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GLOBAL CLIMATE CHANGE SCALE (GCCS): DEVELOPMENT AND VALIDATION

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ABSTRACT

Global Climate Change (GCC) is the increase in global temperature and the change in average climate values. The climate change becoming an 'emergency' that cannot be ignored anymore is called the climate crisis. There is also a need for reliable and validated scales to measure attitudes towards GCC. This study focused on university students' global climate change scale (GCCS) development and validation. In the study, a four-factor scale, called Knowledge, Awareness, Perceived Risk and Responsibility, with an explained variance of 74.51%, was developed. In addition, the general index showing the positive attitude level of high index values towards GCC was 78%, and the index values of Knowledge, Awareness, Perceived Risk and Responsibility dimensions were calculated as 0.76, 0.83, 0.83 and 0.69, respectively.

Keywords: Global Climate Change (GCC), scale development, explanatory factor analysis, confirmatory factor analysis.

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1. INTRODUCTION

While it means the increase in average temperatures as a result of the greenhouse effect assumed to be caused by the gases released into the atmosphere as a result of global warming,

natural events and human activities; global climate change is climate changes caused by global warming. The views of climate scientists are that there will be global warming resulting from the increase in greenhouse gas emissions in the atmosphere and therefore climate change will occur. The climate changes that will occur; It is predicted that it will lead to changes in agricultural activities, habitats of plants and animals.

When the literature is examined, about the GCC; It has been observed that there are significant relationships between awareness, knowledge, perceived risk, attitude and environmental priority behavior concepts [5-7,12,15,21,27]. Ünlü et al. [26] published global warming and the greenhouse effect in the field of environmental education in Turkey was examining the papers and report on results. From the texts analyzed, it has been observed that students at all educational levels, even teachers, from primary education to higher education, have quite a lot of misconceptions and incomplete information problems about global warming and greenhouse effect. Güven and Aydoğdu [11] developed a reliable and valid awareness scale to determine the level of awareness of pre-service teachers regarding environmental problems. As the sample, 203 pre-service teachers studying in the 4th grade of Science Education and 93 pre-service teachers studying in the 3rd grade were taken into consideration. In the study, a 44-item awareness scale has been developed for the environmental problems, whose reliability is ensured. As a result of the study, it was seen that the environmental awareness levels varied according to the items in the scale and the awareness was below the expected.

Milfont [18] proposed three different models for the relationships between knowledge, personal competence, and concern about global warming and climate change. He claims that, in the first model, as the level of knowledge increases, anxiety increases, in the second model, as knowledge increases, efficiency increases, and in the third model, anxiety increases with increasing efficiency. As a result, it was seen that there was a positive relationship between anxiety, knowledge and activity variables. Schuldt and Roh [22] conducted two separate studies in their research. In their first study, a questionnaire was applied to students on whether they believe in global climate change due to exposure to off-season cold weather on campus recently. In the second study, a Web questionnaire was applied to students to describe

the seasonal and non-seasonal temperatures experienced on campus. Studies have shown that those who are exposed to hot weather out of season believe that it is global warming, not climate change, and that it poses a serious threat to them, while those exposed to off-season Zaval et al. [29] stated that the weather being warmer or colder than normal is perceived as climate change. In this study, data were collected by applying a questionnaire to the participants in order to reveal the level of belief and anxiety about global warming. As a result of the study, it was determined that anomalies in temperature increased belief and anxiety about global warming. Biçer and Vaizoğlu [4] investigated the knowledge and awareness of the students of the Faculty of Health Sciences, Department of Nursing about global warming and climate change and their solution suggestions for global warming and climate change. In the study, it was determined that although they are university students, the knowledge and awareness levels of nursing students about global warming and climate change are insufficient.

Tetik and Acun [25] researched the perceptions and thoughts of tourism students about global warming and climate change with the help of a questionnaire. The questionnaire prepared for this purpose was applied to 542 students studying at Balıkesir University Faculty of Tourism. As a result of the research, it was determined that students' perception of global warming and climate change is generally high and they are worried about the possible consequences. Although the students emphasized that the measures taken were insufficient, they stated that the state should take more effective measures rather than individual efforts. Aydın [2] aimed to determine the level of knowledge of university students about global warming. 472 senior students from Karabük University Faculty of Literature participated in the study in the spring term of the 2016-2017 academic year. As a result of the study, it was seen that the knowledge level of students on global warming was above average, but still they had serious lack of knowledge.

Tok et al. [24] examined the classroom teacher candidates' awareness of the effects of climate change, personal and industrial initiatives in climate change, and behavior change trends. The findings of this study show that the classroom teacher candidates have high awareness of the physical consequences of climate change such as the increase in atmospheric temperature, the

rise of sea water level, and the increase in the salinity of the waters. However, the participants stated that they were less aware of issues such as the increase in various diseases, the decrease in the production of agricultural products or mass migration.

Durkaya and Durkaya [8] tried to determine the level of global warming awareness of Bartın University students. A questionnaire was applied to 536 university students randomly selected by the stratified sampling method. It has been observed that 86% of the students know the concept of global warming and this rate is better for women than men. In addition, it has been determined that students who receive education on global warming are more conscious than those who do not. Choon et al. [5,28] investigated the effect of environmental awareness, social trust and environmental knowledge on climate change mitigation behaviors and participation in green activities, and the mediating role of risk perception in this effect. According to the findings, it was seen that there was a significant relationship between environmental awareness and social trust and risk perception, but no significant relationship was found between environmental knowledge and risk perception.

Elshirbiny and Abrahamse [9] conducted a study using mixed methods (an online survey and semi-structured interviews) to examine the climate change risk perceptions of Egyptian people. The findings show that the Climate Change Risk Perception Model (CCRPM) explains 19.2% of the variance in risk perception. The results also showed that although the participants were worried about climate change, they had misconceptions about its causes.

In the United Nations Framework Convention on Climate Change, climate change is defined as "a change in the climate as a result of human activities that directly or indirectly disrupt the composition of the global atmosphere, in addition to the natural climate change observed in a comparable time period". In order to prevent the occurrence of this global problem and to reduce its effects, it is necessary for all individuals to develop positive attitudes on this issue and to reflect these attitudes to environmentally-prioritized behaviors. For this reason, measuring society's attitudes towards GCC comes to the fore as an important issue. When the literature is examined, about the GCC; it is seen that concepts such as awareness, knowledge, risk perception and environmental behavior come to the fore. This study focused on the development and validation of the global climate change attitude scale of university students.

2. MATERIAL AND METHOD

In the Likert scale, which is a typical example of the scaling approach in which the subjects are put at the forefront, there are various expressions that the individuals whose attitudes will be measured will react. Instead of marking the expressions he adopts, the individual who takes the attitude scale determines the extent to which he or she agrees with each statement Therefore, Likert type scales are based on the principle of giving information about the individual. Although the Likert method was first developed to measure attitudes, it is also used to measure psychological variables other than attitudes [1].

The Likert scale is based on the assumption that all items in the scale measure the same structure [19]. This assumption is often difficult to meet because many of the psychological variables are compounded. For this reason, even if there are sub-dimensions in attitude scales, each sub-dimension should show high correlation throughout the scale, that is, the scale should actually represent a single psychological structure.

In the study, many studies from the literature [2,3,5,12,14,17,21] were examined and a 30-item questionnaire was developed inspired by these studies. Later, for the content validity, the number of items was reduced to 21 with the opinions of 3 faculty members and 2 graduate students related to the subject. Afterwards, the number of items was reduced to 15 through a pilot study of 50 university students and face-to-face interviews. Since the aim was to measure the attitudes towards the GCC with the least number of items, a decision was made on 12 items with the experience of the researcher. After the questionnaire was designed, a second pilot study was conducted with 140 students from the Statistics Department of the Faculty of Science and Letters and the Cronbach Alpha (CA) value was calculated as 0.878.

Instead of removing the items from the scale as a result of the EFA and CFA analyzes process, the most appropriate item selection process was applied very carefully and meticulously to measure the attitudes towards the GCC with literature knowledge, experience and expertise in the final item selection. Along with the demographic questions in the questionnaires, the high number of items (more than 30 questions) causes the response time to be prolonged and the results of this situation arise from unwillingness to answer, low response rate and high number of inconsistent answers. For this reason, in the study, after the number

of questions was optimized, the approach to the questionnaire application was preferred. A 10-point Likert was used to measure the items (1-I never agree; 10- I totally agree).

The data of the study were compiled in November / December-2018 by conducting a face-to-face questionnaire study for the students of the Faculty of Science and Literature Department of Statistics and Faculty of Agriculture, Department of Agricultural Engineering at Eskişehir (a metropolitan city with a population of 888.828 and three state universities, geographically in the central region of Turkey). The sample of the study consisted of 400 participants. Power analysis was performed for the sample size. When the desired statistical power level = 0.80, the number of latent variables = 4, the number of observed variables (item) = 12, and the minimum sample size for probability = 0.05 was calculated as 200. These results show that the sample size in the study is sufficient.

46.5 percent of university students are women and 53.5 percent are men. Considering the Faculty / Department, the number of participants in the Department of Statistics and the Department of Agricultural Engineering is equal. 5.8 percent of the participants are 1st grade students, 27 percent are 2nd grade, 32.8 percent are 3rd grade and 34.5 percent are 4th grade students. There are no students studying in Prep, 5th and 6th grade.

3. SCALE DEVELOPMENT PROCESS

3.1. Item analysis

When examining the reliability of a scale, it is necessary to examine how the items in the scale relate to the whole scale, that is, whether it is a part of a whole. This analysis becomes much more important in scale development studies.

Corrected Item-Total Correlation

It shows the correlation between an item in the scale and the total score of all the remaining items. Although the cut-off point varies according to the research purpose, it may be preferable to have an item-whole correlation of at least 0.250. It is expected that there is no negative sign in item-all correlations. An item-total correlation with a negative sign may mean that although the item requires reverse coding, this process was forgotten and / or the item was not well understood by the participants.

Square of Multiple Correlation Coefficient

The square of the multiple correlation coefficient again reveals the item-whole relationship. It shows the rate of disclosure of a substance by all other substances, and rates above 0.300 can be considered sufficient.

Cronbach's Alpha if Item Deleted

When any item is deleted, there should be no noticeable rise or fall in the overall Alpha internal consistency coefficient. When an item is deleted, if the Alpha coefficient increases significantly, that item can be deleted. Otherwise, that item should not be deleted. When the deletion is done, the remaining items are expected to be theoretically sufficient to measure the relevant attitude.

Item analysis results are given in Table 1. When Table 1 is examined, item-total correlations (corrected item-total correlation) is 0.480-0.708, the square of the multiple correlation (specificity) coefficient (r^2-squared multiple correlations) is 0.328-0.60 and the alpha coefficient when the item is deleted (Cronbach's alpha if item deleted) 0.892-0.903 It seems to be between. This finding shows that the item analysis results of the scale draft are consistent and consistent. In addition, it was determined that the mean of the scale draft consisting of 12 items was 95.15 and the variance was 250.53.

Table 1. Item-Total Statistics

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
B18	87.2600	217.857	0.480	0.328	0.903
B19	87.5000	211.554	0.602	0.442	0.897
B20	87.9250	210.285	0.642	0.477	0.895
C22	86.9625	212.086	0.653	0.509	0.894
C23	86.7975	214.242	0.679	0.598	0.893
C24	86.6725	213.840	0.708	0.640	0.892
D25	86.8625	211.141	0.679	0.541	0.893
D28	86.5200	214.792	0.683	0.527	0.893
D29	87.0650	210.587	0.652	0.509	0.894
E31	87.4425	211.084	0.634	0.556	0.895
E32	87.9175	211.334	0.592	0.578	0.897
E33	87.7800	209.545	0.584	0.548	0.898

3.2. Explanatory factor analysis (EFA)

Factor analysis is a statistical process used to investigate the relationships between observed and latent sets of variables. The two main factor analyses are explanatory and confirmatory factor analysis. The EFA researcher is unaware of the number of factors measured by the measuring tool. It is done to reach a conceptually meaningful factor structure and determine the number of factors. Instead of examining a particular hypothesis, the researcher uses EFA when trying to gain insight into the nature of previously identified factors.

In EFA, the data collected in pilot studies were used. First of all, KMO statistics were calculated to determine whether the sample size was sufficient for EFA or not and it was found as 0.912. The KMO value being higher than 0.60 showed that the sample volume was sufficient for EFA. In addition, Bartlett's test of sphericity was conducted to determine the adequacy of the correlation between items for EFA. In the Bartlett test, the null hypothesis tests that there is no correlation between the items (H_0: R = I), in short, the correlation matrix is equal to the unit matrix. As a result of the analysis, Bartlett's statistic was calculated as $\chi 2 = 2473.87$ (df = 66; $p < 0.01$) and as a result, the null hypothesis was rejected and it was decided that there was a correlation between the items.

Principal component analysis, which is widely used in determining factors, was used in conjunction with a varimax rotation approach. As a result of EFA analysis, a 4-factor structure with an explanation ratio of 74.51 was reached with varimax rotation. These factors found, considering the meanings of the items they contain and the highest factor loadings, B: Knowledge; A: Awareness; D: Perceived Risk; E: Named as responsibility. The disclosure rates of the factors are 17.168, 19.046, 17.851 and 20.447, respectively. Factor loads calculated in EFA were calculated as 0.69-0.86. Factor loads higher than 0.50 means that the items adequately represent and measure the relevant factor.

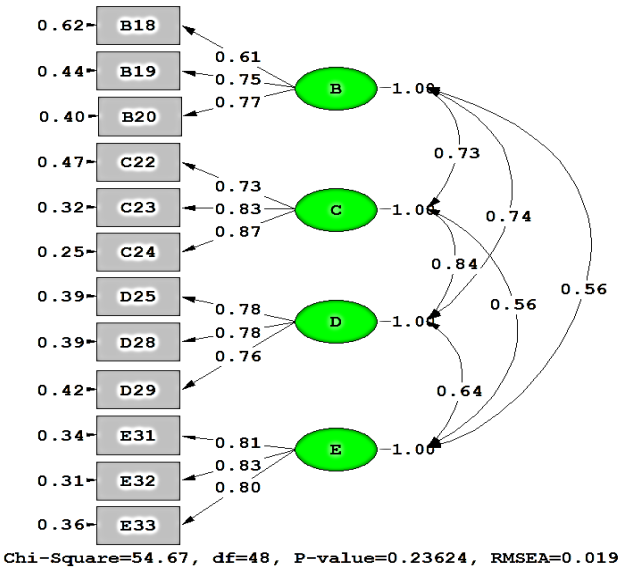
3.2. Confirmatory factor analysis (CFA)

The LISREL program was used for CFA in order to examine the harmony of the factor structure performed with EFA. Before starting the CFA analysis, multivariate normality test was applied to the data for the selection of the appropriate parameter estimation method. Multivariate normality calculated symmetry and kurtosis $\chi 2 = 100.55$ ($p < 0.01$). This result

showed that the data set was not distributed normally in multivariate. For this reason, robust maximum likelihood (Robust ML) method has been used as the parameter estimation method in CFA.

Before doing CFA, the unidimensionality of the data was tested. Multiple fit measures for unidimensional scale for data $\chi 2$ = 382.96 (df = 54, p <0.01), $\chi 2$ / df = 7.09> 3, RMSEA = 0.124> 0.05, CFI = 0.87 <0.90, GFI = 0.80 <0.90, AGFI = 0.71 <0.90, Expected Cross-Validation Index (ECVI) = 1.08. The fit values of the one-dimensional model do not show an acceptable fit. For this reason, it has been evaluated that the model cannot be explained in one dimension.

After this stage, the factor structure determined in EFA was tested with CFA. The path diagram obtained as a result of the analysis is given as first order EFA in figure 2. CFA factor loadings, Cronbach Alpha (CA), Structure Reliability (CR) and Average Extracted Variance (AVE) values are shown in table 2. First order EFA fit measures $\chi 2$ = 54.67 (df = 48, p = 0.23624> 0.05), $\chi 2$ / df = 1.14 <3, RMSEA = 0.019> 0.05, CFI = 1.0. > 0.90, GFI = 0.96> 0.90, AGFI = 0.94> 0.90, Expected Cross-Validation Index (ECVI) = 0.29. Fit values of the 4-factor model given in Figure 1 show good fit. Briefly, it was evaluated that the model can be explained with 4 factors.



B: Knowledge; C: Awareness; D: Perceived Risk; E: Responsibility

Fig.1. First order CFA- Global Climate Change Scale (GCCS)

Table 2. Standard loads (EFA and CFA), Average and R^2 Values

Factors	Items	Standard Loads (CFA)	Standard Loads (EFA)	Average	R^2
Knowledge (B)	B18: Streams, lakes and sea levels will rise as the glaciers melt as a result of the GCC.	0.61 **	0.79	7.89	0.38
CA = 0.76	B19: Rapid increases in greenhouse gases cause GCC.	0.75 **	0.75	7.65	0.56
CR = 0.76	B20: Carbon dioxide emission is one of the main causes of GCC.	0.77 **	0.69	7.23	0.60
AVE = 0.51					
Awareness (C)	C22: I am aware that the rainfall pattern (time and amount) has changed due to the GCC.	0.73 **	0.74	8.19	0.53
CA = 0.831	C23: I am aware that the GCC affects human life.	0.83 **	0.75	8.35	0.68
CR = 0.84	A24:I am aware that GCC affects the natural environment.	0.87 **	0.76	8.48	0.75
AVE = 0.64					
Perceived Risk (D)	D25: GCC is a public health hazard.	0.78 **	0.69	8.29	0.61
CA = 0.854	D28: Agricultural production is at risk due to GCC.	0.78 **	0.69	8.63	0.61
CR = 0.85	D29: The GCC will have a negative impact on the environment in which my family lives.	0.76 **	0.82	8.09	0.58
AVE = 0.66					
Responsibility (E)	E31: I feel it is a moral duty to do something about the GCC.	0.81 **	0.86	7.71	0.66
CA = 0.84	E32: It is my responsibility to encourage my neighbors to behave towards reducing the GCC.	0.83 **	0.84	7.23	0.69
CR = 0.82					
AVE = 0.60	E33: I am willing to change my lifestyle to reduce GCC.	0.80 **	0.79	7.37	0.64

**P<0.01

According to the CFA results in Figure 1, the correlations between B: Knowledge and C: Awareness, D: Perceived Risk and E: Responsibility were found to be 0.73, 0.74 and 0.56 positive and significant ($p < 0.01$), respectively. Correlations between C: Awareness, and D: Perceived Risk and E: Responsibility were calculated as 0.84 and 0.56, and finally, the correlation between D: Perceived Risk and E: Responsibility was calculated as 0.64. All correlations between factors were found to be positive, statistically significant and between 0.56-0.84.

In addition, it was investigated with the second order CFA whether the 4-factor structure determined in the first order CFA is actually sub-factors of the attitude towards GCCS (Figure 2). Second order CFA fit measures $\chi 2 = 58.19$ (df = 50, p = 0.19932> 0.05), $\chi 2$ / df = 1.16 <3, RMSEA = 0.02> 0.05, CFI = 1.0. > 0.90, GFI = 0.96> 0.90, AGFI = 0.94> 0.90, Expected Cross-Validation Index (ECVI) = 0.29. It is understood from the harmony values that the 4-factor structure given in Figure 2 is the sub-factors of the attitude scale towards GCC.

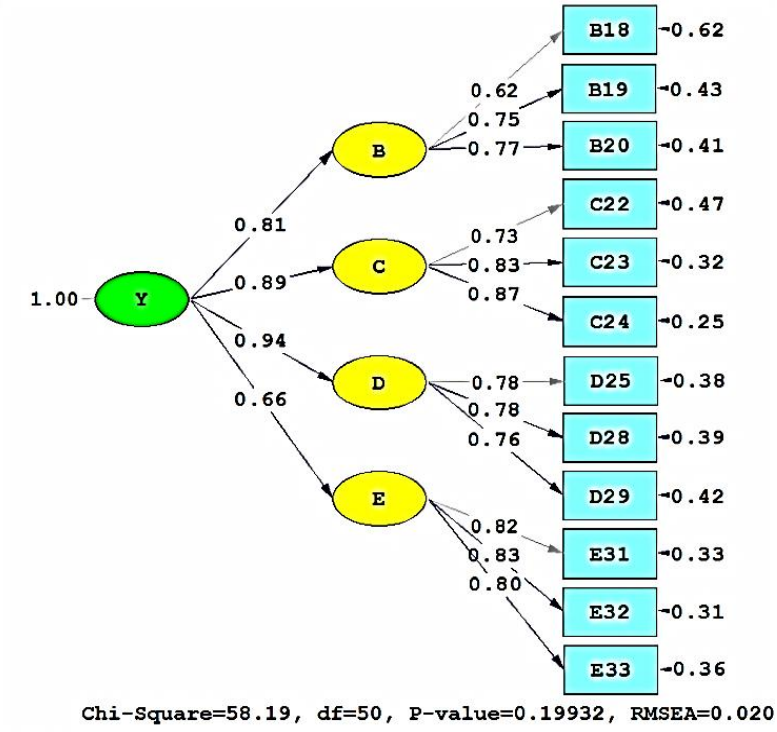


Fig.2. Second order CFA- Global Climate Change Scale (GCCS)

Whether there is a significant difference between the first order CFA and the second order CFA was tested by Chi-square. Since $\Delta\chi^2 = 3.52$ (df = 2, p> 0.05), it was evaluated that there was no significant difference between the two models. When the Consistent Akaike Information Criterion (CAIC) was calculated to compare the two models, it was calculated as CAIC = 264.41 for the first order CFA and CAIC = 253.95 for the second order CFA. This result confirms that the second order CFA represents the structure better and the 4-factor structure is actually the sub-factors of the attitude towards GCCS scale.

3.3. Reliability and validity of the CFA model

The ordering of the items in the scale, the place and time of the application may cause bias in the scoring of the participants. This situation affects the data collected. In other words, method bias refers to the measurement variance at different levels of abstraction, such as the answers related to the measurement method rather than the type of the scale or the established structure [20]. In this study, Harman's single factor test was applied to determine the common method bias. The desired result here is that the total explained variance of the single factor is less than 50% [20]. In this study, the total explained variance of the single factor was found to be 36%. This result shows that the items in the data set are not under the influence of common method bias.

Three conditions must be met to ensure the validity of the model. First, the standard loads for each observed latent variable should be greater than 0.50 and statistically significant [10]. Standard loads that take values between 0-1 approaching to 1; it means that there is a high relationship between the expressions and the factors to which the expressions belong. Secondly, the Construct Reliability (CR) and Cronbach Alpha (CA) values of the factors should be greater than 0.70. Taking values between 0-1, CA value approaching 1 indicates that the reliability is high. Finally, the Average Extracted Variance (AVE) values for the factors should be greater than 0.50 [10, 13, 30].

In Table 2, the standard loads obtained from the CFA analysis, the significance test results of these loads, R^2 values, which are the percentages of explanation of the relevant factor, CR, CA and AVE values are given. When the standard loads are examined, it is seen that the loads are between 0.61-0.87. Since the Cronbach's alpha values for the factors are between 0.76-0.85 and 0.90 for the whole scale in the study, it can be evaluated that the four-factor structure was measured reliably. In addition to these, when the CR values are examined, it is seen that they are higher than 0.70. Therefore, one can evaluate whether the structures have convergent validity. It is seen that the AVE values for the factors are higher than 0.50. As a result of the values in Table 2, it is understood that the reliability and validity of the CFA model is ensured.

4. CONCLUSION

Environmental problems caused by GCC in recent years have worried the lives of all humanity and living beings. In order to prevent the occurrence of this global problem and to reduce its effects, it is necessary for all individuals and especially decision-makers to develop positive attitudes and reflect these attitudes to environmentally prioritized behaviors. Raising environmentalist individuals is also of great importance in this sense. For this reason, measuring the attitudes of the society towards the GCC comes to the fore as an important issue. In this study, it is tried to develop a valid and reliable Global Climate Change Scale (GCCS) that can be used to measure university students' attitudes towards GCC.

In the study, a short form scale for GCCS was developed. In addition, the index values for the dimensions Knowledge, Awareness, Perceived Risk and Responsibility were calculated as 0.76, 0.83, 0.83 and 0.69, respectively. The general GCCS index was determined as 78%. High index values indicate that people's attitudes towards GCCS are positive and desirable. In the study, it was determined that awareness and perceived risk values were slightly above the general index and below for knowledge and responsibility. Especially the low value of the responsibility dimension is thought-provoking. Although awareness and perceived risk values are high among young people, it has been revealed that they are not willing enough to fulfill their responsibilities.

In the scale development process, item analysis, EFA and first and second order CFA analyzes were used, and a 4-factor structure was obtained. This study focused on university students' global climate change scale (GCCS) development and validation. At the end of the study, it was tried to develop a four-factor scale named as Knowledge, Awareness, Perceived Risk and Responsibility with a variance of 74.51%. Skodienė and Liobikienė [23] stated that as people are concerned about climate change and their sense of responsibility to mitigate climate change increases. However, the authors considered that promoting pro-environmental attitudes and behaviors related to climate change mitigation is crucial for the implementation of a successful climate change policy. In the scale developed in this study, a factor expressing the feelings of responsibility was obtained.

The fit of the models was investigated by taking into account the multiple fit criteria used in structural equation modeling. Considering the fit criteria, it was determined that both the first and second order CFA models showed good fit. However, when the model is compared according to the CAIC criterion, it was determined that the 4-factor structure is actually the sub-factors of the attitude scale towards GCC, and the second-order CFA model is more valid. In this model, the relationships between the second-order CFA factor and its sub-factors were found to be Y→D: 0.94, Y→C: 0.89, Y→D: 0.81 and Y→D: 0.66 positive, statistically significant and at a high level. Knight [16] focused on the awareness of climate change and perceived risk in his study and emphasized the importance of these factors in GCC. In our study, it was determined that awareness and perceived risk are the most important elements that make up the GCCS scale.

In the study, it was also investigated whether the mean answers given to the statements in the scale differ by faculty and gender. When examined by gender, it was found that the knowledge and awareness of women and men about GCC were at the same level, their sense of responsibility ($\bar{x} = 7.70$) was higher than that of men ($\bar{x} = 7.22$) and therefore they had a stronger attitude. When the answers given by the students of Statistics ($\bar{x} =$ 6.91; p <0.01) and Department of Agricultural Engineering ($\bar{x}$ =8.27; p <0.01), which are considered as samples, it is It has been determined that they have perceived risk and responsibility. In addition, when all factors are taken into account, it has been revealed that the students of the Department of Agricultural Engineering have higher GCC scale averages. Considering the department of Agricultural Engineering students and the content of the courses they take; it is evaluated that they have higher knowledge and awareness attitudes about the GCC.

5. DISCUSSIONS

The main purpose of environmental education is to raise awareness of all segments of the society about the environment, to bring positive and permanent behavioral changes and to ensure active participation. It is thought that this study will help decision makers in raising

awareness of policies and strategies, raising public awareness on climate change and increasing environmental knowledge, and positively affect attitudes towards the environment. Mutual sharing of information in society on barriers to access to information and the GCC makes finding and implementing solutions less effective. It is also important to include the GCC subject in formal and non-formal education in accordance with the levels of students in order to avoid misconceptions. In addition, by determining the environmental sensitivity levels of students, adopting new approaches in education and training activities can be evaluated in order to increase their sensitivity to higher levels. The theoretical model and the relations between the variables contribute to the issues of global warming, climate change and environment in order to carry forward the theoretical studies.

Given that knowledge, perceived risk, awareness, and responsibility have a significant impact on GCC prevention action, decision-makers need to develop education and communication programs that highlight climate change risks and their possible consequences, and demonstrate the benefits of engaging in behaviors that specifically address climate change issues. It may not be possible for an individual to experience all disasters such as earthquakes, floods, mass epidemics and droughts that occur due to the possible consequences of climate change personally, but by adding information about them to disaster response training programs, awareness and attitude towards preventing GCC and behaviors can be developed.

Society and administrators have great responsibilities regarding the GCC, which has great negative consequences on nature and all living things. Minimizing the use of fossil fuels, preferring renewable energy in energy consumption, and preventing non-environmental misuse of forest lands with the great destruction of forests are common responsibilities. This can only be possible if individuals have a high level of knowledge and awareness about GCC. Increasing the correct knowledge and awareness levels of all individuals who make up the society about the GCC can only be possible with sufficient training on the formation, effects and prevention of the GCC.

Limitations and recommendation

The developed GCCS can be seen as a short form for measuring attitudes towards GCC and may need to be developed. The study, especially the scale presented, can be applied and

developed in other faculties and universities. The model presented in the study can be re-applied in different countries or cultures. In addition, a research model can be developed by adding the factors not addressed in this study to the model. Including demographic factors that could not be discussed in the study can contribute to the model and provide a better understanding of the factors affecting GCC behavior. Structural equation models can be developed that investigate the cause-effect relationships between the factors in the scale and behaviors to prevent GCC.

In future studies, these indexes can be calculated for the youth of different countries and informative studies can be carried out through the necessary training, panels and social media for the low dimensions. In addition, weights can be determined for the dimensions in the developed GCCS and the general index can be calculated by taking these weights into account.

Declarations

Consent for publication

The article titled "**Global Climate Change Scale (GCCS): Development and Validation**" has not been published in any journal,

Availability of data and material

If the material and data set used in the article is requested from us in writing by the journal secretariat and researchers, this information will be shared by us.

Code availability LISREL code for data analysis is available upon request to the corresponding author.

Competing Interest

No potential conflict of interest.

Funding/Acknowledgements

No funds were used in the study.

Ethics approval

The subject of the study and the data collection tool were found to comply with the ethical rules with the decision of the University's Social and Human Sciences Human Research Ethics Committee numbered 2018-13.

6. REFERENCES

[1] Anderson L.W. Attitudes and Their Measurement. New York: Educational Research, Methodology and Measurement. An International Handbook, Keeves, J. P. (Ed), 1988, 421-426.

[2] Aydın F. Determining the level of knowledge of university students on global warming. Journal of Social Sciences and Humanities, 2017, 1 (1): 118-132.

[3] Aydın F. High school students' knowledge level determination of global warming. Turkish Journal of Education, 2014, 3(4), 15-27.

[4] Biçer B.K., Vaizoğlu S.A. Determination of Awareness and Knowledge of Nursing Students About Global Warmness/Climate Change. Journal of Hacettepe University Faculty of Nursing, 2015, 2(2): 30-43.

[5] Choon S.W., Ong H.B., Tan S.H. Does risk perception limit the climate change mitigation behaviors? Environment, Development and Sustainability, 2018, 21 (4): 1891- 1917. https://doi.org/10.1007/s10668-018-0108-0

[6] Dal B., Öztürk N., Alper U., Sönmez,D., Mısır M.E., Çökelez A. Perception of climate change: Reasons, consequences, and willingness to act. How aware are they? International Journal for Cross-Disciplinary Subjects in Education (IJCDSE), 2014, 4(2): 1930-1937. https://doi.org/10.20533/ijcdse.2042.6364.2014.0268

[7] Dal B., Alper U., Özdem-Yilmaz Y., Öztürk N., Sönmez D. A model for pre-service teachers' climate change awareness and willingness to act for pro-climate change friendly behavior: adaptation of awareness to climate change questionnaire. International Research in Geographical and Environmental Education, 2015, 24(3): 184-200. https://doi.org/10.1080/10382046.2015.1034456.

[8] Durkaya B., Durkaya A. Global Warming Awareness Sample of Bartin University Students. Journal of Bartin Faculty of Forestry, 2018, 20(1): 128-144. https://doi.org/10.24011/barofd.379939

[9] Elshirbiny H., Abrahamse W. Public risk perception of climate change in Egypt: a mixed methods study of predictors and implications. J Environ Stud Sci, 2020, 10, 242–254. https://doi.org/10.1007/s13412-020-00617-6

[10] Fornell C., Larcker D.F. Structural equation models with unobservable variables and measurement error: Algebra and statistics. Journal of Marketing Research, 1981, 18(3): 382-388. https://doi.org/10.2307/3150980

[11] Güven E., Aydoğdu M. Development of an Awareness Scale and Determination of Teacher Candidates' Awareness Levels Regarding Environmental Problems. Journal of Teacher Education and Educators, 2012, 1(2): 185-202.

[12] Halady I.R., Rao P. Does awareness to climate change lead to behavioral change? International Journal of Climate Change Strategies and Management, 2010, 2(1): 6-22. https://doi.org/10.1108/17568691011020229.

[13] Hair J.F., Anderson, R.E., Tatham R., Black W.C. Multivariate data analysis (5th ed.). Upper Saddle River, NJ: Prentice Hall, 1998.

[14] Hu S., Jia X., Zhang X., Zheng X., Zhu J. How political ideology affects climate perception: Moderation effects of time orientation and knowledge. Resources, Conservation and Recycling, 2017 127, 124-131. https://doi.org/10.1016/j.resconrec.2017.09.003

[15] Jamelske E., Jang W., Barrettb J., Miller L., Han W.L., Boulter J. Examining differences in public opinion on climate change between college students in China and the USA. Journal Environ. Studies and Sciences, 2015, 5 (2): 87-98, https://doi.org/10.1007/s13412-015-0229-9

[16] Knight K.W. Public awareness and perception of climate change: a quantitative cross-national study Environmental Sociology, 2016, 2(1): 1-13. http://doi.org/10.1080/23251042.2015.1128055

[17] Masud M.M., Akhtar R., Afroz R., Al-Amin A.Q., Kari F. B. Pro-environmental behavior and public understanding of climate change. Mitigation and Adaptation Strategies for Global Change, 2015, 20(4), 591-600. https://doi.org/10.1007/s11027-013-9509-4

[18] Milfont T.L. The interplay between knowledge, perceived efficacy, and concern about global warming and climate change: A one-year longitudinal study. Risk Analysis, 2012, 32(6), 1003-1020. https://doi.org/ 10.1111/j.1539-6924.2012.01800.x

[19] Oppenheim N. A. Questionnaire Design, Interviewing and Attitude Measurement (6th ed.). London and New York: Continuum, 2001.

[20] Podsakoff P.M., MacKenzie S.B., Lee J.Y., Podsakoff N.P. Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of Applied Psychology, 2003, 88(5): 879-903, https://doi.org/ 10.1037/0021-9010.88.5.879

[21] Sever D. Science teacher candidates' thoughts about global warming studying in Turkey and United Kingdom. Elementary Education Online, 2013, 12(4): 1212-1221.

[22] Schuldt J.P., Roh S. Of accessibility and applicability: How heat-related cues affect belief in "global warming" versus "climate change". Social Cognition, 2014, 32(3), 217-238. https://doi.org/10.1521/soco.2014.32.3.217

[23] Skodienė M.J., Liobikienė G. Climate change concern, personal responsibility and actions related to climate change mitigation in EU countries: Cross-cultural analysis. Journal of Cleaner Production, 2021, 281, 125189. https://doi.org/ 10.1016/j.jclepro.2020.125189.

[24] Tok G., Cebesoy, Ü.B., Bilican K. Investigating Pre-Service Primary Teachers' Climate Change Awareness. Western Anatolia Journal of Educational Sciences, 2017, 8 (2): 23-36.

[25] Tetik N., Acun A. The perceptions and views of tourism students on global warming and climate change. The Journal of International Social Research, 2015, 8(41): 1459-1476. https://doi.org/ 10.17719/jisr.20154115127

[26] Ünlü İ., Sever, R., Akpınar E. Analysis Of The Academic Studıes' Results In Environmental Education In Turkey About Global Warming And Greenhouse Effect. Erzincan University Journal of Education Faculty, 2011, 13(1): 39-54.

[27] Verdugo V.C., Lucas M.Y., Fonllem C. T., Valdez A. O. Situational factors driving climate change mitigation behaviors: the key role of pro-environmental family. Environment, Development and Sustainability, 2020, 22, 7269–7285. https://doi.org/ 10.1007/s10668-019-00496-0.

[28] Choon W.S, Boon Ong H., Hooi Tan S. Does risk perception limit the climate change mitigation behaviors? Environment, Development and Sustainability, 2019, 21:1891–1917. https://doi.org/ 10.1007/s10668-018-0108-0

[29] Zaval L., Keenan E., Johnson E., Weber E. How warm days increase belief in global warming. Nature Climate Change, 2014, 4(2): 143-147. https://doi.org/ 10.1038/nclimate2093

[30] Ari, E., Yilmaz, V. The effect of environmental concern on renewable energy awareness, perceived benefit and intention to use. Journal of Fundamental and Applied Sciences, 2021, 13 (2): 995-1013. https://doi.org/10.4314/jfas.v13i2.20