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Finnish Students' Knowledge of Climate Change Mitigation and Its Connection to Hope

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Abstract: Climate change is a global concern, and the need to address it is urgent. Therefore, climate change education has been developed in recent years. Meaning making, coping strategies, and solution-oriented climate education tasks enable and maintain hope for positive results with regard to climate change. However, there is still uncertainty as to how students' knowledge of climate change mitigation measures affects their attitudes. In the present study, elementary and secondary students in Finland (n = 950) responded to an online questionnaire. A principal component analysis, a hierarchical regression analysis, a correlation coefficients, a *t*-test, and a Kruskal-Wallis analysis of variance were used for the analysis to understand what kind of hope students had towards climate change and how their knowledge and optimism regarding climate change affected their hope. The data revealed that the students had a relatively high constructive hope rather than denial hope when it comes to climate change. Additionally, this hope was not built on a minimisation of climate change. The results indicated that the significant predictors for climate change mitigation were gender, climate change knowledge, and constructive hope. A typology of student positions with regard to climate change is introduced as conclusions.

Keywords: hope; climate change; optimism; statistical research; climate change education

1. Introduction

Young people's role in combatting climate change will become critical. Today's youth will be facing the future negative consequences of climate problems. Their lifestyles may determine the way climate change progresses in the future. Therefore, it is vital to understand how the young perceive climate change mitigation and what factors would support their hope and trust in active actions for the future. In recent years in climate change education, the discussion about students' knowledge of climate change has included coping strategies and hope students have related to climate change. Tackling the climate change problem requires all societal actors to get involved. Based on earlier studies, we know that learners from primary and secondary schools through higher levels have quite similar misconceptions regarding climate change [1–3]. The mechanisms of climate change seem to be difficult to learn. In recent years, studies have emphasized more that for example climate change education should also include elements that tackle the emotional coping of young people [4–8]. As the phenomena are difficult and complex, and may cause anxiety, it is important to pay attention to these aspects, too. Moreover, we know that many young people are concerned and report pessimistic attitudes, which is greatly affected by today's environmental problems [4,6,9,10]. The paper structure is as follows: We introduce the core concepts and recent findings about the knowledge of climate change, followed by the statement of research problem and research questions. The measures are then described in detail. After presenting the statistical results, the main results of the study are discussed, and their significance is presented in a typology of student positions towards climate change.

1.1. Key Features of Knowledge of Climate Change

Climate change is a long-term change in the earth's climate appearing as changes in the earth's temperature, precipitation, and other weather patterns [11]. One primary reason for the change are emissions of heat-trapping greenhouse gases caused by human activity [11]. Students struggle to develop mental models to understand climate change [3]. They mainly have two non-scientific mental models of climate change that relate to greenhouse gases and to the ozone layer. Their understanding of these models also seems to vary. The first model aligns with a scientifically accurate model of a defined layer of greenhouse gases in the atmosphere, but the impacts of climate change are not understood as a change in the radiation balance [3,12–14]. Neither do students seem to comprehensively understand what greenhouse gases are [3]. This means that student may have adopted a mental model about the role of greenhouse gases in climate change, but their understanding is not necessarily based on scientific facts. The second model inaccurately connects climate change to the ozone layer [2,3,12,15]. A common misunderstanding is that chlorofluorocarbons (CFCs), carbon dioxide (CO_2), or some other air pollutants cause holes in the ozone layer. These holes allow more heat and/or ultraviolet (UV) rays to reach the earth's surface and thus cause climate change. It is noteworthy for climate change education that those two non-scientific mental models are very similar regarding students from elementary school through university.

1.2. Students Ideas of Climate Change Mitigation

Climate change can be addressed through mitigation or adaptation. This study focuses on mitigation, which means interventions to reduce greenhouse gas (GHG) concentrations through the cutting of GHG emissions or moving carbon out of the atmosphere. These interventions can be anything between investing in carbon capture technologies and forest conservation in order to stabilise and reduce the amount of GHGs in the atmosphere [11].

Aitken, Chapman, and McClure [16] argue that mitigating climate change is recognized as an increasingly urgent task that has to be tackled with a variety of means. One of these is voluntary behaviour change. They found that among New Zealanders, stronger perceptions of powerlessness were regarded as lower levels of action to mitigate climate change. This was also shown as disbelief that individuals could affect climate change in any ways. On the other hand, for the New Zealanders, the perceived risk of climate change and the perception that humans influence climate change were the strongest predictors of mitigation action.

Individuals, national governments, and environmental and international organisations should together act for climate change mitigation, as reported by Özdem et al. [17] in their research among seventh graders. However, children [18] and adolescents [19] have been shown to lay responsibility for climate change on people other than themselves. In some studies, students have considered international agreements, legislation, and education effective mitigation strategies [17,20]. However, Özdem et al. [17] pointed out that more often than not, students think that climate change cannot be mitigated. Bofferding and Kloser [20] found that adolescents demonstrated limited understanding of adaptive responses to climate change. According to their research, learning about climate change mitigation seems to be difficult, because after being taught about climate change, significant misconceptions remained that combined mitigation of and adaptation to climate change. Hermans and Korhonen [21] found that secondary school students experienced climate change as a risk. Although these students considered it important to fight against climate change, their own willingness to act could have been greater.

Looking at individual climate change mitigation actions of students, they seem to think in similar ways. Truelove and Parks [22] found that college students were well aware of factors boosting climate change. Correlations between the college students' beliefs in the mitigating potential of a behaviour and intention were relatively high for behaviours (such as abstaining from eating meat and reducing driving) that do mitigate climate change. Their intention to actions such as not littering do not mitigate climate change and were relatively low. In Finland, Hermans and Korhonen [21] found

that secondary school students were most willing to reduce their use of electric in order to mitigate climate change. About half of them were willing to sell things in second-hand shops and cycle or walk moderate distances. They were least willing to buy used clothes and items, and refrain from motor-driven vehicles, such as mopeds. Secondary school students are ready to take personal acts to mitigate climate change, if it is convenient to them (e.g., meaning that acts do not lead to major lifestyle changes). Thus, if actions require greater personal efforts (e.g., consuming less meat or choosing public transportation over private one), these students are less willing to undertake actions [20,23–25].

As the improvement of traffic systems is one of the key climate change mitigation actions, Boyes et al. [25] studied students' willingness to use fuel-efficient cars and use public transport in ten countries. They found that under half of the students (45%) were willing to use smaller fuel-efficient cars. For this item, there was no significant difference between boys and girls or between different grade levels. However, a statistically significant difference was found between students from different countries. In terms of the willingness to take action, the smallest proportion of students were from the UK (21% responding 'probably not'), and the largest from India (47% responding 'definitely'). A second item of the Boyes et al. [25] study, the willingness to use public transport rather than private cars, was also unpopular, because only 35% of the students were prepared to do it. In addition, the proportion of students decreased as the grade level increased. Again, students from different countries differed from each other significantly. Only about one-fifth of the students in Australia, the UK, and the USA, but about half of the students in Spain, Singapore, and India would choose public transportation.

Not only students, but also teachers had similar opinions towards climate change mitigation. According to Saribas et al [26], teachers were regularly paying attention to involving low carbon emission through simple actions such as using renewable energy sources, recycling, and choosing public transportation [26]. Higde, Oztekin, and Sahin [27] found in their Turkish studies that pre-service science teachers incorporated pro-environmental actions, such as turning off lights, using less energy, and walking and cycling instead of driving a motor vehicle. However, pre-service science teachers changed their purchasing habits, such as consuming products in reusable or recyclable packages and purchasing local food products, less frequently than other mitigation means.

Given the information from the aforementioned studies, it seems that results on students' views on climate change mitigation are somewhat inconsistent. More specifically, there is a large gap between the ways we want to transform our society towards a sustainable future and the mitigation actions we implement [28].

2. The Concept of Hope and Its Role in Climate Change Education

2.1. Hope in Relation to Its Neighbouring Concepts

Hope can be defined as an expectation that something that one wishes for will happen [29]. According to the current understanding of educational psychology, hope is an important human strength that is based on realistic, positive expectations that one's behaviour will be effective and that one can trust in one's own performance and life in general [30]. Snyder [31] defines hope as a positive motivational state that is based on the interactions among goals, planned actions, and agency [32].

In this sense, hope reminds one of its neighbouring concept optimism. However, optimism merely explains how people pursue goals based on their belief in themselves and in their goals being reachable [33]. Gillham and Reivich [34] explain the difference between these two concepts. According to their interpretation, hope is defined as a wish for something with a positive expectation that the wish will happen. Instead, optimism is merely a disposition to expect the best [30]. The difference in concepts means that hope refers to expectations in a specific situation and optimism refers to general expectations.

People have a habitual way of explaining events and perceiving the environment [35], and much of it is learned at home [36]. This is worth remembering when analysing children's attitudes

and behaviours and their level of belief that their actions matter, for example, when it comes to climate change.

Optimism rooted in childhood is shown to be connected to higher life satisfaction, health, perseverance, resilience [37,38]. Still, the optimistic explanatory style does not always contribute to healthy psychological functioning and may even have maladaptive effects if one is overly optimistic [39]. Realistic optimism is based on accurate thinking, an awareness of one's abilities and skills, and positive self-esteem about oneself, whereas unrealistic optimism leads to irrational beliefs [40]. Pessimism on the other hand has a somewhat stable negative effect.

Peterson and Luthans [41] consider optimism an important ingredient of hope. For example, in the context of this article, this would mean that in order to be hopeful about finding solutions to climate change, being optimistic about one's changes to influence it likely boosts hope in a significant manner.

2.2. Hope in Climate Change Education

In climate change education, it is important to maintain a perspective of hope, as hopelessness leads to pessimistic attitudes toward the future and ultimately does not help in mitigating climate change [5,7,42,43]. Hope helps people solve a problem by reinforcing an individual's positive thinking. Li and Monroe [42] emphasize the importance of appropriate information, meaningful means, and belief in the ability of society to take effective action while maintaining hope. Ojala and Bengtsson [43] examined the perspectives of home-based climate education as experienced by young people. Their results can be applied more widely in climate education, as problem-focused and meaning-focused coping strategies had a positive relation with environmental considerations. In a study by Ojala and Bengtsson [43], people's positivity was positively correlated with problem-focused and meaning-focused coping, while negativity was associated with climate-related de-emphasizing.

Research has shown that the way people perceive they cope with climate change is likely to determine whether they are going to behave pro-environmentally [5,44]. According to Ojala [5], high school students' underestimating of environmental problems is related to their optimistic attitudes rather than to their problem-focused coping strategies. Thus, the low level of concern among young people reduces environmental behaviour by denying environmental problems. On the other hand, hope is linked to environmental behaviour among children [44]. These contradictory results can be explained by wishful thinking [45], which can be a way for children to deal with threats, whereas for adolescents and adults, it is a way to avoid responsibility. Although the hopefulness of young people has proven to be useful, a more realistic view and an adequate level of taking responsibility are also needed [44].

In climate education, it is important to distinguish between optimism and hope. Optimism refers more to faith in success, whereas hope emphasizes a certain attitude and the meaningfulness that this attitude creates [46]. According to Pihkala [8], this is particularly important with regard to climate change, as realistically, there are no definitive guarantees that mankind will succeed in mitigating and adapting to climate change.

3. Aims of the Study

Although we know in general students' perceptions and hopefulness regarding climate change, there are still shortcomings about how their knowledge of climate change mitigation measures affect their attitudes. Successful climate change education needs to concentrate on climate mitigation actions that really decrease the amount of greenhouse gases in the atmosphere. The present study sought to increase the understanding of hope and climate change by answering the following research questions:

1. What kind of hope do students have towards climate change?
2. How do students' levels of knowledge about climate change and optimism affect their hope?

4. Methods

4.1. Procedure and Participation

The target group consisted of 950 elementary and secondary students living in six communities in Finland (Table 1). In Finland, Programme for International Student Assessment (PISA) results indicated the spatial differences of students' environmental awareness and optimism [46], and therefore climate change issue is interesting to study. The average age was 13.6 years, and the sample was composed of 49% girls and 51% boys. Both elementary and secondary classes were included in the study. We were in contact with the classes through a nationwide training school list containing email addresses to teachers, and cannot say how many students in the classes of those teachers who chose to participate in this research did not answer the questionnaire. Therefore, we cannot report an exact response rate and therefore, the sample should be considered as a convenience sample. The training schools were chosen because research permits were easy to obtain. However, these schools were located in city areas, which must be taken into account when interpreting the results. The students participated in the study by taking the online questionnaire at school. The data collection was fully anonymous. Students had the opportunity to refuse to participate in the research, and parental consent forms were required. Teachers were instructed to guide students in responding to the survey following the instructions in the research form. The response time was 30–45 minutes.

Table 1. Gender, Age, Class Level, and City of Participants (n = 950).

Gender	Frequency	%
Girl	467	49.2
Boy	483	50.8
Age		
11	77	8.1
12	172	18.1
13	142	14.9
14	254	26.7
15	251	26.4
16	52	5.5
17	2	0.2
Class level		
Fifth	95	10
Sixth	195	20.5
Seventh	141	14.8
Eighth	290	30.5
Ninth	229	24.1
City		
Rovaniemi	692	72.8
Jyväskylä	110	11.6
Tampere	67	7.1
Helsinki	27	2.8
Joensuu	14	1.5
Turku	12	1.3
Oulu	28	2.9

4.2. Measures and Statistical Tests

For measuring students' climate change knowledge, the participants were asked to complete the statement "Climate change is because … ", and nine possible responses were provided: "Too much greenhouse gases", "Intensive forest logging", "Nitrogen oxides from fertilizers", "Too much IR radiation stays on the Earth", "Purchased products generate greenhouse gases", "Landfills produce

methane", "Consumption of a lot of milk and dairy products", "Emitted IR radiation is absorbed by greenhouse gases" and "Using fossil fuels such as oil and coal". For developing statements, the study of Ratinen [3] was used. Each response could be rated on a five-point Likert scale: Strongly disagree = 1, disagree = 2, no disagree or agree = 3, agree = 4, or strongly agree =5. The Cronbach's alpha value for all the items was 0.84. A principal component analysis (PCA) was conducted for the calculation of the principal scores by a regression method. Those scores were used for a hierarchical regression analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.90. The principal component solution explained 45% of the total variance with an eigenvalue of 4.052.

The students' own opinions regarding optimism towards climate change adaptation was measured with three items: "I think that science and technology will help us to adapt to climate change", "I'm trustful that the Finns can adapt to climate change" and "I'm trustful that people can adapt to climate change". Each response was rated on a five-point Likert scale: Strongly disagree = 1, disagree = 2, no disagree or agree= 3, agree = 4, or strongly agree = 5. The Cronbach's alpha value for those items was 0.70.

Student's knowledge of climate change mitigation was captured by completing the statement "If climate is to change as less as possible, we need to … " with eight possible responses: "Reduce the purchase of goods", "Eat local food", "Use wind and solar power", "Reduce the use of fossil fuels", "Favour a vegetarian diet", "Use public transport", "Walk and bicycle more" and "Avoid food waste". Each response was rated on a five-point Likert scale: Strongly disagree = 1, disagree = 2, no disagree or agree= 3, agree = 4, or strongly agree =5. The Cronbach's alpha value for those items was 0.87.

A PCA (Table 2) was conducted for the estimation of the students' opinions towards climate change mitigation knowledge and trust. The KMO value of 0.87 showed that the sample was suitable for performing a PCA, and a varimax rotation method was chosen. The principal component solution accounted for 55.4% of the total variance, and the factor loadings were satisfactory (0.50 or greater) (Table 2). Finally, two scales were created: Mitigation knowledge (α = 0.87) and optimism of adaptation (α = 0.70). The principal component scores were calculated by regression methods. Those scores were used for a hierarchical regression analysis and the calculation of Pearson correlation coefficients.

Table 2. Principal component analysis (PCA) Results for Climate Change Mitigation Knowledge and Optimism.

I think that …	**Mitigation Knowledge**	**Optimism of Adaptation**
… climate change decreases by walking and bicycling more.	0.80	
… climate change decreases by using wind and solar power.	0.76	
… climate change decreases by avoiding food waste.	0.75	
… climate change decreases by using public transport.	0.74	
… climate change decreases by reducing the use of fossil fuels.	0.72	
… climate change decreases by eating local food.	0.69	
… climate change decreases by purchasing fewer goods.	0.61	
… climate change decreases by favouring vegetarian diets.	0.64	
… the Finns can adapt to climate change.		0.82
… people are able to adapt to climate change.		0.78
… science and technology will help us to adapt to climate change.		0.76
Eigenvalues	4.203	1.893
Total variance explained (%)	38.2	17.2

Finally, students' attitudes towards hope for climate change were measured. Ojala's study [43] was used for the construction of statements, and students expressed their opinions by completing the statement "I think about climate change hopefully because … ". A total of 11 possible responses were used: "We have to take climate issues seriously and responsibly", "I can change my behaviour, and together, we can have a positive impact on the climate", "Awareness has increased", "I can help in many ways to reduce climate change", "People in environmental organizations can solve climate

change", "Because of the Paris Climate Agreement", "Science and technology promote the solution to climate change", "Climate change is natural, and I suspect that anthropogenic emissions cause climate change", "Warmer summers in Finland are good", "Climate change is not as serious a problem as scientists claim", and "I do not think the climate will change". Each response was rated on a seven-point Likert scale: Not at all = 0, only a little = 1, a little = 2, a little or somewhat = 3, somewhat = 4, much = 5, very much = 6. The Cronbach's alpha value for the items of constructive hope was 0.87 and for the items of denial of hope was 0.72.

A PCA (Table 3) was also conducted for the measurement of the students' hope for climate change. The KMO value of 0.86 showed that the sample was suitable for performing a PCA, and a varimax rotation method was chosen again. This principal component solution accounted for 57.6% of the total variance, and the factor loadings were satisfactory (0.50 or greater) (Table 3). Finally, two hope scales were created: Constructive hope (α = 0.87) and denial of hope (α = 0.72). The principal component scores were calculated by regression methods. Those scores were used for a hierarchical regression analysis and the calculation of Pearson correlation coefficients. The regression analysis [42,43,46] has proven to be a good method in environmental psychometric studies. In the present study, the hierarchical regression analysis was performed, and it showed that the relation between climate change mitigation knowledge and gender is strong, and the influence decreased when climate change knowledge and hope was inserted into the last step in the model.

Table 3. PCA Results for Hope for Climate Change.

I think about climate change hopefully, because ...	**Constructive Hope**	**Denial of Hope**
... we have to take climate issues seriously and responsibly.	0.82	
... I can change my behaviour, and together, we can have a positive impact on the climate.	0.81	
... awareness has increased.	0.79	
... I can help in many ways to reduce climate change.	0.75	
... people in environmental organizations can solve climate change	0.75	
... because of the Paris Climate Agreement.	0.66	
... science and technology promote the solution to climate change.	0.61	
... climate change is natural, and I suspect that anthropogenic emissions cause climate change.		0.50
... warmer summers in Finland are good.		0.76
... climate change is not as serious a problem as scientists claim.		0.82
... I do not think the climate will change.		0.78
Eigenvalues	4.212	2.122
Total variance explained (%)	38.3	29.3

The statements about hope for climate change were further analysed statistically for gender differences using *t*-test. Multiple groups (age and location) were compared using a Kruskal-Wallis analysis of variance (KW-ANOVA), because the groups to be compared were not of the same size, although the homogeneity of the variances would have been sufficient according to Levene's test.

5. Results

The students' knowledge of climate change was rather good. In particular, students identified the greenhouse gases responsible for climate change. Students expressed that too much greenhouse gases ($\bar{x}$ = 3.9, sd = 1.1), using fossil fuels such as oil and coal ($\bar{x}$ = 4.0, sd = 1.1), consuming a lot of milk and dairy products ($\bar{x}$ = 3.8, sd = 1.3), and intensive forest logging ($\bar{x}$ = 3.7, sd = 1.2) increase climate change. The students' understanding of the scientific basis of climate change was not commensurate with the causes of climate change, because their answers that emitted IR radiation is absorbed by greenhouse gases ($\bar{x}$ = 3.1, sd = 0.96) and too much IR radiation stays on the Earth ($\bar{x}$ = 3.5, sd = 1.1) were not very high. Also, the students' knowledge that nitrogen oxides from fertilizers ($\bar{x}$ = 3.5,

sd = 1.0), purchased products ($\bar{x}$ = 3.5, sd = 1.1), and landfills ($\bar{x}$ = 3.3, sd = 0.97) generate climate change were also rather low.

Girls knew the causes of climate change significantly more than boys ($p < 0.00$ for all the variables). The fifth graders' understanding of greenhouse gases was the lowest, and that of the ninth graders was the highest, $\chi^2(5) = 18.805$, $p < 0.001$. Surprisingly, the fifth graders' understanding of the impact of forest harvesting on climate change was the greatest, $\chi^2(5) = 27.028$, $p < 0.000$. The respondents' place of residence affected the understanding of climate change for some variables. The understanding that too much greenhouse gas generates climate change was lowest at Turku, $\chi^2(6) = 17.667$, $p < 0.007$. Similarly, logging for Rovaniemi, $\chi^2(6) = 14.751$, $p < 0.022$; products for Helsinki, $\chi^2(6) = 13.882$, $p < 0.031$, and landfills for Oulu, $\chi^2(6) = 17.308$, $p < 0.008$, were associated with a lower understanding of the acceleration of climate change.

Figure 1 shows the students' answers regarding hope and climate change. When we look at the students as a whole, the hope for climate change was not built on a minimisation of climate change, and denial of hope received fewer positive responses. For example, the idea that climate does not change (56% from "not at all" to "a little") did not increase students' hope ($\bar{x}$ = 1.9, sd = 1.7). Similarly, 39% of students said that hope did not increase when summers are warmer in Finland ($\bar{x}$ = 2.7, sd = 1.9). These variables had the largest standard deviations. In large datasets, larger standard deviations may mean an uncertainty of what the variable measures or that the students think very differently about that aspect of climate change.

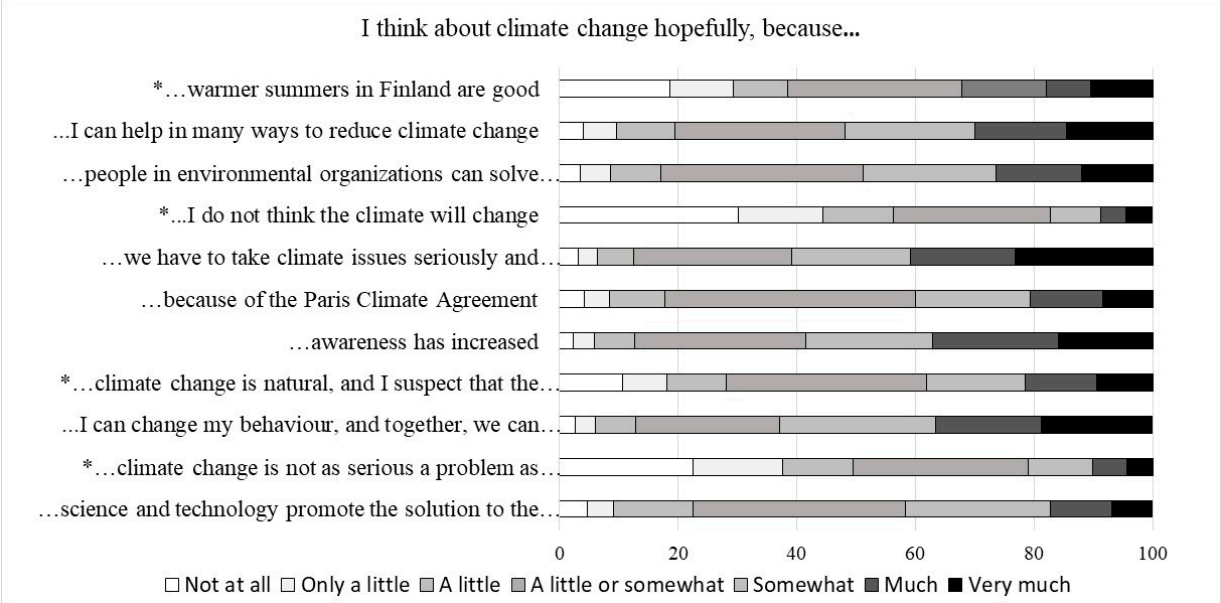

Figure 1. Students' answers regarding hope of climate change. Denial of hope items are marked by * (n = 950).

In examining the students' responses in more detail, particularly in regard to constructive hope, there were significant associations with various perspectives expressed by the students. For this statement, 61% of the respondents chose "somewhat" to "very much" ($\bar{x}$ = 4.0, sd = 1.6). Moreover, 52% of the students answered similarly for the statement "I can change my behaviour, and together, we can have a positive impact on the climate" ($\bar{x}$ = 4.0, sd = 1.5). Self-empowerment was seen as having a hopeful effect with 52.8% of the students responding at least "somewhat" for their own possibility of affecting climate change ($\bar{x}$ = 3.6; sd = 1.6). Similarly, climate work by environmental organizations was perceived to guide much (48.8%) of the increase in the pupils' hope towards climate change ($\bar{x}$ = 3.6; sd = 1.5). The Paris Climate Agreement seemed to be difficult for the students to recognize or understand, because 42.3% of the students did not express a strong view on either end of the scale ($\bar{x}$ = 3.4; sd = 1.4).

Based on this data, it was quite obvious that there was not much regional difference in the students' hopes regarding climate change, as the students' answers differed by region only for warm summers, $\chi^2(6) = 3.277$, $p < 0.039$. In contrast, gender differences were found for a number of variables associated with the hope of climate change. Girls were less confident than boys on the effectiveness of science and technology to address climate change, $t(941.5) = -2.307$, $p < 0.022$, d = 0.15. Climate change underestimation did not increase hope in girls as much as in boys, $t(948) = -6.710$, $p < 0.00$, d = 0.44. The girls also thought more highly than boys that the positive effects of individual and collective actions would increase hope for climate change, $t(948) = 6.394$, $p < 0.00$, d = 0.41. Increased awareness has created more hope for girls than boys with regard to climate change, $t(948) = 4.345$, $p < 0.00$, d = 0.28. Constructive hope for climate change also varied in that the attitude of responsibility and severity of climate change was also significantly higher for girls than boys, $t(948) = 4.378$, $p < 0.00$, d = 0.29. In addition, girls did not think as often as boys that climate change denial creates hope for climate change, $t(948) = -5.300$, $p = 0.00$, d = 0.33. They also believed more than boys that their own climate change mitigation actions increased hope, $t(948) = 5.360$, $p = 0.00$, d = 34. Warmer summers in Finland increased boys' hope for climate change more than girls, $t(943.278) = -3.728$, $p = 0.00$, d = 0.24.

Age also influenced students' hope for climate change in some variables. The belief that climate change was not as severe as climate scientists claim increased the hope for climate among 14-year-olds, $\chi^2(6) = 15.657$, $p < 0.016$. In addition, 16-year-olds felt that the increased awareness created hope for climate change, $\chi^2(6) = 18.607$, $p < 0.005$. Both 11-year-olds and 16-year-olds felt that taking climate change seriously and responsibly increased their hope, $\chi^2(6) = 12.708$, $p < 0.048$. The youngest students felt that warming summers increased hope for climate change, $\chi^2(6) = 15.762$, $p < 0.014$.

As depicted in Table 4, when taken alone, gender was a significant predictor in all steps of the hierarchical regression model; girls expressed better mitigation knowledge of climate change than boys. In Step 2, the city and class level were entered in the model, but they did not predict climate change mitigation knowledge. In Step 3 of the model, the other control variables were entered, and finally, constructive hope, denial of hope, climate change knowledge, and trust for climate change adaptation were inserted. In this final step, knowledge of climate change was the strongest positive predictor. The results indicated a strong connection between climate change knowledge and the understanding of climate change mitigation means. In addition, constructive hope was a significant positive predictor. Denial of hope was a significant negative predictor. So, it seems to be evident the scientifically correct climate change knowledge and constructive hope, for example, the beliefs of one's own possibilities to make change, predict well students' knowledge to mitigate climate change. The full model accounted for 45% of the variance, $F(7, 942) = 168.623$, $p < 0.001$.

Table 4. Hierarchical Regression Model Predicting Climate Change Mitigation Knowledge.

	Climate Change Mitigation Knowledge		
	Step 1	**Step 2**	**Step 3**
	β	**β**	**β**
Gender (girls = 1, boys = 2)	−0.326 ***	−0.326 ***	−0.120 ***
Grade (class5 = 1, . . . , class9 = 5)		-	-
City (Rovaniemi = 1, others = 2)		-	-
Climate change knowledge			0.516 ***
Optimism of adaptation			-
Constructive hope			0.260 ***
Denial of hope			−0.169***
R^2	0.106 ***	-	0.556 ***
Adjusted R^2	0.105 ***	-	0.553 ***
ΔR	0.106 ***	-	0.450 ***

*** $p \leq 0.001$.

A Pearson's correlation analysis (Table 5) was conducted between constructive and denial of hope and climate change mitigation knowledge and trust for climate change adaptation. All four correlations were significant. The strongest significant positive correlation was between mitigation knowledge and constructive hope, and the weakest was denial of hope with optimism of adaptation. Thus, it would seem that positive thinking about climate change was linked to higher knowledge of climate change mitigation. Students were also confident that people in Finland and elsewhere, and science and technology would help us to adapt to climate change, but the correlations were not high, especially related to denial of hope. Actually, a Spearman correlation analysis revealed the students' ideas that warmer summers ($r_s = 0.208$, $p < 0.001$) and doubt that climate change is a natural phenomenon ($r_s = 0.194$, $p < 0.001$) affected hopefulness towards climate change adaptation. Therefore, they somehow think they have greater confidence in climate change adaptation, or that adaptation may not even be needed.

Table 5. Pearson Correlation Results.

	Constructive Hope	Denial of Hope
Mitigation knowledge	0.479 **	−0.274 **
Optimism of adaptation	0.245 **	0.176 **

** $p \leq 0.01$.

Limitations of the Study

This study had some limitations. Because it explored a new area of research, some of the scales were created specifically for this study. Thus, although the reliability of the scales was satisfactory, they should be further validated in future studies. Additionally, the correlations were at best of medium strength. The results of this study were based on a convenience sample of Finnish elementary and secondary students. To be able to generalize the results in a broader way, it is important to use random sampling in future studies and to include young people from different cultures and countries [25].

6. Discussion

6.1. Students' Hope Related to Climate Change

According to the present study, students' constructive hope is a more common attitude towards climate change than denial of hope. The result is similar to that found by Ojala [44]. She concluded the concentrating on hope is one important aspect in climate education. We detected that gender had significant effects on hope, with girls having greater hopefulness towards climate change than boys, a result similar to that of Ojala [5,44]. In contrast, age and dwelling place did not affect hope regarding climate change. Ratinen and Vettenranta [46] indicated regional differences in eighth graders' hope towards the state of environment in the future, and especially students from Finnish Lapland expressed their pessimistic hope towards environmental issues. Li and Monroe [42] suggested that the association between concern and hope is positive. Those young people who are strongly concerned with climate change can also report higher levels of hope. In this study, we found that students' constructive hope towards climate change correlated positively with the optimism of adaptation means of climate change. However, the understanding of climate change adaptation should be further explored. Ojala [6] pointed out that trust and optimism are important aspects of the constructive hope concept and may even influence young people's voting behaviours.

In this study, students' constructive hope and especially their belief that we have to consider climate change seriously and responsibly significantly predicted their knowledge of climate change mitigation. About two in three students thought that changing their own behaviour would also contribute to the creation of hope related to climate change. Jylhä [47] found that denying the climate problem was related to understating the threat, and our finding was associated with the students'

denial of hope and their lower climate change mitigation knowledge. About a third of students thought that climate change does not exist and can therefore be considered positively. This result is interesting in particular, because their belief is not in line with scientific thinking, and their lack of understanding was also reflected in a poorer perception of climate change mitigation. Ojala [6] pointed out in her study that boys especially use hope based on denial, which can be explained by their teachers not taking their negative emotions seriously.

When it comes to climate education, it seems that, especially for boys, constructive hope should be emphasized. For them, climate hope seems to be based on the fact that climate change is seen as less harmful. According to Ojala [6], it is crucial to educate teachers how to pay attention to and reflect on how they react to negative emotions in the classroom. Her questionnaire also provided indications that climate education should be implemented in the same way among the youngest, the fifth grade. However, caution should be exercised in interpreting the responses, as the effect sizes, or values that represent the magnitude of the differences, remained quite small for all the variables. More research is needed to find out which educational strategies are the most effective for students with a background with only few opportunities to learn about practices of climate change adaptation.

6.2. Students' Level of Knowledge About Climate Change and Optimism Affect Their Hope

Ojala [6] found that hope can be both positively and negatively related to engagement. The relation seems to be dependent on the characteristics of the more specific sources of hope. To ensure that students feel good is not enough, but in climate change education, students need to use their knowledge in a constructive way for mitigating climate change. In the present study, the students' understanding of climate change was rather good, and this clearly affected their knowledge of climate change mitigation. All in all, knowledge of climate change seemed to increase the students' hope more than their optimism. Previous studies [8,44] have found similar results, and it is possible that optimism is also about wishful thinking and therefore, does not increase hope for climate change. Thus, research from environmental psychology argues that the appearance of some kind of hopefulness did not always prove useful for climate change mitigation; individuals need a more realistic view, such as energy efficacy, where one's own responsibility was sufficiently recognized [43,48].

7. Conclusions

Given the earlier notion about the unclear connection between students' knowledge about climate change and their hope, it is interesting to think about the possible variation between the level of knowledge and the type of hope. Acknowledging the fact that one is being optimistic about the influence of one's actions (or opportunities to contribute) is an important part of hope. However, when considering the difference between constructive hope and denial of hope, it is also interesting to consider the role of realistic optimism in this. For example, does lack of knowledge always mean denial of hope and environmental awareness constructive hope? Then, what about worry and hopelessness due to environmental anxiety [4]? Strife [9] even uses the concept of "ecophobia" to describe children who are fearful of environmental problems. Can denial of hope become a protective factor of psychological health? At the same time, there are plenty of other children denying climate change exists and thus, can report high levels of optimistic attitudes.

This can lead us to describe four extreme types of *student positions with regard to climate change*:

1. Profound knowledge and constructive hope: This position refers to a type of student who is well aware of the meaning of climate change and actions that people may take to act pro-environmentally. They also realize the role of nations and international agreements about sustainability. This student shows high levels of optimism that foster their constructive hope. They believe that right actions can be taken, that these actions matter and they can be influential. They are aware of their own behaviours and know their abilities and opportunities to act pro-environmentally. Therefore, they show hope towards the future.

2. Profound knowledge and denial of hope: Some students show familiarity with the reasons, outcomes, and nature of climate change, but their attitudes and their abilities to influence others' actions are quite pessimistic and doubtful. They are afraid of climate change developments in a way that may cause them anxiety, even depression. Strife's [9] term ecophobia falls into this category.
3. Superficial/lack of knowledge and constructive hope: This position includes students who are not very familiar with or interested in climate change. They have learned about climate change, for example, at school, but do not consider it something that affects their daily lives much. They still show high levels of optimism toward the future. They may believe that activists and politicians will guide nations to pursue the right solutions to fight against climate change, and a good outcome can be reached. In this sense, their hope is constructive, but lacks a personal connection to the phenomenon of climate change.
4. Superficial/lack of knowledge and denial of hope: This category resembles the group of students who are not well aware of the phenomenon of climate change. They lack correct information and may base their opinion on climate change, for example, on prejudices and opinions learned from home. Especially in this group, parental influence may have a huge role (in a negative sense). These students may think climate change is not real or that it is a natural phenomenon. When it comes to their hope, according to the findings of this research, the students may have unrealistic confidence in climate change mitigation or, depending on their opinion on the nature of climate change, may think that mitigation may not even be needed.

Interestingly, the link between education and knowledge and environmental attitudes and feelings is not clear [49–51]. Earlier studies have shown that children and youngsters tend to worry more about others' actions toward nature than their own environmental behaviours [10]. This tendency could refer to the second type of students illustrated above. With respect to education, one should remember that realistic, positive expectations closely relate to self-knowledge; thus, constructive hope and its connection to environmental knowledge and awareness as it was demonstrated in this data is worth a closer inspection. The question for environmental education is then how to increase awareness and simultaneously enhance and secure constructive hope in children? One answer from educational psychology can be to promote their realistic optimism, which helps them identify their own attitudes and support trust in not only themselves as environmental actors, but to mankind in general—to provide hope.

In conclusion, there are perceptions about actions regarding climate change, and respondents can build more hope when they also trust and believe that society and others have the ability and willingness to take the right actions.

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