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Identifying Climate Literacy Competencies: A Delphi Study at the Middle School Level *

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Abstract

This study aimed to identify climate literacy competencies for middle school students. The study used a descriptive survey design. The data were collected using the Delphi method. Climate literacy competencies for middle school students were identified through Delphi questionnaires administered in three rounds. A panel of experts in social studies, geography education, and climate science participated in the Delphi applications. The number of experts was changed in each round. Four basic levels were defined for the selection of Delphi panelists. Each level was divided into two categories so that a more detailed and comprehensive approach to expert selection was used. Measures of central tendency (mean, median, and mode) and central dispersion (standard deviation and interquartile range) were used in the data analysis to reveal the general judgment of the panelists. Expert opinions were analyzed according to the criteria defined within the scope of the study and climate literacy competencies were identified for middle school students. A 70% consensus was achieved on the entire Delphi procedure among the panel of experts. The results of the three-round Delphi exercise showed that climate literacy competencies that middle school students should have consist of six categories and the items thereof. Accordingly, these categories are "concepts related to climate", "basic knowledge of climate", "knowledge of national and local climate", "relationship between climate and life", "skills", and "attitudes and values".

Keywords

Climate Literacy
Middle School
Subject-Matter Expert
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Introduction

The search for quality in education has gradually grown in importance. The main indicators of quality include the predetermination of educational standards and the selection of an appropriate course of action to follow at every stage of education. What will be taught at educational levels? What are subject-specific core competencies? To what and to whom will educational competencies be specified? How adequate are curricula to achieve specified competencies? These are important questions that should be answered to improve quality in education. The Education Vision 2023 issued by the Ministry of National Education defines a long-term perspective for the future of the education system in Turkey. The Education Vision 2023 lays great emphasis on the concepts "future skills", "21st-century skills", and "competencies". The most prominent objectives set by the Ministry of National Education in the Education Vision 2023 are competency-based evaluation and assessment, and teacher, curriculum, course and language competencies. The other objectives include defining competencies in different subject areas, establishing standards, ensuring the compliance of curricula with these standards, monitoring students with different competencies to take actions, and initiating support programs for sub-competencies (Ministry of National Education [MoNE], 2018).

The concept of literacy is defined as the ability to effectively use socially constructed communicative signs (Kress, 2003). Literacy encompasses all forms of social acceptance and meanings that vary according to the needs of the era and is widely conceptualized as a skill (Kurudayıoğlu & Tüzel, 2010). Reading environments that today involve not only written texts but also sounds, pictures, animations, and visual images have given rise to the concept of "multiliteracy" (Çakmak, 2013). Climate literacy is a type of multiliteracy cover the dimensions of knowledge, skills, and attitudes. Climate literacy refers to the ability to understand human impacts on climate and, in turn, climate impacts on humans and involves comprehending the basic concepts and principles of climate, establishing meaningful links between climate and climate change, and making scientific and responsible decisions about climate (U.S. Global Change Research Program [USGCRP], 2009). All people, as world citizens, must develop climate literacy to better understand the impact of global change and the response of the Earth system to this change (Harrington, 2008).

At secondary school level, climate and climate related subjects are mainly taught in Science and Social Studies courses. it is very difficult for students to acquire all of these concepts in Social Studies course, since the concepts related to geography are quite intensive (Alkış, 2005). Active learning approaches should be adopted in teaching students climate related issues, taking into consideration the cognitive levels of the students (Doğar & Başıbüyük, 2005). Therefore, first of all, the basic competencies of the subject to be taught should be determined. Competences are the mainstay for understanding which behaviors and objectives are related to a situation and are often determined based on predictions (Boyatzis, 2008).

The researches conducted in different scales such as weather, weather, climate, wind, humidity, flood, precipitation types, severe weather events and global warming (Coşkun, 2003; Demirkaya, 2008; Akbaş, Koca, & Cin, 2012; Akbaş & Uzunöz, 2013; Aksan & Çelikler, 2013; Alkış, 2006a, 2006b, 2007; Alkış & Ünlü, 2006; Kaya & Akış, 2015; Oluk & Oluk, 2007; Pınar & Akdağ, 2012) are the studies actually conducted on the sub-components of climate issues. Climate literacy aims to raise public awareness of the causes of climate change and to assist in the ability to adapt climate information to its plans and activities (Shafer, James & Giuliano, 2009). Therefore, today, within the framework of climate literacy, students need to make informed decisions and become "climate literate citizens" (Arndt & LaDue, 2008).

The general framework of climate literacy is outlined in papers such as "Climate Literacy: Essential Principles and Fundamental Concept" (National Oceanic and Atmospheric Administration [NOAA], 2007) and "Essential Principles and Fundamental Concepts of Atmospheric Science"

(University Center for Atmospheric Research [UCAR], 2008). These papers point to "the need for informed decision making and a climate literate citizenry" (Arndt & LaDue, 2008, p. 487). Several studies conducted in the United States on the frameworks of literacies (e.g. American Association for the Advancement of Science [AAAS], 1989, 1993; Atmospheric Science Literacy, 2008; Earth Science Literacy Principles, 2010; Ocean Literacy, 2005; USGCRP, 2009) were developed for the formal education structure based on criteria and principles that are suitable for primary and middle school students (Dupigny-Giroux, 2010). The international literature on climate literacy includes several studies with different designs (Babcock, 2015; Bhattacharya, 2016; Hestness, 2016; Holzer, 2016; Light, 2016; Marzetta, 2016), while no previous research in Turkey has directly focused on climate literacy. Therefore, the study fills a gap in the Turkish literature by identifying climate literacy competencies that middle school students should have in line with expert opinions.

Method

Research Design

This study employed a descriptive survey design because it aimed to identify climate literacy competencies that middle school students should have. Survey research defines "a past or present situation as it is and investigates a group of people, an event or an object under their own conditions" (Karasar, 2011, p. 77). The purpose of survey research is to describe the situation studied. For this purpose, data are collected from a population of interest or from a group of people that represents that population using data collection instruments selected by researchers (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2008). There are a variety of ways of data collection in survey research. In survey research, data can be collected through in-person interviews, e-mails, phone surveys, and internet-based surveys (Leon, Brown, Ruch, & Johnson, 2003).

Sample

The sample consisted of experts selected using the Delphi method to identify climate literacy competencies for middle school students. To determine the sample of the study, first, university websites and the academic web page (http://akademik.yok.gov.tr/AkademikArama) and thesis center web page of the Council of Higher Education (YÖK) were searched in detail; thus, a pool of experts was formed. The experts in this pool were classified taking into account the scope and dimensions of the concept of climate literacy. Thereby, the experts were subsumed under four subject areas that deal with the teaching of climate and climate subjects. These are (a) geography education, (b) social studies education, (c) geography/climatology, and (d) atmospheric science and meteorology Engineering. Subject areas, graduate theses, articles, papers, and projects of the experts in the sample and thesis that they supervised were examined. Then, the criteria given in Table 1 were defined to select Delphi panelists.

Table 1. Criteria for Selecting Delphi Panelists

Levels		Criteria
Level 1	1A	To hold a Ph.D. in the teaching of climate subjects.
	1B	To hold a master's degree in the teaching of climate subjects.
Level 2	2A	To hold a Ph.D. in the teaching of geography subjects.
	2B	To hold a master's degree in the teaching of geography subjects.
Level 3	3A	To hold a Ph.D. in the teaching of geography subjects in social studies.
	3B	To hold a master's degree in the teaching of geography subjects in social studies.
Level 4	4A	To have published research on climate (articles, papers, or projects).
	4B	To have published research on the teaching of primary or middle school geography subjects (articles, paper presentations, or projects).

As shown in Table 1, a total of eight levels subsumed under four main levels were defined for the selection of Delphi panelists. According to Tersine and Riggs (1976), experts chosen for a Delphi panel must have basic knowledge of the problem situation in question and a sufficient level of education in their respective areas and be objective and rational. Therefore, each level of selection was divided into two categories so that a more detailed and comprehensive approach to expert selection was adopted. Target experts, who were previously investigated, were evaluated in line with the criteria for selecting Delphi panelists; thus, the sample was determined. Table 2 displays the demographics of the participating experts.

Table 2. Demographics of the Experts Participating in the Delphi Rounds

Variables		**n**	**%**
Area of Expertise	Social Studies Expert	24	45.3
	Geography Education Expert	21	39.6
	Climate Science Expert	8	15.1
Criteria of Expertise	Level 1	4	7.5
	Level 2	12	22.7
	Level 3	11	20.7
	Level 4	26	49.1
Gender	Female	15	28.3
	Male	38	71.7
Title	Professor	9	17
	Associate Professor	15	28.3
	Assistant Professor	22	41.5
	Lecturer Doctor	1	1.9
	Research Assistant Doctor	6	11.3
Age	29-31	3	5.7
	32-34	3	5.7
	35-37	13	24.5
	38-40	11	20.7
	41-43	8	15.1
	44-46	2	3.8
	47-49	5	9.4
	50 years and over	8	15.1
Professional Seniority	1-5 years	2	3.8
	6-10 years	15	28.2
	11-15 years	8	15.1
	16-20 years	12	22.7
	21-25 years	12	22.7
	26 years and over	4	7.5
Total		53	100

As seen in Table 2, a total of 53 experts with diverse characteristics participated in the Delphi rounds. Among them, 45.3% were social studies experts, 39.6% were geography education experts, and 15.1% were climate science experts. The rate of male participants (71.7%) was higher than that of female participants (28.3%). Given the distribution of the experts according to titles, the majority were assistant professors (41.5%) and associate professors (28.3%). Most of the experts were within the age range of 35 to 37 and 38 to 40 years, while the age range of 21 to 25 years had the fewest number of experts. Considering the professional seniority of the expert, the majority had 6 to 10 years' seniority, followed by 6 to 20 years' and 21 to 25 years' seniority.

Data Collection

The Delphi method was used as the data collection method. The Delphi method is defined as a series of procedures to explore the ideas of a group of people and to organize these ideas (Dalkey, 1967). The purpose of the Delphi method is to plan for dealing with complex matters, collect extensive views from experts, fine-tune their views, and reach a consensus on predictions (Brewer, 2007). The existing literature on the Delphi method includes several terms to define types of the Delphi method. Some of these terms are related to the type of application and some are related to the method of scoring used, while some indicate the difference of the approach used (Mullen, 2003). This study used the e-Delphi procedure. E-Delphi helps "conduct Delphi studies more efficiently and effectively" and allows panel members to connect directly to the system and express their opinions (Chou, 2002, p. 232). E-Delphi, also called web-based Delphi research, is an iterative method by which data are aggregated through an online survey tool in several rounds (Helms, Gardner, & McInnes, 2017). The Delphi procedure was initiated by sending out a letter of invitation and the first-round Delphi questionnaire online to the experts who met the participation criteria. The research are limited in terms of scope; the climate literacy competencies that are to be determined the secondary school level, in terms of participants; working in universities in Turkey, having at least doctoral degrees and with selected experts in the field according to predetermined criteria and the use of data; the participants' responses to the data collection tools sent to them. Interviews were conducted with field experts to improve response rate in Delphi process. In addition, reminder messages were sent to the experts to provide feedback and thus, it was ensured that the experts were involved in the work process. Table 3 below describes the data collection procedure for the Delphi tours.

Table 3. Data Collection Procedure in Each Delphi Tour

	Round 1	**Round 2**	**Round 3**
Number of Invitations	65	56	59
Number of Respondents	46	41	40
Response Rate	71%	73%	68%
Data Collection Instruments	First Round Delphi Questionnaire	Second Round Delphi Questionnaire	Third Round Delphi Questionnaire
Number of Items	5	180	40
Collected Data	General views on climate literacy and climate literacy competencies of middle school students	The level of consensus for each level of competency identified (5-point Likert)	The final level of consensus for each level of competency identified (5-point Likert)
Data Analysis	Evaluation of proposed competencies and categorization through content analysis	The mean, standard deviation, median, and interquartile range of responses to the competency items	The mean, standard deviation, median, and interquartile range of responses to the competency items

Data Analysis

First, a consensus criterion must be laid down or the definition of consensus must be made before the analysis of data derived from Delphi surveys (Heiko, 2012; Powell, 2003; Şahin, 2009). The main statistics used in Delphi studies include measures of central tendency (mean, median, and mode) and central dispersion (standard deviation and interquartile range) to reveal the general judgment of panelists (Gordon, 1994; Şahin, 2010). The lower the interquartile range is, the greater the consensus is, or vice versa (Şahin, 2001). The indication that experts participating in the Delphi rounds reach a consensus on items depends on the satisfaction of three criteria. Accordingly, *a-)* the median of items

must be equal to or greater than 4, *b-)* the interquartile range must be equal to or less than 1, and *c-)* the total 4 (agree) and 5 (totally agree) frequency answered by experts must be equal to or greater than 75%.

Because the Delphi procedure was initiated with a general question addressed to the experts, their opinions were analyzed at the end of the first-round Delphi exercise using content analysis. Content analysis is a technique that requires a systematic review of texts of different characteristics to classify and interpret their implicit and explicit content (Robert & Bouillaguet, 1995, as cited in Bilgin, 2006).

The content validity of Delphi studies is based on a detailed review of the literature and expert opinions (Paykoç & Ok, 1990). Accordingly, to ensure the content validity, a detailed search of the literature was undertaken prior to the initiation of the procedure and expert opinions were aggregated and evaluated during the procedure. According to Fish and Busby (2005), the validity of Delphi studies is closely linked to the selection of experts who are asked for opinions during the application process. Because the content and steps of the research process are shaped in line with expert views, explaining the qualifications of experts is of major importance. To this end, a set of criteria were laid down for the selection of experts (Table 1). Expertise criteria were established by holding in-person interviews with various experts before the research process started. The content validity of Delphi studies can be achieved by employing a diligently selected panel of more than 10 experts (Linstone & Turoff, 2002). The content validity of this Delphi study was achieved by the selection of panelists based on the predefined criteria and the participation of more than 10 experts in the Delphi rounds. Consensus rates that emerge as a result of each round can be used to estimate the reliability between Delphi rounds. If a reasonable level of consensus is reached on many items on the second questionnaire, it indicates that the underlying meaning of the responses of the first questionnaire has been adequately outlined (Fish & Busby, 2005). In this Delphi study, the consensus rate was 74% at the end of the second round and 55% at the end of the third round, while the overall consensus rate at the end of the Delphi procedure was 70%.

Results

First-Round Delphi Exercise

To identify climate literacy competencies for middle school students, the panel of experts selected according to the predefined criteria were asked a general open-ended question in the first round of the Delphi procedure. This question asked the experts to itemize climate literacy competencies. Climate literacy competencies itemized by the experts were analyzed using content analysis. As a result of the analysis, categories related to climate literacy were created. The categories were created taking into account the views expressed by the experts in the suggestions and remarks section of the questionnaire.

Among the experts participating in the first round, 50% were social studies experts, 37% geography education experts, and 13% climate science experts. 67.4% were male and 32.6% were female. The experts participating in this round had different titles. 41.3% were assistant professors, 28.3% were associate professors, 17.4% were professors, and 13% were research assistant doctors. At the end of the first-round Delphi exercise, competencies identified by the experts were subjected to content analysis and a pool of 203 competency items was formed. Examples of competency items and categories are given in Table 4.

Table 4. Examples of Competency Items in the First-Round Delphi Exercise and Categorization of Items

Competency Items	Codes	Categories
1. "Makes inferences about the effects of climate on human life in relation to the place of residence."	- *The impact of climate on human life* - *Prediction*	Relationship between climate and life Skill (Making Inferences)
2. "Knows the climate types in the world."	- *Climate types of the world*	Knowledge of Global Climate
3. "Explains the relationship between climate elements."	- *Climate elements* - *Cause and effect*	Basic Knowledge of Climate Skill (Causality)
4. "To be able to interpret daily weather events."	- *Weather events* - *Skill of interpretation*	Basic Concepts Skill (Interpretation)
5. "Knows the climatic characteristics of the place of residence."	- *Climate conditions in the place of residence*	Knowledge of national and local climate
6. "Explains the effects of climates on human character at a basic level."	- *Relationship between climate and human character*	Relationship between climate and life
7. "To be able to respect the differences that arise as a natural result of climate."	- *Respect for differences*	Attitudes and Values (Respect)

The opinions of the experts were subsumed under seven categories. Accordingly, climate literacy competencies were grouped under the following categories: "basic concepts related to climate", "basic knowledge of climate", "knowledge of global climate", "knowledge of national and local climate", "relationship between climate and life", "skills", and "attitudes and values". As can be seen from Table 4, some competency items are comprehensive and broad and reflect multiple aspects. Therefore, such items were placed in more than one category while categorizing items.

Second-Round Delphi Exercise

In the Delphi procedure, competency items identified in the first round form the basis for the second-round Delphi exercise. Thus, expert opinions aggregated in the first round were resubmitted for the approval of the experts in the second round. The second-round Delphi questionnaire that consisted of 180 items and was designed on a 5-point Likert scale was sent out to the panel of experts. Among the experts participating in the second round, 44% were social studies experts, 39% geography education experts, and 17% were climate science experts. 73.2% were male and 26.8% were female. 48.8% were assistant professors, 21.9% were associate professors, 17.1% were professors, and 12.2% were research assistant doctors.

25 items were eliminated from the 180-item questionnaire in line with expert opinions and recommendations. These items were excluded from the following categories: concepts related to climate (6 items), basic knowledge of climate (6 items), knowledge of global climate (6 items), skills (6 items), and attitudes and values (1 item). The experts did not propose excluding any item from the category of knowledge of national and local climate and the category of relationship between climate and life. Table 5 summarizes the number of items obtained from the second-round Delphi exercise and consensus rates for each competency category.

Table 5. Number of Consensus Items in the Second-Round Delphi Exercise and Consensus Rates For Each Competency Category

Categories	Total Number of Items	Number of Consensus Items	Consensus Rate
Concepts related to Climate	35	28	%80
Basic Knowledge of Climate	42	18	43%
Knowledge of national and local climate	17	12	70%
Relationship between climate and life	18	16	88%
Skills	27	25	93%
Attitudes and Values	16	16	100%
Total	155	115	74%

Given the number of items and consensus rates for each category that emerged at the end of the second-round Delphi exercise, a consensus was reached on 115 items of the 155-item questionnaire, while no consensus was reached on 40 items. The overall consensus rate for the second-round Delphi exercise was 74%. The category of attitudes and values was the only category, all items of which the experts reached a consensus on. The other categories contained items, which the experts did not reach a consensus on. The categories with the highest consensus rates were attitudes and values (100%), skills (93%), and relationship between climate and life (88%), respectively. Compared to these categories, consensus rates were lower in the categories basic knowledge of climate (43%), knowledge of national and local climate (70%), and concepts related to climate (80%). However, consensus rates were generally high. Considering the consensus rates for the items in the six-category questionnaire of the second-round Delphi exercise, basic knowledge of climate was the only category that had a consensus rate lower than 50%. The other categories had a consensus of 70% or more.

Third-Round Delphi Exercise

The third-round Delphi exercise was the last Delphi exercise to identify climate literacy competencies for middle school students. The non-consensus items of the second-round Delphi exercise were replaced on a 5-point Likert scale to prepare the third-round Delphi questionnaire. 25 items were excluded from the first-round 180-item Delphi questionnaire in line with expert opinions in the second-round Delphi exercise; thus, the second-round Delphi questionnaire was prepared to consist of 155 items. At the end of the second-round Delphi exercise, no consensus was reached on 40 items under five competency categories. These 40 items formed the basis of the third-round Delphi questionnaire. Among the experts participating in the third round, 45% were social studies experts, 40% geography education experts, and 15% were climate science experts. 75% were male and 25% female experts. 37.5% were assistant professors, 27.5% were associate professors, 20% were professors, 12.5% were research assistant doctors, and 2.5% were lecturer doctors. Table 6 summarizes the number of items obtained from the third-round Delphi exercise and consensus rates for each competency category.

Table 6. Number of Consensus Items in the Third-Round Delphi Exercise and Consensus Rates for Each Competency Category

Categories	Total Number of Items	Number of Consensus Items	Consensus Rate
Concepts related to climate	7	3	43%
Basic Knowledge of climate	24	15	62%
Knowledge of national and local climate	5	3	60%
Relationship between climate and life	2	1	50%
Skills	2	0	0
Total	40	22	55%

Given the number of items and consensus rates for each category that emerged at the end of the third-round Delphi exercise, a consensus was reached on 22 items of the 40-item questionnaire, while no consensus was reached on 18 items. The overall consensus rate for the third-round Delphi exercise was 55%. As shown in Table 6, the experts did not reach a general consensus on all items of any of the categories in this round. Additionally, the skills presented to the experts in this round were not accepted because a consensus was reached on none of the items of this category. The categories with the highest consensus rates were basic knowledge of climate (62%), knowledge of national and local climate (60%), and relationship between climate and life (50%), respectively.

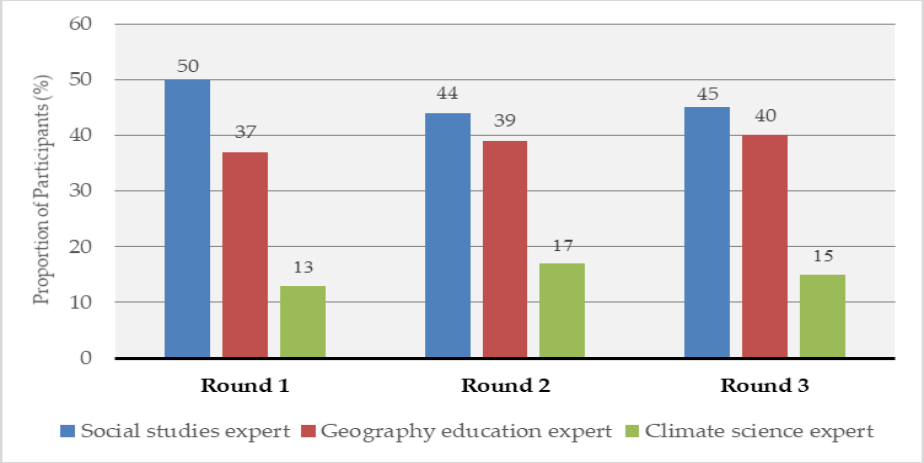

Figure 1. Proportional Distribution of the Experts Participating in Each Delphi Round

As can be seen from the figure above, the proportional distribution of the experts across the three rounds was similar. Accordingly, social studies experts had the highest participation rate in each of the three rounds, while climate science experts had the lowest participation rate. Social studies experts participated in the first round at a rate of 50% (*f:23*), in the second round at a rate of 44% (*f:18*), and in the third round at a rate of 45% (*f:18*). Geography education experts participated in the first round at a rate of 37% (*f:17*), in the second round at a rate of 39% (*f:16*) and in the third round at a rate of 40% (*f:16*). Finally, climate science experts participated in the first round at a rate of 13% (*f:6*), in the second round at a rate of 17% (*f:7*) and in the third round at a rate of 15% (*f:6*).

Table 7. Number of Items and Consensus Rates for Each Round

	Round 2	Round 3	Total
Number of Items	155	40	195
Number of Consensus Items	115	22	137
Number of Non-Consensus Items	40	18	58
Consensus Rate	74%	55%	70%

An important aspect of the overall evaluation of a Delphi procedure is the number of items and consensus rates that change in each round. Looking at Table 7, it is apparent that a total of 195 items were sent out to the experts in the second and third rounds of the Delphi procedure; the experts reached a consensus on 137 items but no consensus on 58 items. A consensus of 70% was achieved for the overall Delphi procedure. In the second-round Delphi exercise, 155 items were sent out to the experts; they reached a consensus on 155 items but no consensus on 40 items. The overall consensus rate for the second round was 74%. In the last round of the Delphi procedure, 40 items were sent out to the experts; they reached a consensus on 22 items but no consensus on 18 items. The overall consensus rate for the last round was 55%. When the categories of middle-school climate literacy competencies were evaluated after the general evaluation of the rounds, a different situation emerged. Although seven competency

categories were established in the first round of the Delphi procedure, a final number of six categories was set in line with expert opinions at the end of the second-round Delphi exercise. In general, these categories had a different number of items and different consensus rates.

Table 8. Number of Items and Consensus Rates for Each Competency Category

Categories	Total Number of Items	Number of Consensus Items	Consensus Rate
Concepts related to Climate	42	31	74%
Basic Knowledge of Climate	66	33	50%
Knowledge of national and local climate	22	15	68%
Relationship between climate and life	20	17	77%
Skills	29	25	86%
Attitudes and Values	17	16	94%
Total	195	137	70%

As can be seen in Table 8, among 195 items presented to the experts, 137 were accepted. A consensus of 70% was achieved for the overall Delphi procedure. The categories with the highest consensus rates in the entire Delphi procedure were attitudes and values (94%), skills, (86%), and relationship between climate and life (77%). The categories with the lowest consensus rates were concepts related to climate (74%), knowledge of national and local climate (68%), and basic knowledge of climate (50%). In general, there was a consensus of 50% or more in all categories. As a result of the Delphi procedure, the lists of climate literacy competencies presented in Appendix 1 were identified for middle school students in line with expert opinions.

Discussion, Conclusion and Suggestions

Climate literacy competencies for middle school students were identified in line with expert opinions in the first phase of the study. As a result of the three-round Delphi procedure, climate literacy competencies were subsumed under six categories: "concepts related to climate", "basic knowledge of climate", "knowledge of national and local climate", "relationship between climate and life", "skills", and "attitudes and values". According to Milér and Sládek (2011), the key question as to climate literacy is "who should be educated in the basis of climate science and what level of knowledge is appropriate for different ages of pupils?" (p. 150). In this respect, in the first phase of the study, expert opinions were sought to find an answer to this question. Because climate change affects the future, the need to equip today's students and citizens with the knowledge and skills to understand and deal with climate change has become increasingly essential (McNeal, John, & Sullivan, 2014). Climate literacy plays a leading role in promoting individuals' involvement in environmental management. Thus, today's educators have to equip future generations with the skillsets and knowledge they need to develop solutions for tomorrow (Wachholz, Artz, & Chen, 2014). The lack of certain standards is one of the most noticeable shortcomings in the teaching of climate literacy. The new standards established in the United States have helped, to a certain extent, eliminate these shortcomings. The achievement of a scientific consensus and the recognition of what this consensus means are particularly important and valuable for the teaching of climate change (Branch, Rosenau, & Berbeco, 2016).

The basic principles and concepts of climate literacy established by the U.S. Global Change Research Program consist of seven main categories and their subcategories. Accordingly, the essential principles of climate literacy are as follows: 1) Life and climate, 2) How do we know?, 3) Energy source of the Earth, 4) Complex interactions, 5) Variability and change, 6) Human activities, and 7) Decision-making (USGCRP, 2009). The categories of climate literacy principles established by USGCRP were compared to the climate literacy competencies identified in this study, which shows that the category "life and climate" is similar to the climate literacy competency category "relationship between climate

and life". Both categories include items about the effects of climate on daily human life. Similarly, the principles of climate literacy under the other categories "how do we know?", "energy source of the Earth", "complex interactions", "variability and change", and "human activities" match the items in the "basic knowledge of climate" and "knowledge of national and local climate" categories set out in this study. It seems that the principles in the "decision-making" category are consistent with the items in the "attitudes and values" category set out in this study. On the other hand, the items in the "concepts related to climate" and "skills" categories set out in this study were not directly covered in the essential principles of climate literacy established by USGCRP in 2009.

Concept teaching is of key importance for the teaching of geography subjects. Therefore, in this study, the experts first determined concepts related to climate and the general framework of these concepts, while identifying climate literacy competencies. n a study on the concept of climate definitions of teacher candidates, it was determined that four different definitions were made. These definitions, which are classified as related and unrelated, have been found to follow a sequence from simple to complex (Demirkaya & Tokcan, 2007). In their experimental study with students, Akbaş et al. (2012) found that the students had difficulty understanding the concepts of climate and weather and a lot of misconceptions about these two concepts. Coşkun (2010) highlights that students have difficulty perceiving concepts because many concepts in geography are abstract. These abstract concepts include concepts covered in the climate topic, such as climate, weather condition, relative humidity, absolute humidity, pressure, high pressure, low pressure, temperature, and heat. Likewise, Keçeci (2012) found that primary school students had difficulty scientifically understanding the concepts related to astronomy in the way that they were taught in social studies and science courses. Kaya and Akar (2015) investigated geography students' cognitive constructs of the concept of weather geography and noted that students learn the concepts related to geography as a result of the interaction between the scientific information taught at university and the information learned in daily life. Therefore, the information provided in the school about concepts must be complete, permanent, and sound for students. Against this background, determining concepts related to climate literacy and identifying competencies related to the teaching of these concepts are crucially important for the teaching of climate subjects.

Yalçın (2018) asserts that the knowledge and skills that students should acquire gradually increase in parallel with technological developments. This situation indirectly changes the measurement and evaluation of these skills. Therefore, it is of key importance to define the framework of 21st-century skills that students must acquire within the education system. According to Karakuş (2006), broad-based applications are needed to ensure that students have easy access and more self-directed access to information on climate subjects.

The final category of climate literacy competencies is the "attitudes and values" category. The items included in this category generally highlight the "attitude" and "behavior" dimensions of climate literacy. The experts agreed 16 items about the attitudes and values of climate literacy. These items include love for the environment, environmental protection, act with environmental awareness, economization, love of nature, scientificness, developing an awareness of climate types, respect for differences, self-control, patience, respect, love, responsibility, patriotism, helpfulness, and unprejudicedness. Given the attitudes and values category of climate literacy competencies, it seems that these values are "individual" (e.g. self-control, responsibility, and unprejudicedness), "social" (e.g. love of nature, respect for differences, love, patriotism, and helpfulness), "economic" (e.g. economization), "moral" (e.g. patience), and "scientific" values (e.g. scientificness).

Within the scope of this study, the general framework for climate literacy competencies at the middle school level was established in line with expert opinions. It is recommended that this general framework be taken into account particularly by policymakers. The climate literacy competencies identified in this study can be taken into consideration in middle-school curriculum development efforts. The contents of future middle-school curricula can be defined taking into account the concepts, knowledge, skills, and values dimensions of climate literacy.

This study set out to identify climate literacy competencies at the middle school level. Further research might focus on the measurement of these competencies. Further research could also be conducted to determine which climate literacy competencies should be taught at different class levels. Thus, a framework for climate literacy competencies could be proposed for every class level.

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Appendix 1. Climate Literacy Competencies Identified for Middle School Students

	Concepts related to Climate
1	Climate
2	Climate Science
3	Weather
4	Weather Event
5	Season
6	Solstice Days
7	Atmosphere
8	Climate Types
9	Climate Element
10	Climate Event
11	Climate Diversity
12	Climate Change
13	Temperature
14	Humidity
15	Precipitation
16	Wind
17	Fog
18	Global Warming
19	The Greenhouse Effect
20	Global Climate Problem
21	Disaster
22	Climate Disaster
23	Vegetation
24	Agriculture
25	Geographical Formations
26	Environment
27	Relative Location
28	Absolute Location
29	Weather Forecast Report
30	Layers of the Atmosphere
31	Soil
	Basic Knowledge of Climate
1	Knows the atmosphere and its properties
2	Defines the concept of climate
3	Knows the elements that make up climate
4	Knows the climate types
5	Knows the basic concepts of climate elements
6	Knows the relationship between climate elements
7	Knows the factors affecting climate
8	Knows the difference between climate and weather
9	Makes a connection between climate and daily weather events
10	Knows the seasons and the months
11	Know the factors affecting the distribution and differentiation of temperature
12	Makes a connection between climate and other geographical events
13	Knows the differences in climates
14	Makes a connection between environmental awareness and climate
15	Knows the natural and human factors on climate
16	Associates climate with disasters

Basic Knowledge of Climate -continued	
17	Knows the global climate problem
18	Becomes aware of the effects of global climate change on humans
19	Knows that the concept of climate is dynamic and multivariate
20	Knows how climate elements develop
21	Will have enough knowledge about climate change
22	Associates vegetation with climate
23	Distinguishes types of precipitation
24	Explains the effects of climate on geographical formations
25	Interprets daily weather events
26	Explains weather conditions
27	Knows the concepts used in weather forecast broadcasts (TV)
28	Gives examples of productions and animal and plant species in different climate types
29	Questions the causes of climate change
30	Shows certain climates on the map
31	Associates the distribution of different plant communities with climate
32	Knows the types and characteristics of climates found in the world
33	Gives examples of different climate types in the world
Knowledge of National and Local Climate	
1	Knows the types and characteristics of climates found in his or her country
2	Interprets the basic precipitation and temperature graphs of his or her country
3	Knows the regions of climate types found in his or her country
4	Distinguishes the climate types in his or her country
5	Knows the vegetation specific to the climate types in his or her country and the characteristics thereof
6	Knows the general characteristics of the climate in the region of residence
7	Makes inferences about the effects of seasons on human life in the place of residence
8	Knows the seasonal temperatures of the place of residence
9	Describes the climatic characteristics of regions distant from the region of residence
10	Compares the climatic characteristics of the region of residence with those of other regions
11	Knows the effects of the climatic characteristics of the region of residence on economic activities, settlement, and sectors such as tourism
12	Interprets climate graphs of the place of residence
13	Becomes aware that climate events in different regions of the world affect his or her country
14	Becomes aware that climate events in different regions of his or her country affect the climate in the place of residence
15	Becomes aware that geographical formations in the place of residence shape the climate
Relationship between Climate and Life	
1	Knows the impact of human on climate
2	Knows the effects of climate on human life
3	Becomes aware of the importance of climate in human life
4	Knows the effect of climate on the economy
5	Explains the relationship between climate and economic activities
6	Knows the effect of climate on production, distribution, and consumption of a product
7	Relates climate to settlement
8	Knows the negative effects of climate change on living life
9	Knows the importance of climate and natural balance for a sustainable life
10	Explains the impact of climate on daily life
11	Becomes aware of climate events that occur in daily life
12	Explains how climate elements shape everyday human life

Relationship between Climate and Life -continued	
13	Gives examples of the effects of climate on daily life from his or her life
14	Gives examples of the effects of climate on daily life from his or her immediate environment
15	Knows the negative effects of humans on climate change
16	Makes a connection between the human-caused destruction of the natural environment and climate change
17	Gives examples of the importance of climate for a planned life
Skills	
1	Accessing accurate information
2	Using information
3	Analyzing information
4	Evaluating information
5	Making inferences
6	Seeing a cause-effect relationship
7	Prediction
8	Interpretation
9	Critical thinking
10	Problem-solving
11	Research and analysis skills
12	Making observations
13	Interpreting graphs
14	Map skills
15	Space perception
16	Change and continuity perception
17	Decision-making
18	Self-direction
19	Self-management skills
20	Self-regulation skills
21	Time perception
22	Time management
23	Adaptability
24	Making a connection between climate and natural events
25	Making a connection between climate and human events
Attitudes and Values	
1	Love for the environment
2	Environmental Protection
3	Act with environmental awareness
4	Economization
5	Love of nature
6	Scientificness
7	Developing an awareness of climate types
8	Respect for differences
9	Self-control
10	Patience
11	Respect
12	Love
13	Responsibility
14	Patriotism
15	Helpfulness
16	Unprejudicedness