used distancing more often than older students, purposefully attempting to deny threatening emotions. Emotional distraction is a similar phenomenon, implying that they purposefully choose to be occupied with (or thinking about) something else to avoid threatening feelings. The students in this age group were also more willing to trust in science, technical developments, and active peers (see also Byrne et al., 2014). Hence, instead of denying the existence of the problems, they perceived others as rescuers. Importantly, a passive focus on negative emotions was not obvious in this age group, and they were more hopeful compared to older students. As mentioned earlier, constructive hope (cf. Ojala, 2012) is a central factor in predicting climate change mitigation (Ratinen and Uusautti, 2020).

3. CCE in the curricula of primary education in Finland and Tanzania

According to the Finnish national core curriculum (Finnish National Board of Education, 2016), a sustainable lifestyle is one of the main values of basic education in Finland. Within the curriculum, sustainability issues connected to climate change are frequently addressed. One of the seven transversal competence areas in the curriculum is *Participation, involvement and building a sustainable future*, which is aimed at society members actively participating in democratic processes and being responsible for a common future. Moreover, the subject of environmental studies (comprising biology, geography, physics, chemistry and health education) includes the topic *Building a sustainable future*. Climate change is also mentioned in relation to the protection of diversity and sustainable use of natural resources. Sustainability issues are also included in other subjects in grades 1–6, such as in social studies, religion, visual arts, and sloyd.¹ However, climate change is seldom mentioned explicitly.

Climate change is only referred to once in the *Tanzanian National Framework for Basic and Teacher Education* (Ministry of Education Science and Technology, 2019a). It appears on the list of various cross-curricular themes for pre-primary to advanced secondary education, which includes, for example, environmental education, peace education, children's rights, and gender issues. Furthermore, sustainability is described as one of the core values, a prime example being environmental education mentioned as one of the learning areas. However, climate change is not referred to in Science and Technology Syllabus for Primary School Education Standard III–VII (Ministry of Education Science and Technology, 2019b), although contents related to climate change, such as renewable energy and gases that form air components, are mentioned. According to Apollo and Mbah (2021), East African countries are increasingly integrating issues of climate change into their curricula. Moreover, based on their literature review, the major challenges for CCE are ascertaining the role of educators, dealing with misconceptions among the population, the complexities of interdisciplinarity, and understanding the content of CCE. In Finland, CCE is facing similar challenges. However, Apollo and Mbah (2021) also identified opportunities for CCE in the East African region, such as teachers' overwhelming support and the governments' commitment to integrating educational aspects into their national climate change policies. Undoubtedly, there are many obstacles to a successful implementation of climate change issues in Tanzania. Environmental issues are mentioned in the curricula, but Tanzanian teachers lack resources and training, and their student groups are large (Kimaro, 2018). Thus, even if the teacher education curriculum emphasises learner-centred education, there are hindrances to such an approach. Additionally, environmental education goals

conflict with other educational goals (Kimaro, 2018). Similar problems are obvious in Finland regarding complex policy foci and conflicting educational goals (Wolff et al., 2017; Zilliacus and Wolff, 2022).

4. Material and methods

This study adopts and builds on a qualitative research design and, more specifically, a hermeneutic approach (Patterson and Williams, 2002). Hermeneutics dates back to antiquity and was originally focused on the interpretation of texts (George, 2020). However, contemporary researchers have extended hermeneutics to the understanding of individuals, as well as various forms of groups and communities. Therefore, it has also become a method to study people's views in relation to their environment (Arunachalam, 2006), various aspects of sustainability (Coronel et al., 2022; Leonardi, 2010; Yao, 2019), and a transformation into circularity (Róto et al., 2022). An analysis inspired by hermeneutics is a valuable tool for many types of qualitative educational research and for answering a wide range of research questions (see, e.g., Agrey, 2014).

Instead of searching for a common truth, the hermeneutic approach shows the researchers various views through which people understand a phenomenon (Paterson and Higgs, 2005; Patterson and Williams, 2002). In this study, the data were collected through semi-structured interviews that were flexible to the situation (Merriam, 2009), rendering them suitable for studying children. Using interviews as a method for collecting data is an established practice in educational research (Creswell, 2008), and it is also common in hermeneutic studies.

4.1. Participants and data collection

In this interview study, the respondents consisted of six primary school students from Tanzania (with a school language of English) and six from Finland (with a school language of Swedish). In Finland the school was a public school, while the Tanzanian school was a private school, but not an international school. The researchers established contact with the respondents following the current ethical guidelines of each country (Finnish National Board on Research Integrity TENK, 2019; L. Kimaryo, personal communication, October 7, 2019; Ministry of Communication, Science and Technology, 2010). In the Tanzanian school, the principal informed about the study according to advice from the educational authorities in the country. The parents were also notified about the aims, voluntary nature and confidentiality of the study.

In Tanzania, all students in one class received information about the interviews. From the interested students, three girls and three boys were randomly chosen. Similarly, the Finnish respondents comprised three girls and three boys randomly chosen from students who were interested in participating. In both countries, the participants were aged 11–12 years. The development of the interview guide was based on the research questions and previous research. It comprised 17 questions with follow-up questions. The topics included what climate change is, what its consequences are and the students' emotions related to climate change. For the Tanzanian interviews, the original Swedish document was translated into English. The same researcher conducted the interviews in Tanzania and Finland, each lasting 20–30 min.

The interviews started with the researcher presenting herself and repeating the information about the interview, emphasizing that the interview would not affect the students' grades. Since the interview was semi-structured, the interviewer was flexible with the interview guide. The respondents could recount what came into their minds and respond to follow-up questions if needed. All the interviews were audio recorded.

4.2. Data analysis

The analysis began with a verbatim transcription of the interviews. Because the researchers work in Finland and Sweden, the interpretation of the Tanzanian students' answers could be perceived as biased due to

¹ Crafts, design and technology education.

the researchers' position as 'cultural outsiders' (Mason, 2014). However, hermeneutics does not aim to elicit a totally unbiased understanding. The concept is more about letting "horizons" meet (Gadamer, 2004; Patterson and Williams, 2002).

According to hermeneutics, researchers must acknowledge their subjective pre-understanding, which varies from person to person. Within a hermeneutic analysis process, the researcher moves from the parts to the whole in the hermeneutic circle or spiral, back and forth in the data (Gadamer, 2004; Patterson and Williams, 2002). In this study, the researchers repeatedly listened to the interview audio recordings, read the transcripts, and related the students' commentaries to their context. Finally, they reflected on and discussed the findings to reach a deeper understanding. Although QSR NVivo (a qualitative analysis software) was employed as a tool in the process of organising the data and moving between the parts and the whole, the researchers also worked manually. Thus, they coded the content relevant for the research questions and compared the codes, searched for similarities and differences in the data, identified common themes, and constantly returned to the original transcripts to anchor their understanding.

5. Results

The following section presents the results of the analysis and answers the research questions. The results of the Finnish and Tanzanian data is presented separately. As is usual in a qualitative study based on a hermeneutic analysis, the results are exemplified and clarified through quotations (e.g., Eldh et al., 2020). The quotes from the Swedish interviews were translated into English. For anonymity, the students' names are pseudonyms.

5.1. Students' descriptions of the concept of climate change

When the interviewer asked the Finnish students to describe climate change, some started by talking more generally, saying "it will be warmer", "something is changing", or "we have global warming". All of them were aware of the threats against the climate. Moreover, since they probably did not consider climate change as a natural phenomenon, they did not describe the concept beginning from the natural processes in the atmosphere. Further, they did not explain the word climate in the same way as many of the Tanzanian respondents. Instead, they directly described both the causes and consequences of climate change (see 5.2 and 5.3). One of the students (Sandra) condensed the problem into one word, "humans", saying "we are in a way used to living like this, and not thinking about the consequences".

Some of the Tanzanian students explained climate change as changes in weather recorded for a longer time, while Busara and Amos described climate change as weather change recorded for 30 years or more. Joseph and Jamil defined climate change as changes in the atmosphere and weather. Other respondents acknowledged that climate change is both a natural variation in weather and a process dependent on human activities, similar to Busara:

Climate change is the change of weather, because the weather is the day-to-day conditioner around the atmosphere, so climate change[s] are the changes of climate for us. For example, today we are having a normal [season] but according to human activities and all natural forces climate can change. That is what you call climate change.

However, some respondents explained climate change exclusively as natural changes in the atmosphere. For example, Amina explained climate change as the change of weather from one stage to another due to the air. Although it is somewhat unclear what she meant, she continued describing how the climate and the weather are changing around the Earth and in the atmosphere, possibly due to rain. Accordingly, it would appear that she meant normal natural weather fluctuations. Irene's reasoning about the cause of anthropogenic climate change was mixed with the cause of the ozone layer thinning: "because

when human activities, like industries, the smoke it destroys the layer that protects us from the sun rays in the atmosphere".

5.2. Student descriptions of the causes of climate change

Three of the Finnish students mentioned carbon dioxide emissions as a cause of climate change, and two students talked about exhaust emissions in general. For example, Rasmus stated that "people (...) emit too much carbon dioxide and exhaust". Although the students rarely specified the emission sources, they mentioned aircraft, cars, boats, and factories. For example, Ellen replied, "Driving cars a lot, aircrafts and boats". However, misconceptions were also obvious in the student descriptions. A group of students stressed that littering causes climate change, with Vincent commenting, "We are littering in the water for example". Sandra repeatedly claimed that plastic (specifically in the sea) is the first thing that comes to her mind when she hears about climate change. Furthermore, she talked about the textile industry as a cause of climate change, similar to Ellen. According to her, the industry uses substantial amounts of water, thereby contributing to climate change. However, she correctly emphasized that clothing manufacturing is a major source of carbon dioxide emissions.

The Tanzanian student Busara described human activities and natural forces as the causes of climate change. She pointed out that the production of charcoal from wood contributes to climate change, even if the evaporation from both naturally grown and cultivated trees cools the climate. Amos and Busara stressed that harvesting trees contributes to climate change, with Busara commenting, "When the human activities like cutting down trees, it causes the hotness to cover all the place the water will evaporate. And cause the habitat to be destructed". Busara was not familiar with the concept of greenhouse gases, since she started explaining how tea is cultivated in greenhouses. Amina talked about natural processes, electrical charges in clouds, and currents in oceans affecting the climate: "It may be some electrical charges in the clouds that can make it happen, the lines and the currents maybe in the oceans, the currents may cause a strong winter to happen". Amina did not connect carbon dioxide to climate change, although she explained how it is ruining the atmosphere and the environment. Joseph claimed that weather changes cause climate change. When the interviewer asked about gases from cars and carbon dioxide, Joseph answered that climate change is caused by pollution, although he did not explain this any further. Amos listed the pollution of air and water and smoking tobacco as causes of climate change. He also used carbon dioxide as an example of a greenhouse gas. Three students confused climate change with pollution. For example, Jamil stated, "When it [pollution] affects the climate as people will be affected like coughing and headache and many other diseases".

5.3. Students' descriptions of the consequences of climate change

The Finnish students commonly referred to the melting of ice and snow as consequences of climate change. All students mentioned changes in seasons and the endangering and extinction of animals. The students claimed that the polar ice would melt, causing problems for polar bears, and they also mentioned darker and shorter winters with less snow. Generally, the respondents considered that the climate would change in both windier and rainier directions. They connected changes in seasons mostly to northern latitudes, while they perceived the risk of natural disasters as more obvious in southern latitudes.

The Finnish students mentioned consequences such as floods, tornados, and forest fires. With regard to floods, Rasmus commented, "The polar caps melt and will cause floods in some parts [of the world]". Sandra also mentioned fires: "There has been a lot of forest fires in Sweden". Some of the respondents pointed out that different parts of the world will be affected in different ways, for example, pertaining to farming conditions. In addition, two of the respondents emphasized that people in poorer countries would be more strongly affected by climate

change compared to people in wealthier countries. Wilma concluded, “Those who are not doing well can have problems, the poor ones there will be floods, they will affect their houses”.

The consequences of climate change caused feelings of sadness among the students. For example, Rasmus was worried about animals and their fate, while it was difficult for Erik to convey his emotions regarding climate change in words, claiming that he did not feel anything particularly and was not worried. Vincent stressed that pollution and climate change make him feel sad, because animals are endangered when ice at the North Pole melts. However, he was not worried about his own future because he did not think that it would be affected by climate change.

When asked to think about whether climate change would have any positive consequences, the only example was when Sandra said that people could learn from climate change. Some of the students also expressed negative views and claimed that everything would be destroyed, rendering it impossible to live on Earth in the future. Erik was very negative about the future, stating “Our planet will be destroyed”. However, the students mainly described their futures in hopeful terms. For example, Sandra commented, “Well, I think there won’t be any big difference while I live on Earth”. The students also believed that various technological solutions, such as electric bicycles and cars, would enable the future.

It was easier for the Tanzanian students to describe the consequences of climate change, rather than the causes. They mentioned extreme weather conditions and talked about their effects, such as storms, even tornados, and increasing or decreasing precipitation. They commented that large amounts of precipitation will create floods with far-reaching outcomes for plants, animals, and humans. Some of the respondents talked about the effect of climate change on trees. For example, Jamil stated “... the plants will be affected because even plants need air and sunlight, so when heavy rainfall is coming then the plants will be dying, and the trees will be falling down”. The interviewees stressed that climate change causes habitat destruction and mentioned animals such as fish, hippopotamuses, and crocodiles. According to some students, droughts will lead to death for numerous animals due to a lack of drinking water and food. Two respondents expressed concerns about water-spread diseases caused by floods. Busara was also worried about the increasing number of mosquitoes, causing diseases such as dengue fever due to the virus they spread:

... when the floods come, that water there it just becomes dirty. When it becomes dirty, the mosquitoes will be more and also houseflies, and they stay in dirty areas. So, they will lay their eggs there and their eggs will hatch, with many more mosquitoes.

Another effect of climate change is soil erosion and its consequences, which raised concern among some students. They commented that together with heavy rainfall, soil erosion can also cause landslides. Furthermore, according to the students, soil erosion results in problems with the growing of crops, which when combined with droughts, will affect access to food. Busara also stressed the risk of more refugees because of climate change: “... for an example in Congo there is climate change, the people will not like their place and the thing is that Tanzania is a good place to live so they will come into Tanzania”.

However, the Tanzanian students also expressed misconceptions related to the consequences of climate change. For example, Jamil commented “... pollution of air and destruction of trees will cause carbon dioxide too”. For him, climate change is also caused by pollution, and this view certainly makes it more difficult for him to understand the phenomenon. He continued by saying it was problematic when humans breathe carbon dioxide. Joseph argued similarly, explaining climate change as harmful for animals, because they can die when breathing polluted air.

The consequences of climate change evoked mixed feelings among the students. They were also worried that friends, neighbors, children, and animals might die. Busara explained how thinking about climate

change makes her sad and angry:

... there is a Kilimanjaro national park and there are animals in there, so when the climate changes, when the animals die, it will cause the economy of Tanzania to decrease.

5.4. Students’ descriptions of how to mitigate climate change

The Finnish students were convinced that everyone could combat climate change. They mentioned activities such as sorting waste, picking up rubbish, throwing away chewing gum properly, using textile shopping bags, and reusing clothes. In addition, they mentioned riding bicycles and using public transport instead of riding mopeds and flying. As Erik noted: “I can throw away my chewing gum in the waste bin instead of just spitting it out, and I can ride my moped less”. Vincent mentioned picking up rubbish, and he felt good about being able to do something for the environment and the climate. Ellen recommended riding bicycles and walking as climate-smart alternatives and emphasized the importance of acting before it is too late. She also recommended reusing clothes and cultivating plants. The students shared the view that they could do more themselves, with Sandra commenting, “I could do a lot more myself”. She also wondered how the young Swedish climate activist *Greta Thunberg* could accomplish so much as a child when some adults cannot even sort their own waste.

The Tanzanian students had great confidence in the power of education to actively combat climate change, with one recurring idea being to educate their families. Adana recounted how she contributed: “Yes, I have been educating my parents and friends and even my relatives when they come to see me at Christmas, I have told them about good things for the environment”. Irene also emphasized the importance of studying, stating, “My grandmother always tells me I need to study hard so that when I become a grown-up person, I can do something that will be better for the country and for other people”. Two of the Tanzanian students wanted to become researchers to ensure an undestroyed atmosphere. Irene said that although she could not do anything now, in the future she wants to become a scientist and contribute to solving the problems.

All of the Tanzanian students clearly expressed how everyone, even young children, can participate in the mitigation of climate change. Further, they repeatedly mentioned planting trees. Amina answered the question about what she could do to minimize the effects of climate change by saying, “Everybody can do something for the environment, even the young kids; they can start learning how to plant trees and stop harassing the plants and that”.

6. Discussion

The Tanzanian students described climate change by defining the climate concept. Somehow, they seemed to have a deeper and more elaborate understanding of the atmospheric processes compared to the Finnish students. However, it was apparent that the Tanzanian students also confused natural changes in the weather and climate with anthropogenic climate change, even if some of them knew that there is a necessary natural greenhouse effect. The confusion was obvious when they described the water cycle and how rain is formed. When doing this, they did not connect rainfall to changes in the climate. Therefore, when clarifying the climate concept, some of the students started by thoroughly explaining the concept in relation to the weather. Based on the available data, we can only speculate on the reasons for this mixing of concepts. Maybe the water cycle was central in the preparations for national exams, or maybe a particular teacher underlined this content in their teaching. Nevertheless, this type of confusion between the weather and climate change is also prevalent in other studies (e.g., [Fleming et al., 2021](#)).

The Tanzanian students also held other misconceptions, such as the meaning of the concept of greenhouse gases and why degradation of the ozone layer causes climate change. One of the students confused the

source of anthropogenic climate change with the source of the thinning of the ozone layer, which is a phenomenon caused by the enhancement of ultraviolet radiation reaching the Earth. While this phenomenon is clearly a problem, it is not connected to climate change in the way the student described it. Other researchers have also reported similar misconceptions (Chang and Pascua, 2016; Chang et al., 2018; Fleming et al., 2021; Ratinen et al., 2013), although this did not occur in the Finnish students' explanations in this study. Both student groups mixed pollution with climate change, which other researchers also have noted (e.g., Chang and Pascua, 2015; see also, Truelove and Parks, 2012). The Finnish students may have had other misconceptions as well, even if they did not immerse themselves in the problems in the same way as some of the Tanzanian students. Although there is no linear connection between knowledge of climate change issues and climate-friendly actions, understanding the causes and consequences of climate change promotes action (cf., Konelaty et al., 2022; Ratinen and Uusautti, 2020). Knowledge is not enough, but essential. Students with more adequate knowledge about climate change have greater trust in mitigation strategies (Jurek et al., 2022).

Many researchers have found similar misconceptions among adults and older students. Misconceptions are usual, and they may have developed before studying the phenomenon in school. Thus, it is challenging to correct them (Chang et al., 2018; Ratinen et al., 2013). As Ratinen et al. (2013) demonstrated, it is difficult for teachers to promote student understanding of climate change if they have strong and mistaken presumptions. Since the causes of the misconceptions are complex and relate to conditions of the entire planet, the atmosphere, and to all disciplines and human domains, it is hard for a teacher to know what to focus on. The climate change topic cannot be dealt with appropriately within limited lesson times and with a single teacher responsible for the entire complexity. The topic requires a significant amount of time and broad interdisciplinary approaches in a context in which the teachers encourage each other. According to Pascua and Chang (2015), teachers should develop pedagogical content knowledge with an emphasis on how to help students overcome misconceptions.

The geographical regions in which the students lived obviously affected the types of consequences of climate change they mentioned in the interviews, which was an expected result (cf. Bofferding and Kloser, 2015; Nnko et al., 2021). Thus, the consequences of climate change affected the Tanzanian students more strongly than the Finnish students, which might be connected with the country's higher climate change vulnerability (University of Notre Dame, 2021). Soil erosion, disease spread, and food availability concerned the Tanzanian students. Accordingly, they had already experienced the consequences of climate change. Even if they described future scenarios, they also mentioned many current and tangible climate challenges. The Finnish students were specifically worried about animals in other countries. They saw climate change as a threat, but not for themselves, while the Tanzanian students talked about how climate change affects people in their neighborhoods and their families. These results indicate that educational interventions would benefit from an emphasis on local circumstances and vulnerability to climate change, even in the form of a tailored curriculum emphasizing geographically relevant action (cf. Bofferding and Kloser, 2015). However, in parts of the world that are not obviously vulnerable to climate change, this approach might not have the same impact. Therefore, the global situation cannot be neglected in education.

When discussing how to mitigate climate change, the Finnish students mentioned how they can contribute through small individual, daily efforts, such as using low-emission means of transport. However, some of their ideas were based on misconceptions, such as avoiding littering in nature as a way of mitigating climate change. In line with the results of Truelove and Parks (2012), the students suggested mitigation examples that do not have any influence on the emissions of greenhouse gases. Some Tanzanian students suggested planting trees, which cool the climate, as a way of mitigating climate change. One student explained

how evaporation from trees causes cooling. However, none of the students mentioned how the trees absorb carbon dioxide, thereby decreasing the gas content in the atmosphere. Some of the Tanzanian students regarded education and research as solutions, but the Finnish students did not mention this perspective. While this is an interesting result, it is impossible to draw any conclusions based on this detail due to the small sample size. However, this result demonstrates that even if climate change was closer to the daily life of the Tanzanian students, they still had faith in the future and saw their roles as individuals who can make a difference, which aligns with the idea of constructive hope (see Ojala, 2015).

According to Hung (2014), it is important to understand students' presumptions before implementing CCE. Only then would it be possible to design instruction and bridge the gap between knowledge and action. Unfortunately, the teachers were not interviewed in this study, which could have made it easier to understand the causes of any misconceptions. However, misconceptions may have arisen in both formal and informal contexts (see Hung, 2014). Even though our study is limited, it might offer clues about the problems related to CCE. CCE in schools is important and can make a difference, but family and friends are also central factors in predicting climate change concern (Stevenson et al., 2019).

Most of the students in this study seemed to understand the severity of climate change. This is a positive result because when people understand the risks, they are likelier to act on behalf of the climate and support climate policy (Smith and Mayer, 2018). Their awareness of the risks also awakened emotions in both the Finnish and the Tanzanian target groups, and many of the students expressed that they felt sad because of climate change. Another positive outcome was that the Tanzanian students had not lost hope even though they were more familiar with the tangible consequences of climate change. They could imagine themselves playing future roles in mitigation. Notably, the teachers' roles as empowers and creators of hope are crucial. Teachers need to profoundly understand climate change in all its dimensions. Therefore, teacher education has a great responsibility to emphasise the topic.

This study did not investigate the amount of time allocated to or the quality of teaching about climate change in the two schools. In Finland, the curriculum is relatively unspecified, and the teachers have autonomy to decide what to focus on in their teaching. In Kimaro's (2018) study, Tanzanian teachers emphasized a lack of time and training as hindrances to the implementation of sustainability issues in their teaching. Jurek et al. (2022) state that it is important to acknowledge that changes in the curriculum are not enough to have an educational impact on students' knowledge about climate change issues; rather, the approaches taken by teachers are highly relevant and only indirectly guided by the curriculum. Further studies could fruitfully explore this theme by investigating the amount of time used for CCE in schools and outlining how it is done, through observations and interviews in schools, involving both students and teachers as respondents.

This study was problematic in that most of the CCE-related publications that were available through the researchers' databases are written in Western countries. Roberts et al. (2015), who have studied the CCE situation in Africa have reached results that are more relevant for an East African context. When considering how young people reason about climate change, the complexity of the issue must also be recognized. The thinking of children is not sufficiently developed to fully understand the complicated questions related to this wicked problem (Ojala, 2012; Rittel and Webber, 1973). Further, the language levels of the informants might have influenced the results. The students had not necessarily developed sufficient vocabulary to express the multifaceted interrelationships contained in the questions. In addition, the informants might have been on different levels concerning communication and academic reasoning (see also Lindberg, 2008). The Tanzanian informants were not interviewed in their native language, which may have affected the results to some degree, despite English being their school

language.

7. Conclusions

The aim of this study was to explore Finnish and Tanzanian primary students' views on climate change. Few in-depth studies have explored young students' views on this topic. Thus, most studies have been quantitative (surveys and questionnaires) with older students as targets. The focus on young students' thoughts and voices in this study is a valuable complement to the existing body of research. In addition, this study compared how students express themselves regarding climate change in two countries with extremely different preconditions in terms of climate change severity, educational resources, as well as cultural and natural conditions.

The results showed similarities as well as differences in the students' views. Most of the students realised the seriousness of the climate change dilemma. In both countries, the students also mixed concepts and had misconceptions related to the causes as well as the consequences of climate change—even if they were mixed in different ways. However, the Tanzanian students had experienced the consequences of climate change and were familiar with them in their daily lives. Therefore, their answers to questions regarding the consequences of climate change were more detailed and closer to the students' own realities than the Finnish students' answers. When the students described the mitigation of climate change, the Finnish students mainly talked about what they could do immediately on an individual level. While these students mentioned acts related to changing consumption patterns, the Tanzanian students saw possibilities in education and research and in their own roles when becoming educated. Thus, they believed in their own possibility of making a social impact as adults.

Even if this was a small study from which the results could not be generalised, the most interesting finding was that the Tanzanian students still had hope for the future. These children had experienced many signs of climate change, and they still believed in their own possibilities of changing the process. This might be interpreted as not only a difference in the way the students view their role in society, but also in the role that the natural environment plays in their daily lives and their families' livelihoods. However, making fully accurate statements based on these findings will require additional studies. An obvious result is that climate change needs to be emphasized at many educational levels to prepare students all over the world to mitigate climate change.

The step from empirical research results and models (e.g., Cantell et al., 2019) to implementing CCE in schools, promoting student understanding of the topic in all its complexity, and empowering their agency, is easier said than done. In addition, the values involved in CCE are extremely complicated, and educational policy has many goals to fulfil, some of which are not in line with how to solve the climate change dilemma (Zilliacus and Wolff, 2022). Accordingly, teachers have the demanding task of choosing and prioritizing between all the demands and fulfilling various educational goals. In CCE, Apollo and Mbah (2021) consider it crucial to ascertain the teachers' role, and deal with misconceptions related to climate change, as well as the complex and interdisciplinary nature of the topic, since teachers in many countries lack guidance of how to deal with it. Importantly, implementing a complex issue such as climate change in education cannot solely be the teachers' responsibility. Major sustainability challenges require a rethinking of education (Lehtonen et al., 2018), and they must be developed in collaboration with organisations, researchers and others outside the schools (Apollo and Mbah, 2021). Further, educational leaders play an important role when the learning topic is urgent, value-related, and complex (Zilliacus and Wolff, 2022). Complicated educational topics such as climate change have to connect to both their context (Apollo and Mbah, 2021; Nnko et al., 2021) and a wider global perspective. Moreover, they should be taken seriously and comprehensively negotiated in policy, research, and practice (Blum et al., 2013), and developed as a part of teacher education (Apollo and Mbah, 2021).

As shown in this study, climate change education is largely context-dependent, and relates to both society and nature. Therefore, every country and region need their own way of implementing this educational topic. A future life on this planet has to become a priority in the development of education on all levels.

Alexander (2000) noted that understanding different school systems is crucial when making comparisons. In this study, the students' thoughts guided the researchers to understand what each school system 'produces for knowledge' without overgeneralising the results for that purpose. The educational situation in Tanzania is different from that in Finland and the threat of climate change has another dimension. Climate change is a common and real threat to all world citizens, and cannot be neglected anywhere, but the educational methods used may and must differ. Notably, in the described study, all the Tanzanian students expressed the opinion that all people, independent of age, can participate in the mitigation of climate change.

CRedit authorship contribution statement

Pia Sjöblom: Conceptualization, Formal analysis, Methodology, Investigation, Writing – original draft. **Lili-Ann Wolff:** Conceptualization, Methodology, Writing – original draft. **Sari Vuorenmaa:** Formal analysis, Methodology, Writing – original draft. **Rebecka Grahn:** Methodology, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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