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Research

Determination of high school students' cognitive structures related to the atmosphere and climate

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Abstract:

The aim of this study was to determine the cognitive structures of high school students related to the atmosphere and climate. The study group consists of 70 students in the 10th grade of a state high school affiliated to Konya Provincial Ministry of National Education. In this study, a survey model, which allowed us to determine the current situation, was used. Data were collected using the word association test (WAT). The key concepts related to the subject were climate, atmosphere, temperature, pressure, wind, humidity, and precipitation. A frequency calculation, a descriptive analysis technique, was used to analyze the data. The obtained data were subjected to evaluation, and a frequency table was prepared. Among the key concepts, the most response words were related to climate (n=20). The others were the atmosphere (n=14), temperature (n=14), humidity (n=11), precipitation (n=11), pressure (n=10) and wind (n=8). The answer word rain (n=49) was written for the key concept of precipitation and had the highest frequency value. The answer words for the key concepts were analyzed in detail, and concept networks were created using the cut-off point technique. Thus, it was attempted to reveal the cognitive structures of the students regarding the subject. In addition, sentence examples were analyzed and classified according to their characteristics and a scientific content table was created.

Keywords: Geography, atmosphere, climate, word association test, cognitive structure

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INTRODUCTION

The atmosphere comprises various layers of gases surrounding the earth. Its most important feature is that it is a natural environment where weather events occur. While this environment enables life, it also prevents the earth from overheating and cooling by retaining some of its sunlight. The atmosphere, which is a mixture of many different gases, contains life-giving gases such as oxygen for humans and animals and carbon dioxide for plants. Climate is a branch of science that establishes connections between humans, the environment, and meteorological events. In other words, a close relationship between the climate of a region and its natural environmental characteristics. The climate has a shaping effect on the society living in a region, its landforms, natural vegetation, and human activities. Therefore, it is important to understand the atmosphere, which is a natural environment, and the climatic characteristics that reflect the average character of atmospheric events. Only by achieving this can society become sensitive to the environment. Thus, it can be understood that there is a mutual relationship between different components, such as the atmosphere, climate, society, and environment, landforms, and vegetation, and the importance of this being sustainable. In achieving this, geography has a very important duty and responsibility.

Geography is a field that analyses the human-space relationship and the distribution of natural and human events within the framework of causality (Ünlü, 2014). Geography is a science that reveals the characteristics of the places on earth and investigates and explains the causes of these characteristics and the similarities and differences between various places and the laws governing them. Geomorphology (landform science), climate, and vegetation play the most important roles in the formation of these features, similarities and differences (Erinç, 1977).

Climate is the most important environmental factor affecting the life of organisms in terrestrial ecosystems. The average character of atmospheric events that occur over any area on earth for a long time is called climate. Climate is formed as a result of the Sun's rays not reaching Earth under the same angle. Temperature, precipitation, wind, air humidity, pressure, and its changes during the day and year are the factors that affect the formation of climate in a region. Among these, precipitation and temperature are the two most determining elements of climate (Gökmen, 2007). Climate encompasses all elements such as temperature, precipitation, humidity, wind, and pressure (Efe, 2010). The weather and climate are two separate concepts that are often confused with each other. The weather is the atmospheric conditions over a short time interval in any place. Instantaneous, hourly, daily. Weather events are meteorological events. Climate, on the other hand, is the average expression of weather events and characteristics measured and observed at certain intervals over long periods of time anywhere in the world (Şahin, 2006). Climate is the most important physical geography feature in the world. Physical

features such as underground and surface waters, plants, animals, landforms, soils, and many other social and economic activities such as settlement, agriculture, tourism, trade, energy, transport, construction, and health, as well as the physical, psychological, and sociological characteristics of people and even all living things are under the influence and control of climate (Şahin, 2006). Climate is defined as all of the limit and average values of weather conditions in a region over a long period. Therefore, changes in conditions over time are not attributed to climate changes. However, the climate of a region also changes over thousands of years or longer periods (Aydeniz, 1985). The atmosphere is an important region where weather events occur. In this respect, it is important to understand the relationship of climate elements with the atmosphere, their properties, how they are formed and their effects. In this respect, it is useful to briefly explain the key concepts (climate, atmosphere, pressure, humidity, temperature, wind, precipitation) selected in relation to the subject.

The atmosphere is the gas mass that surrounds the earth with the effect of gravity. In ancient Greek, the term translates as atmos = breath, sphere = globe. The atmosphere refers to the breath or air sphere (Karaoğlu, 2013). The gas molecules that make up the atmosphere have a certain weight, like all other substances. Therefore, these molecules exert force on each other to the extent of their weight under the influence of gravity. This force or weight is called the atmospheric pressure (Yazıcı, 2020). The wind is the movement of an air mass consisting of different pressures and changing horizontal displacements (Akman, 1990). Temperature is also an important climatic element. Because temperature also affects other climate elements to a great extent. The total amount of (potential) energy in the mass of an object is called heat, and the effect of this energy on the environment as electromagnetic waves, is called temperature. The main source of heat on earth is the sun. Solar energy is the main factor influencing both the life of living things and the occurrence of atmospheric events (Gökçe, 2010). The earth, which is heated by energy from the Sun, gives back most of the energy it receives to the atmosphere. Thus, the atmosphere surrounding the Earth has reached a certain temperature. The temperature of the atmosphere is expressed as air temperature or temperature in both meteorology and climatology (Şahin, 2006). The amount of water vapor in air is called humidity (Yazıcı, 2020). Very small water grains with a diameter of 0.001 to 0.040 mm, which form fog and clouds, combine or become larger with the new condensation added to them, reaching a size larger than 0.5 mm and becoming heavier. Thus, because this weight can overcome the vertical air movements present in clouds, it starts to fall toward the ground. These grains falling to the ground by following a short or long path in the atmosphere are called precipitation. The precipitated grains can be solid or liquid (Erol, 2010). Although these concepts are abstract, they constitute the basis of related subjects. Correct and meaningful learning of these concepts is important for understanding the subject. To realize conceptual learning, concept teaching strategies should be employed. Abstract concepts should be as concrete as possible and given examples. Otherwise, it may be difficult and time-

consuming to understand and learn the concepts in our minds.

Concepts consist of directly or indirectly observed properties of objects and events. Directly observed properties are the physical properties of the object or event. Indirectly observed properties are its meanings. In other words, observable properties are concrete, whereas indirectly observed properties are abstract. In this regard, concepts are divided into two parts: concrete and abstract. The concepts perceived by sense organs are concrete concepts, whereas those that cannot be perceived are abstract concepts. People learn concrete concepts, which are formed by observing the physical environment from birth by making generalizations at first. Learning abstract concepts is much more difficult and requires a complex process (Yılmaz & Çolak, 2011). Concepts are formed according to people's experiences and change over time. Regardless of how concepts are acquired, they gain meaning only through people's experiences. Concepts that are in the process of continuous redefinition in terms of quantity and quality because of diversity, dynamism, and complexity in experiences have multidimensional features. Some concepts include many interrelated concepts (Yılmaz & Çolak, 2011). Concepts form the foundation of human thought. From this perspective, concepts are the building blocks of thought and knowledge production (Kılıç, 2009). Since concepts are abstract units of thought derived from objects, events, and phenomena, concept teaching should consider students' abstract thinking skills. In modern teaching approaches, the idea that permanent learning should be conceptual rather than procedural is dominant. If an individual can transfer the knowledge to new situations, he/she is considered to have grasped the knowledge learnt (Yılmaz & Çolak, 2011). It can be said that the more important it is for prospective teachers to be equipped in terms of general culture, professional and field knowledge, the more important it is for them to know/learn the concepts of their fields. Especially for the field of social sciences, it can be said that mastery of social sciences disciplines, correct use of concepts belonging to these disciplines, and teaching and learning of concepts are also important (Pınar & Akdağ, 2012).

According to Barth and Demirtaş (1997), one of the most distinctive properties of the science of geography is that it frequently uses concepts to define and explain geographical phenomena and events on earth (cited in Ünlü, 2014). The fact that geography forms conceptual links with different disciplines causes different perceptions and definitions of the concept of geography (Özgen, 2011). As is known, concepts enable us to understand our physical and social worlds. Thanks to concepts and terms, we distinguish events, phenomena, thoughts, and substances from each other. In geography teaching, concepts and terms constitute word groups to be taught to the students both in the transfer of the lesson to the students and during the processing of the lesson; that is, the building blocks of the information, and geographical facts and events can only take place in the minds of the students through concepts and terms (Turan, 2002). Thus, the information learned in geography education gains meaning, and information about any subject is obtained. Issues such as the level of information learned about any subject in

students' minds, for which concepts this information consists of the accuracy of the information they have learned are related to the cognitive structure, and the realization of this can only be achieved through meaningful learning. Students have difficulty attaining high cognitive levels regarding atmosphere and climate. In other words, students have difficulty analysing and evaluating issues such as the structure of the atmosphere, its properties, weather events occurring in the atmosphere, their causes, and their effects. The same applies to climate. A similar situation can be observed in issues such as climate elements, climate factors, air masses, climate types, and the causes and effects. The reasons for this include misunderstanding and thus misinterpretation of scientific concepts on this subject. In addition, their low level of prior knowledge and their attempts to memorize without understanding negatively affected their cognitive structures in this regard. Another reason may be that the participants had difficulty associating the concepts of these subjects with daily life.

The importance of students' cognitive structures should be considered in successful education. When teaching a concept, the teacher should combine it with other related concepts. Meaningful education considers the organization of knowledge and the combination between old experiences and new experiences. It should consider the learner's brain as a database of well-organized and stored items linked together. It should also meet the educational needs of students and define what students need to learn (Abdelhalim, 2019). Cognitive structures play an important role in learners' information-processing abilities because they serve as frames of reference, allowing learners to grasp and work with one or several aspects of a concept (Navaneedhan, & Kamalanabhan, 2017). For this reason, cognitive structure is also called "schema". Cognitive structures or schemas are hierarchical and individualized. In a hierarchical structure, general information can be easily remembered at the upper level and has a fixed character, while there is more specific information at the bottom (Berber & Yıldız, 2019). Cognitive structures are basic mental patterns that people employ to process information (Navaneedhan, & Kamalanabhan, 2017).

Determining the cognitive structure is crucial in geography lessons. An important misconception in geography lessons consists of concepts related to nature. While some of this information was acquired outside school, some of it was acquired in classroom environments due to its abstract nature. Therefore, it is necessary to reveal students' cognitive structure for any subject. One of the techniques used in this study is word association tests. Polat (2013) stated that researchers mostly use the WAT technique to determine the cognitive structures of students before and after teaching and reveal changes in their cognitive structures with teaching.

Word association is a method developed to reveal the relationships established between concepts. Since concepts can be units within subjects, word association can be used to measure how not only concepts but also a discipline, situations, and even people are understood (Atasoy, 2004). In its simplest form, a word association test simply asks

students in an oral or written forum what a series of key words evoke (Aydın & Güngördü, 2016). The basis of this type of test consists of presenting a stimulus word to each participant and asking them to say a predetermined number of words through free association (Graneri et al., 2023). Word association is a method developed to reveal the relationships established between concepts. Since concepts can be units within subjects, word association can be used to measure how not only concepts but also a discipline, situations, and even people are understood (Atasoy, 2004). WAT is a highly effective measurement and evaluation technique for diagnostic purposes in determining cognitive structure and investigating misconceptions (Işıklı et al., 2011). It can be said that WAT is a measurement-evaluation technique that serves the purposes emphasized in the curriculum (MoNE, 2005) as evaluating an interconnected, well-structured knowledge network and meaningful and deeply learned knowledge. This is because students are expected to reveal the words and vocabulary evoked in their minds by the concepts presented with the WAT in any number they want without limitation. In addition, WAT provides the opportunity to obtain visual data as it reveals the relationships and conceptual organization between these concepts, words and vocabulary with concept networks (Taşdere et al., 2014).

In this study, the word association test was used as a data collection tool to determine what students understood from the concepts related to weather and climate, with which concepts they associated it, and what their cognitive structures were on this subject.

Purpose of the Study

In this study, we aimed to determine the cognitive structures of high school students on the subject of "atmosphere and climate" by using independent word association test. It is also aimed at determining the concepts with which high school students explain the subject of "atmosphere and climate" in the 9th grade unit of geography, their thoughts about this subject, their ability to establish relationships between concepts, and whether meaningful learning has taken place in this subject.

METHOD

Research Design

In this study, a descriptive research (screening, survey) model was used to determine the current situation. Descriptive research (screening, survey) describes and explains what has already been experienced and what is experienced. The researcher does not intervene in these phenomena. He/she does not prevent their flow. In other words, he/she does not introduce a new variable into the environment. Analyzes the event as it is and how it works. He/she does not engage in any activities that will ensure its change and development. The phenomenon will continue to exist in the same manner regardless of whether the researcher engages in research activity or not (Sönmez & Alacapınar, 2011). The survey is a research

model that aims to determine a situation that existed in the past or that still exists as it exists. The event, individual, or object that is the subject of the research is tried to be defined in its own conditions and as is. No effort was made to change or influence them in any way. The thing to be known exists and is present. The important thing is to observe and document it appropriately (Karasar, 2016). According to Aslantürk (2008), this method is especially used with test and interview techniques when the number of people to be reached increases. In the survey model, the interaction between events, phenomena, objects, concepts, and situations is tried to be revealed as it is by taking into account their current conditions and characteristics (cited in Yılmaz, 2019). In this study, a descriptive survey model study was preferred because the concepts of high school students' knowledge of the atmosphere and climate and their level of ability to establish relationships between concepts were investigated. According to Karasar (2016), the aims of survey models are usually expressed in question sentences. What were these? What is it? What is it related to? What does it consist of?

Therefore, what are the cognitive structures of the respondents' key concepts regarding the atmosphere and climate? Which answer words were related to the concepts? Trying to find the answers to questions such as this is a screening study. Demographic features were neglected in this study because of the nature of the study. The creation of concept networks is the main theme of this study. It is not possible to display answer words in the concept networks according to demographic characteristics. Because participants with different demographic characteristics can write the same answer phrase, the visuality of concept networks disappears.

Working Group

This study was conducted with 10th grade students in a state high school affiliated with the Ministry of National Education in Konya Province (Türkiye) in the autumn term of the 2023-2024 academic year. The participants consisted of a total of 70 people, 39 of whom were female and 31 of whom were male. However, demographic characteristics were not considered in this study.

Data Collection Tool

The data of this study were obtained using an independent word association test (WAT). In order to conduct the test, 7 key concepts related to the subject of atmosphere and climate in the 9th grade natural systems unit of geography were used as data collection tools. In selecting key concepts, geography textbooks and achievements were examined, and expert opinions were examined. These key concepts were the basic concepts related to the subject and were determined as climate, atmosphere, temperature, pressure, wind, humidity, and precipitation, respectively.

To write the answer words for each key concept, each key concept was written 10 times, one after the other, and a blank space was left. If possible, the answer words were written as a single word in this space quickly. An example of a measurement tool prepared

in this way is given below. Bahar and Özatlı (2003) explained that the reason for writing the key concept is to prevent the risk of chain answers. Thus, it is ensured that students return to the key concept after writing each answer. Otherwise, instead of the key concept, the learner will write the words that the concept brings to mind as an answer.

A sample page of the measurement tool is shown below.

Climate .....

Climate .....

Related sentence: .....

In this study, 1 min (60 seconds) was given for each key concept, and students were asked to write the words that came to mind about the key concept within this time. In Geeslin and Shavelson's (1975) study, it was determined that the participants were given 1 min to write answer words related to the key concept.

At the end of the one-minute period, students were asked to move on to the next key concept. Thus, it was ensured that students made inferences about key concepts using the free-association technique during the period. In addition, in this way, students were given the opportunity to apply each key concept simultaneously.

In addition, the participants were asked to write sentences describing each key concept. These sentences were analyzed one by one during the data analysis phase, and necessary evaluations were made. Işıklı et al. (2011) stated that more meaningful and conceptual information can be obtained through related sentences.

According to Ercan et al. (2010), because a sentence related to a keyword has a more complex and higher-level structure than a one-word answer, it is necessary to consider situations such as whether the sentence is scientific or not and whether it contains misconceptions of different qualities in the evaluation process.

Analyzing Data

A frequency calculation, a descriptive analysis technique, was used to evaluate the data obtained using the word association test. The answer words produced for each key concept were classified and grouped. Thus, a frequency table showing the types of answer words and the number of times these answer words were repeated for which key concepts was formed (Table 1). By evaluating the data in the frequency table, the cut-off point (BP) technique proposed by Bahar et al. (2010) was used, and concept networks were created for each cut-off point level.

In this technique, in the frequency table, 3-5 numbers below the most frequent answer for any key concept in the word association test are used as a cut-off point, and the answers above this answer frequency are written in the first part of the map. Then, the cut-off point is lowered at certain intervals, and this process is continued until all keywords are revealed. A concept map made in this way reveals how students perceive the relationships between

concepts and leads to the discovery of new relationships. Teachers can revise their teaching methods by taking this concept network map into consideration or can orient themselves toward conceptual connections that are missing in the map (Bahar et al., 2010). In this study, the upper level of the cutoff point was determined as 46, and response words with a frequency of 46 and above were included at this level. For example, at this level, the frequency of the answer words "rain" is f = 49 and has a value greater than 46. That is why the answer to the word "rain" is shown at this level. Because the frequency of the answer words for other key concepts was not 46 or above, they were moved to a lower level. This lower level is determined by taking 7 below 46. Thus, response words with frequencies between 40 and 45 were included in this sublevel. Other levels below this level were created using the same approach.

In this regard, frequency tables related to the answers given by the students to the key concepts were prepared. According to the results obtained from the tables formed from the students' answers, concept networks were formed. The cut-off point technique was used in the creation of these concept networks. The cut-off point was colored according to the frequency range of the students' answers to the keywords. 46 and above are shown in black, 40-45 in red, 34-39 in dark blue, 28-33 in orange, 22-27 in pink, 16-21 in green, and 10-15 in blue. For example, the key concepts of precipitation with a cut-off point of 46 and above and the answer word "rain," which ensures precipitation at this level, are shown in black. Key concepts and answer words that appear at the lower level (i.e., between the cut-off points 40 and 45) are shown in red. The key concept of rainfall at the next level, i.e., 46 and above, and the rain answer words are shown at the lower level, preserving their colors. In the others, the same approach was continued, and the color level indicated which key concept and answer words appeared at each level, thus eliminating confusion.

In addition, the dashed lines in the concept networks indicate that a stimulus (response word) is written as a response to another stimulus. Level colors were used to easily understand at which level and in relation to which key concept the response words appeared. In other words, the stimulus words were written with the colors of the level at which they appeared and with capital letters in the boxes. The response words for the key concepts are written in lowercase letters with the colors of the level at which they occur. In this study, the answer words appearing at any level are shown with the color of the level at which the key concept occurred. Sometimes the same answer may be used for different key concepts at different levels. In this case, a straight line is established between the two key concepts; however, the answer words are shown with the colors of the level at which they appear. For example, the answer word "rain" was written for the key concept of rain and appeared at levels 46 and above and was shown in black. Again, the answer word "rain" was written in humidity, and the cut-off point appeared in the range of 22-27. Pink color is used in this range, a connection is established with a straight line, and the key concepts of humidity and precipitation are associated with the color pink. If key concepts are written as answer words for each other, they are shown as a dashed line. For example, the cut-off point

for temperature in the range of 28-33 is written as humidity, and temperature is the answer word within the key concept of humidity. Thus, key concepts are associated with each other and are shown as a dashed line and orange because they are both at the same level.

In this study, a scientific content table was created to present the sentences related to key concepts. Additionally, sentence examples for each key concept were analyzed, and sentence examples containing scientific, non-scientific, or superficial information were included. Again, when creating concept networks, a dashed line was used between two key concepts if one of the key concepts was written as an answer to the other.

Ensuring Validity and Reliability

The main purpose (and claim) of scientific research is to find the right (convincing) answer to the questions or problems that the researcher seeks to answer. For this purpose, two points are given special importance in research: validity and reliability (Altunışık et al., 2002). To ensure the validity of the study, all steps of the study method should be presented in detail. Presenting the sampling, data collection, and analysis stages in detail also contributes to the validity of the study (Özkan, 2023). In this context, data collection, analysis, and how the researcher obtained the results were explained in detail. The results were reported, interpreted, and presented in detail.

To ensure reliability, either different observers should associate events (items) to the same category, or the same observer should associate the same category in the same way at different times (Altunışık et al., 2002). Accordingly, the data obtained were coded, and frequency tables were created separately by two researchers. These codes were compared for the reliability of the research, and consensus was achieved. The reliability of the data analysis was calculated using the formula [Agreement / (Agreement + Disagreement) x 100] (Miles & Huberman, 1994). The average reliability between the coders was calculated as 95%.

Ethical Considerations

Before starting the research, ethical principles were applied to the Necmettin Erbakan University Social and Human Sciences Research and Publication Ethics Committee, and an ethics committee approval certificate numbered (Date: 08/12/2023, No: 2023/586) was obtained.

RESULTS AND INTERPRETATION

For the key concepts related to the subject of atmosphere and climate, a cut-off point was created with the answer words inferred by the students with a repetition number of 10 or more (Table 1). The number of these answer words was calculated as 66. The key word for which the greatest number of answer words were written was climate (n=20), while the others were atmosphere (n=14), temperature (n=14), humidity (n=11), precipitation (n=11), pressure (n=10), and wind (n=8), respectively. The answer word rain (n=49) with the highest

frequency was written for the key concept of precipitation. It is noteworthy that more than half of the students wrote the answer words: high pressure (n=45), low pressure (n=44), snow (n=43), and wind (n=36). The frequencies of other answer words were written by fewer students.

Table 1.

Frequency Table of Key Concepts and Response Words Related to the Atmosphere and Climate

Answer Word	Climate	Atmosphere	Temperature	Pressure	Wind	Humidity	Precipitation
Mediterranean	*	*	3	*	*	11	*
Mediterranean climate	25	*	*	*	*	*	*
Low pressure	*	*	2	44	19	1	3
Atmosphere	8	1	2	19	3	4	5
Nitrogen	*	12	*	*	*	*	*
Relative humidity	*	*	*	*	*	23	*
Barometer	*	*	*	10	*	*	*
Pressure difference	*	*	*	4	15	*	1
Pressure force	*	*	*	13	*	*	*
Pressure	2	20	12	*	23	1	2
Flora	17	*	2	*	*	1	5
Steam	*	*	*	*	*	10	1
Evaporation	*	*	5	*	1	10	8
Cloudy	2	6	*	3	2	8	28
Desert	10	*	11	*	2	*	1
Sea	*	*	2	1	*	19	2
Degree	*	*	17	*	*	*	*
Full	*	*	11	*	*	4	27
Equator	11	*	12	2	*	12	3
Gas	*	6	*	10	*	3	*
Sun	4	2	17	*	*	1	1
Incident angle of sun rays	*	*	10	*	*	*	*
Sunlight	11	5	3	*	*	*	*
Weather	5	23	8	16	13	9	1
Weather events	16	17	2	3	4	3	6
Heat	1	*	19	*	*	4	*
Climate	*	3	17	2	1	11	10
Climate types	2	*	11	*	*	*	*
Ionosphere	*	19	*	*	*	*	*
Snow	5	*	3	*	*	4	43
Blacksea climate	14	*	*	*	*	4	11
Continental climate	20	*	*	*	*	*	*
Layers	*	19	1	*	*	*	*
Frost	*	*	1	*	*	4	14
Climatology	15	*	*	*	*	*	*
Convective precipitation	*	*	*	*	*	*	10
Dry	18	*	7	*	2	*	2
Pole	12	*	9	2	*	*	*
Lithosphere	*	10	*	*	*	*	*
Breeze winds	*	*	1	2	16	*	*
Meteor	*	12	*	*	*	*	1
Season	13	*	10	*	1	1	1
Mesosphere	*	28	*	*	*	*	*
Monsoon climate	18	*	*	*	*	1	8
Absolute humidity	*	*	*	*	1	22	1
Moisture	12	4	20	6	2	1	25
Oxygen	*	17	*	*	*	*	*
Ozone	*	10	*	*	*	*	*
Ozon layer	*	20	*	*	*	*	*
Wind	1	4	6	36	*	*	*

Wind speed	*	*	*	2	10	*	*
Hot	11	*	9	7	6	5	2
Heat	20	7	*	17	7	33	13
Cold weather	13	*	16	8	8	1	9
Cold winds	*	*	*	*	12	*	*
Stratosphere	1	22	*	*	*	1	*
This	1	2	3	5	1	2	10
Water vapor	*	4	*	*	*	18	4
Thermometer	1	*	29	*	*	*	*
Thermosphere	*	17	*	*	1	*	*
Tundra	10	*	*	*	*	*	*
Long-years average	16	*	*	*	*	*	*
Precipitation	12	1	3	5	5	19	*
Rain	9	1	2	*	3	23	49
High pressure	*	*	1	45	22	*	*
Height	*	*	*	12	*	1	*

When the sentences produced for the keywords are analyzed, it is seen that the sentences containing the most scientific information were written for the key concepts of atmosphere (n=50) and wind (n=50). This was followed by pressure (n=45), climate (n=44) and precipitation (n=44) (Table 2). The least number of response words was written for humidity (n=36). When the number of sentences containing non- scientific and superficial information is analyzed; temperature (n=23), humidity (n=17) and climate (n=15) appeared as the key concepts with the highest frequency. The number of sentences containing misconceptions was highest for the key concept of pressure (n=11). In addition, the key concepts that did not have many sentences (no answer) were humidity (n=10) and precipitation (n=10).

Table 2.

Scientific Content Table containing Sentences Related to Key Concepts

Key Concept	*Number of sentences containing scientific information*	*Number of sentences containing non-scientific or superficial information*	*Number of sentences containing misconceptions*	*No response*
Climate	*44*	*15*	*7*	*3*
Atmosphere	*50*	*9*	*4*	*6*
Temperature	*40*	*23*	*1*	*5*
Pressure	*45*	*8*	*11*	*5*
Humidity	*36*	*17*	*6*	*10*
Wind	*50*	*10*	*2*	*7*
Precipitation	*44*	*11*	*4*	*10*

When the sentences written by the students for the key concepts are analyzed, it is seen that there were more examples of sentences containing scientific information (Table 3). These sentence examples are correct and academic scientific sentences. Some of these sentences for key concepts consist of similar expressions. However, there are also examples of sentences representing very different features of key concepts. In the second place, examples of sentences containing non-scientific or superficial information. It can be seen that a significant number of these sentences are correct, but they do not possess the characteristics of a scientific expression. Again, among the examples of sentences written about key concepts, there are expressions containing misconceptions.

Table 3.

Examples of sentences made by students related to the key concepts of "atmosphere and climate"

Key Concept	*Examples of sentences containing scientific information*	*Examples of sentences containing non-scientific or superficial information*	*Examples of sentences containing misconceptions*
Climate	-Türkiye generally has a Mediterranean climate (P1) -The climate of Konya is dry and hot in summer and mild and cold in winter (P4) -Climate depends on the mathematical position of a region and affects human life significantly (P10) -Ocean currents affect climate (P12) -40-50-year average weather conditions that affect the living conditions of people and the vegetation of the environment are called climate (P32) -Black Sea, Mediterranean and continental climate is observed in our country (P36) -There are various climates in the world and each of them has its own characteristics (P39) -Climate is one of the most important factors affecting settlement (P42) -Climate has been the most important factor determining the settlement of people since the earliest times (P44) -Equatorial and monsoon climates receive a lot of rainfall (P56) -The atmosphere is being damaged day by day due to air pollution (P57)	-People organise their lifestyle according to the climate (P2) -There are many different climates in the world (P4) -Climate is important for tourism (P14) -Türkiye is one of the few countries where four climate types are seen (P21) -Global warming is effective in changing climates (P34) -The climate is changing (P46) -Climates are long term (P49) -Climate is changing day by day (P53) -Climate change has recently become more important (P54) -The climate here is very harsh (P58) -Our atmosphere is polluted every year (P58) -Let's not pollute the air please (P63) -We damage the atmosphere (P64) -Atmosphere too hot (P65)	-The climate of the Aegean region is warmer than other regions (P6) Climate is the result of long-term research (P7) -General weather (P18) -Türkiye is generally under the influence of continental climate (P48) -Climate change damages the atmosphere (P59) -Gases in the atmosphere are proportional (P66) -There is life in our atmosphere (P69)
Atmosphere	Weather events occur in the atmosphere (P1) -Nitrogen is more abundant in the atmosphere than oxygen (P2) -Atmosphere blocks harmful rays coming to the earth (P3) -The atmosphere consists of different layers (P5) -The Earth's atmosphere protects us from various harmful rays and meteorites (P6) -Atmosphere is important for life (P14) -Atmosphere is the eye layer that surrounds the earth (P16) -Because the gases in the atmospheric layer pressurise the earth, open air pressure occurs (P34) -The mesosphere is a layer of the atmosphere (P47) -78% of the atmosphere is nitrogen, 21% is oxygen and 1% is other gases (P52)	-Layers of the sky (P17) -Atmosphere is related to life (P26) -Let's protect our atmosphere (P46)	-Air decreases as the atmosphere gets closer (P22) -The thickness of the atmosphere is decreasing day by day (P53)
Temperature	-Temperature depends on the angle of incidence of the sun's rays, the temperature is higher where it is perpendicular and close to perpendicular (P10)	-Today the temperature was 12 degrees (P4) -The temperature was high today, humidity will increase (P5) -The temperature in Konya will	Temperature is the average temperature (P43)

	-Temperature affects pressure (P2) -If the humidity is high, the temperature felt is high (P8) -Temperature forms the EU and HP fields (P9) -The unit of temperature is Celsius (P12) -Equatorial belt has the highest average temperature (P21) -Temperature and heat are different concepts (P26) -Temperature is the average kinetic energy of the particles that make up the substance (P27) -The temperature decreases as you rise above sea level (P28) -Latitudes are very effective on temperature. The average temperature decreases as you move away from the equator (P39) -Mathematical position and the angle of incidence of the sun's rays affect the temperature (P47) -The hottest regions in the world are deserts (P48) -Southeastern Anatolia is the region with the highest temperature in Türkiye (P52)	drop tomorrow (P6) -Humidity increases as the temperature increases (P7) -Temperature affects agriculture (P14) -There are many factors affecting the temperature (P18) -The temperature increased (P46) -Today the temperature is 36,5^{o} C (P53) -The temperature can drop to minus degrees in winter (P58) -The weather is very cold (P63) -High temperature is uncomfortable (P64) -The temperature increased with climate change (P66)	
Pressure	-Wind blows from high pressure to low pressure (P67) -Pressure is divided into high- and low-pressure areas (P60) -The pressure decreases as you go higher (P58) -Cloudy at low pressure, clear at high pressure (P55) -Wind occurs if there is a pressure difference between two regions (P49) -Descending air movements are observed in high pressure areas (P48) -Wind direction is determined by pressure (P47) -Pressure is the force exerted by gases on a unit surface (P32) -If the temperature increases, the pressure decreases (P23) -Pressure fields are formed due to temperature difference (P19) -The higher the pressure difference between two regions, the higher the wind intensity (P10) -Open air pressure decreases with increasing altitude (P7) -There is a pressure difference between cold and hot regions (P5)	- Pressure change had a bad impact on life (P66) -Pressure difference too high (P65) -Pressure is very important (P63) -Liquids transmit pressure exactly (P22) -Pressures create winds (P14) -We studied solid pressure in physics (P4) -It is the pressure on the surface (P50) -Pressure change is felt in the body (P59)	- The pressure applied to the bottom of the container (P69) -Winds are from low pressure to high pressure (P41) -The place with high pressure is cold (P37) -The ratio of the perpendicular bathtub of a substance to the surface to the area (P30) -The perpendicular force exerted by the mass on the unit surface (P20) -It is the force that compresses natural wastes and turns them into coal (P25) -Force exerted on materials under the influence of moving gas (P15)
Humidity	-Maximum humidity is the maximum amount of moisture that air can carry (P1) -For precipitation to occur, the amount of moisture in the atmosphere must be high (P1) -If the temperature is high in places near the water, humidity is high (P5) -Water vapour in hot air condenses	-The weather was humid today (P4) -Maximum humidity is high in the Black Sea (P11) -Humidity is high in the Mediterranean region (P13) -Humidity makes breathing difficult (P59) -The weather is too humid (P62) -Humidity too high (P64)	-Moisture is evaporated water (P18) -Precipitation is observed in case of excess moisture (P19) -Ratio of water vapour in the sky (P30) -It is formed by evaporation of sea water (P36) -Moisture is measured by

	and forms precipitation (P9) -The higher the humidity in a region, the greater the difference between the actual temperature and the felt temperature (P10) Humidity is used when calculating the sensed temperature (P12) -Equator and its surroundings are the most humid regions (P14) -Water vapour in the atmosphere is called moisture (P16) -The ratio of absolute humidity to maximum humidity is called relative humidity (P44) -Humidity is one of the factors determining climate (P57)	-Humidity makes breathing difficult (P66) -The weather will be very humid next week (P67) -The weather in the Mediterranean is very humid (P68) -High humidity (P69)	alluvometer (P47)
Wind	-Winds carry the temperature of the region they come from to the place they reach (P1) -The winds blowing from the poles are cold (P11) -Wind can erode (P12) -Breeze winds are the winds with the least effect (P13) -Wind is a horizontal air movement from high pressure to low pressure (P15) -Winds are formed due to pressure difference (P19) -The region with the strongest winds in Türkiye is the Central Anatolia Region (P21) -Pressure difference and wind speed are directly proportional (P26) -Barchans are forms of wind accumulation (P37) -Witness rock is formed by erosion of winds (P52)	-The winds blew strongly (P4) -The wind was so strong, it almost blew us away (P6) -Winds affect the climate (P14) -The name of the wind changes according to the regions (P43) -Windy weather dries our skin (P51) -The weather is very windy (P58) -The wind got stronger and stronger (P62) -The wind blows hard (P64) - It's windy (P65)	-Winds carry heat (P3) -Heated air rises (P22)
Precipitation	-Precipitation is higher at the equator (P2) -In Türkiye, precipitation is high in the Black Sea (P3) -Precipitation is weather events (P9) -Can comment on the amount of precipitation by looking at the climate characteristics of a region (P10) -Precipitation occurs when the relative humidity is 100% (P11) -The Indian peninsula has the highest rainfall in the world (P12) -Precipitation is formed by condensation of water vapour in the atmosphere (P16) -Rain and hail are types of precipitation (P18) -Precipitation is regular at the equator (P34) -Where humidity is high, precipitation is high (P39) -Monsoon precipitation is a type of precipitation (P47)	-It rained for a long time today (P4) -We can understand that rain may come from the clouds (P21) -Today there is a lot of rain (P22) -Precipitation occurs as a result of the water cycle (P23) -Grey indicates that clouds will bring rainfall (P37) -Rain is expected today (P51) -Increased precipitation (P62) -It is raining today (P64) -Very little rainfall (P66) -Increased rainfall (P66) -It is raining in Konya today (P67) -No precipitation for a long time (P69)	-Elevation precipitation is observed on mountain slopes (P1) -Precipitation types are elevation, slope and convectional (P8) -Water vapour accumulated in the clouds cools down and descends to the earth (P17) -Clouds must collide for rain to fall (P36)

Concept networks are an important technique for revealing the organization of knowledge in students' minds on any subject. In other words, it is possible to determine

the level of a student's cognitive structure on a subject using this technique. With this technique, what the student knows about the subject, what concepts he or she has structured in her mind, the nature of these concepts, and his or her ability to establish relationships between concepts can be determined. Frequency of answer words for key concepts are very important when creating a benchmark. Because the frequencies of answer words written for key concepts indicate the level at which the key concept appears. The fact that all of the key concepts emerged at high levels and with high-frequency answer words reveals that the students' cognitive structures on that subject were sufficient. If a significant part of the key concepts is revealed with low-frequency response words at levels below the cut-off point, this indicates that the cognitive structure is not at a sufficient level. In addition, the concept networks created at each level of the cutoff point are visuals that allow students to see their knowledge about a subject more clearly. These maps reveal the concepts that students' cognitive structures consist of and their level of establishing relationships between concepts. The greater the relationships (connections) between concepts at the upper levels of the cut-off point, the more meaningful learning occurs. In line with these explanations, the following evaluations were made for this study.

Between cut-off point 46 and above; the first key concept that emerged in this range was identified as precipitation. The participants associated the word precipitation with the word rain. At this level, the number of repetitions of the answer phrase "rain," which emerged in connection with the key concept of precipitation, was calculated as n=49. In this range, a single key concept appeared in relation to a single answer word (Figure 1). At this level, no word associated with other key concepts was produced. Therefore, it can be concluded that students' cognitive structures regarding weather and climate are not sufficient for this level. Because the frequency of answer words for the emergence of other key concepts at this level is not sufficient and there are no related answer words. It is important that the key concept of precipitation, one of the climate elements, first emerged at this level in relation to rain. Among the climatic elements, precipitation is the most important, and it is also an important form of precipitation.

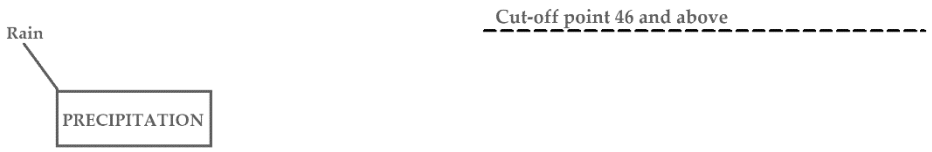

Figure 1. Concept network constructed according to key concepts (cut-off point 46 and above)

Between cut-off point 40 and 45; The key concept of pressure emerged from the key concepts given as stimulus in the range of cut-off point 40-45. The key concept of pressure was associated with the answer words low pressure (n=44) and high pressure (n=45) (Figure 2). The number of repetitions of these two answer words was equal and both answer words

were written by approximately the same students. The key concept of pressure given as a stimulus caused more than half of the students to associate low and high pressure as answers. At this level, the answer to the term "snow," which is one type of precipitation, also emerged in relation to the key concept of precipitation. At this level, the number of answer words for these two key concepts is not sufficient to represent the students' cognitive structure. At the same time, it can be seen that these two answer words emerged independently of each other. However, the answer words "snow," which the students wrote for precipitation, and the answer words "low pressure" and "high pressure," which they wrote for pressure, are the basic concepts of the atmosphere and climate subject, and it is important that they appear at this level.

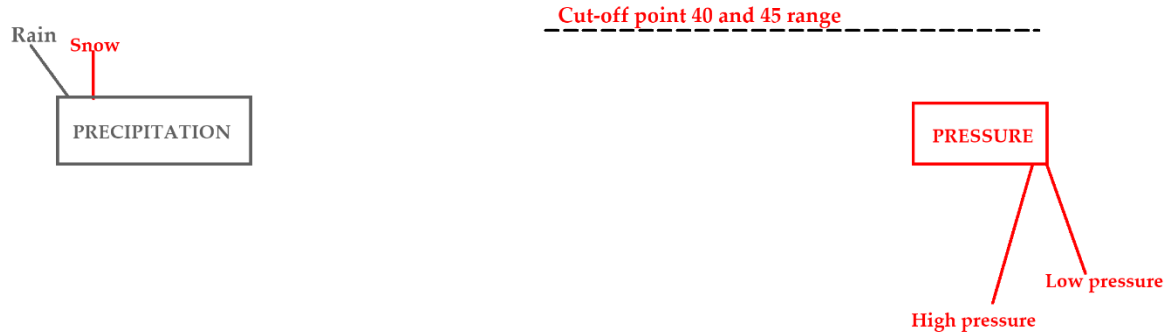

Figure 2. Concept network constructed according to key concepts (Between cut-off point 40 and 45)

Between cut-off point 34 and 39; this level of the cut-off point shows characteristics similar to those of the cut-off point at the upper level. At this level, it can be seen that the answer word "wind" was written in relation to the key concept of pressure. The number of students who associated the answer word wind with the concept of pressure was found to be n=36 (Figure 3). However, at this level, both key concepts are independent of each other. In other words, common answer words that represented the two key concepts at this level did not emerge. According to this result, students could not establish relationships between concepts at this level.

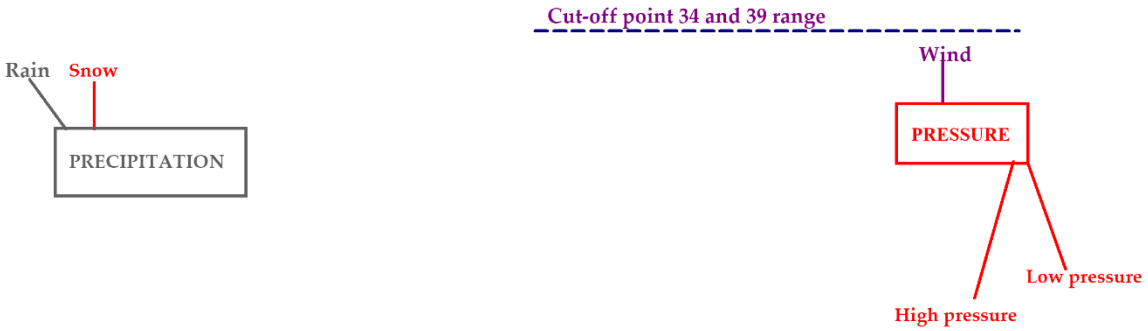

Figure 3. Concept network constructed according to key concepts (Between cut-off point 34 and 39)

Between cut-off point 28 and 33; 5 key concepts emerged in this interval. The key concepts of temperature, humidity, and atmosphere were included in the key concepts that emerged at previous levels. The key concept of temperature was associated with

thermometer (n=29). For the key concept of atmosphere, students wrote the answer phrase mesosphere (n=28), which is one of the layers of the atmosphere (Figure 4). In addition, the key concept in which one stimulus is written as an answer to the other stimulus is also observed at this level. In other words, for the key concept of humidity, the key concept of temperature was written as the answer word, leading to the establishment of a relationship between humidity and temperature.

There are no words associated with the key concepts of atmosphere, pressure, and precipitation at this level. Although 5 key concepts emerged at this level, it can be seen that the concepts are independent from each other because the relationship between the concepts has not yet been established. Because most of the answer words were not common to the key concepts, and each of them is specific to a single key concept. At this level, a relationship could have been established between temperature and pressure, pressure and atmosphere, and temperature and precipitation. However, it can be seen that this did not happen. In short, although 5 key concepts emerged in this range, the cognitive structures of the students were not fully revealed.

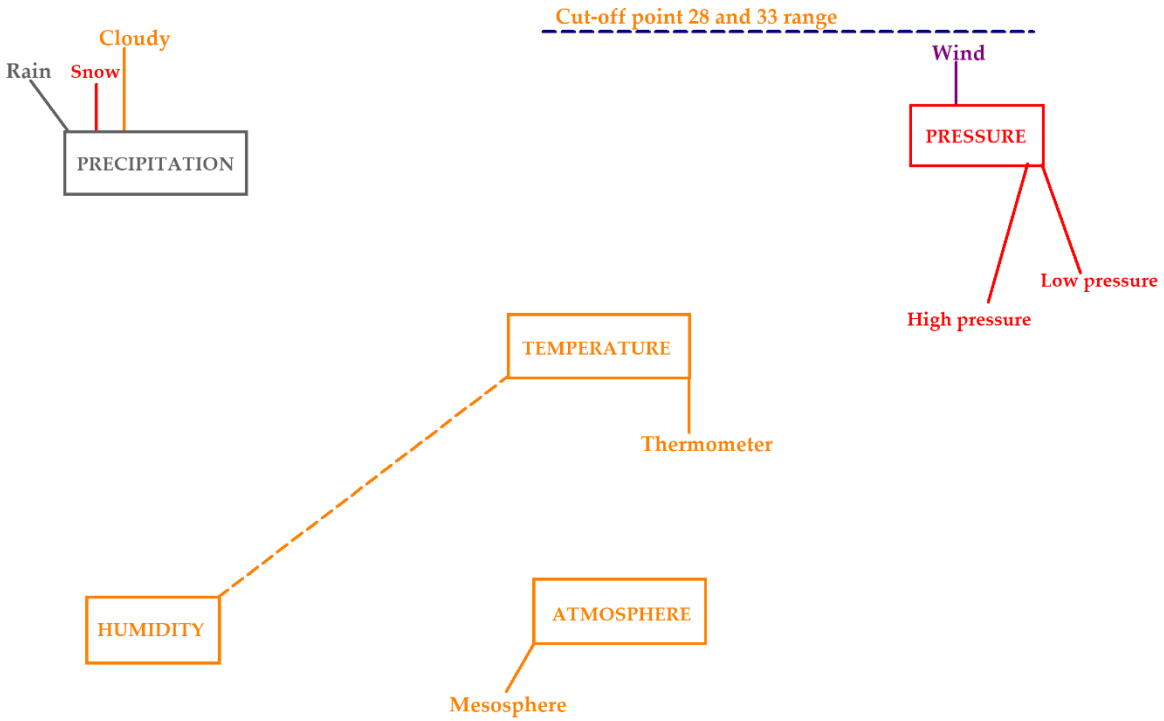

Figure 4: Concept network constructed according to key concepts (Between cut-off point 28-33)

Between cut-off point 22 and 27; in this range of the key concepts emerged in this range of cut-off point. The concepts of wind and climate were added to the key concepts at the previous level. At this level, the concept of pressure (n=23) was written as the answer word for the key concept of wind; thus, the two concepts were related to each other. In addition, the answer phrase "high pressure (n=22) written for the key concept of wind caused a relationship to be established between the key concepts of pressure and wind at this level. Again, at this level, the answer word rain (n=23) appeared for the key concept of humidity,

which led to the establishment of a relationship with the key concept of precipitation. For the stimulus word precipitation, the stimulus word humidity (n=25) was written as an answer term and appeared at this level. Hail (n=27) for the key concept of precipitation, Mediterranean climate (n=25) for climate, relative humidity (n=23) for humidity, air (n=23) and stratosphere (n=22) for atmosphere were produced as answer words (Figure 5). These answer words are basic concepts that represent key concepts. At this level, common answer words enable the establishment of relationships between the key concepts of precipitation, humidity, pressure, and wind. This result is important in terms of revealing the level of students' cognitive structures related to the subject. Because the number of answer words increased and the network of relationships between key concepts began to form. However, the key concepts of the atmosphere and climate still form islands at this level and exist independently.

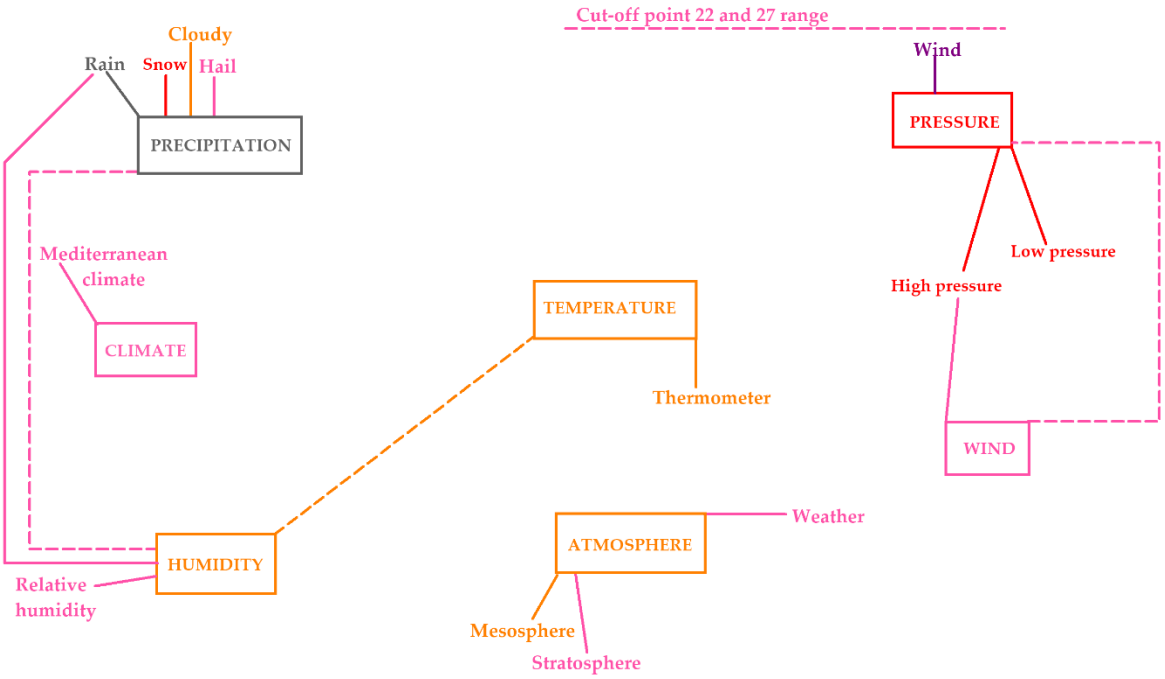

Figure 5. Concept network constructed according to key concepts (Between cut-off point 22-27)

Between cut-off point 16 and 21; the number of answer words written for key concepts, which were fully revealed at the upper level, increased in this range. However, the frequency of these answer words remained low. However, there was also an increase in the number of answer words that associate key concepts with each other. It can be seen that there are common answer words for all the key concepts. We can consider this a level at which students' cognitive structures begin to emerge more clearly. Because there is an increase in the number of answer words, there is also an increase in the number of relationships established between the key concepts. Although there are independent concepts, the answer word weather (n=16) for the key concept of pressure led to the establishment of a relationship with the key concept of atmosphere. In addition, the concept of atmosphere was written as an answer to the key concept of pressure, and a meaningful relationship was

established between the two concepts. Weather events were written n=16 times for the key concept of atmosphere and n=17 times for the key concept of climate, thus establishing a connection between the two concepts. Again, the key concepts of precipitation for humidity (n=19), climate for temperature (n=17), humidity for temperature (n=20), and temperature for pressure (n=17) emerged as answer words. At this level, all the key concepts were linked with different answer words. At the same time, there was an increase in the number of independently written answer words for key concepts. While there were no independent answer words for the key concepts of precipitation and pressure, for the key concepts of atmosphere, ozone layer (n=20), oxygen (n=17), and thermosphere (n=17); for the key concepts of climate, terrestrial climate (n=20), long-term average (n=16), and vegetation (n=16); degrees (n=17), heat (n=17) for temperature; relative humidity (n=23), absolute humidity (n=22), water vapor (n=18) for humidity; and breeze winds (n=16) for wind key concept (Figure 6).

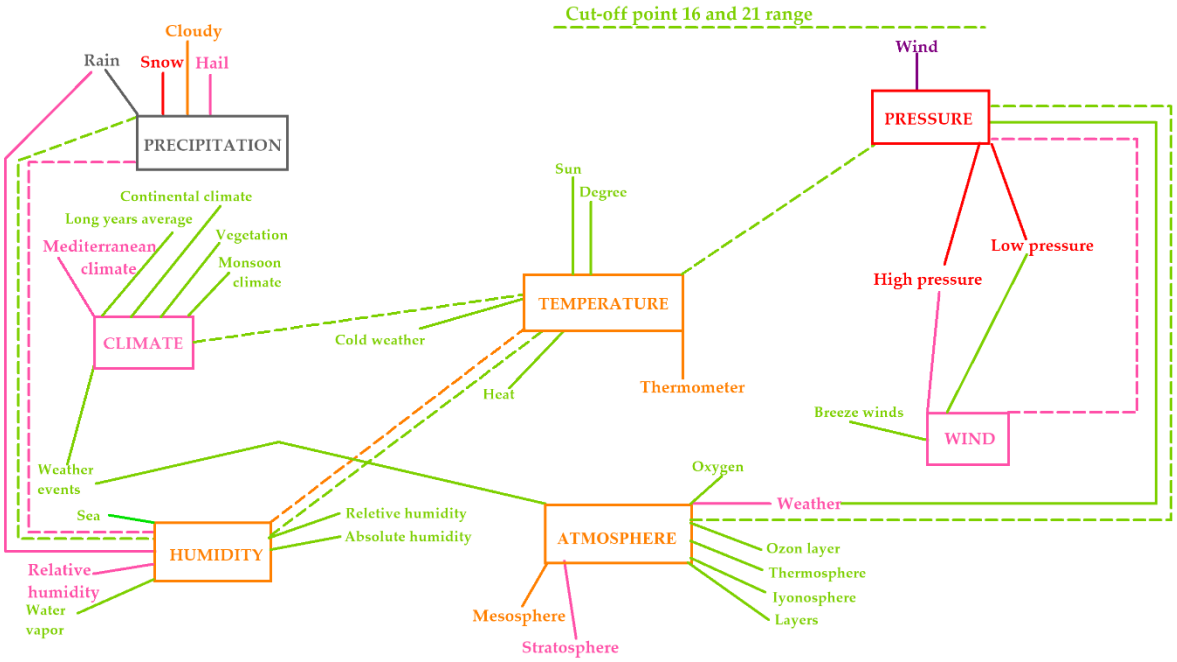

Figure 6. Concept network constructed according to key concepts (Between cut-off point 22-27)

Between cut-off point 10 and 15; in this range, the connections and relationships between key concepts and answer words increased slightly. The concept network showing these relationships started to become sufficiently clear. In other words, although more words were produced at this level, fewer students wrote these words. In this interval, there was an increase in the number of answer words that associated the key concepts of precipitation, temperature, climate, and humidity with each other, resulting in the formation of a concept network. A more complex structure emerged compared with the other intervals. It can be seen that the answer words for the key concepts of pressure, wind, and atmosphere are independent answers specific to these concepts. For the key concepts of pressure, pressure force (n=13), height (n=12), barometer (n=10), and gas (n=10); for the key concepts of wind,

cold winds (n=12), pressure difference (n=15), and wind speed (n=10); for the key concepts of atmosphere, nitrogen (n=12), ozone (n=10), and lithosphere (n=10) were written as answer words. The students believed that the answer words for these key concepts were independent of each other. Many answer words that did not appear at higher levels were expressed by the students at this level, although their frequencies were low. Although a direct relationship was established between the concepts of temperature and precipitation, a similar situation was observed between the concepts of climate and humidity. In other words, temperature (n=13) for the key concepts of precipitation, humidity (n=12) for climate, and climate (n=11) for humidity were written as answer words, and the key concepts were associated with each other. In addition, the answer word desert was written n=10 times for the key concept of climate and n=11 times for the key concept of temperature at this level, thus establishing a connection between the two concepts. The answer word equator generated a triple relationship between the key concepts of climate, humidity, and temperature. In addition, the answer word air (n=13) appeared at this level for the key concept of wind, and a connection was established between the key concepts of atmosphere and pressure (Figure 7). In summary, it can be seen that there is an increase in the number of common words associated with key concepts at this level. Although the connections between the key concepts and the answers given to them increased, their frequencies remained low. For this issue, it can be said that conceptual learning is not sufficient and cognitive structures are disconnected from each other; that is, meaningful learning has not fully occurred. Because important answer words that count the connection between key concepts were not produced at higher levels, most of the answer words that emerged had low frequencies and were not common to the key concepts. Thus, a connection could not be established with the previously revealed key concepts, and each concept was considered independent from the other. However, at this level, new answer words were produced for each key concept.

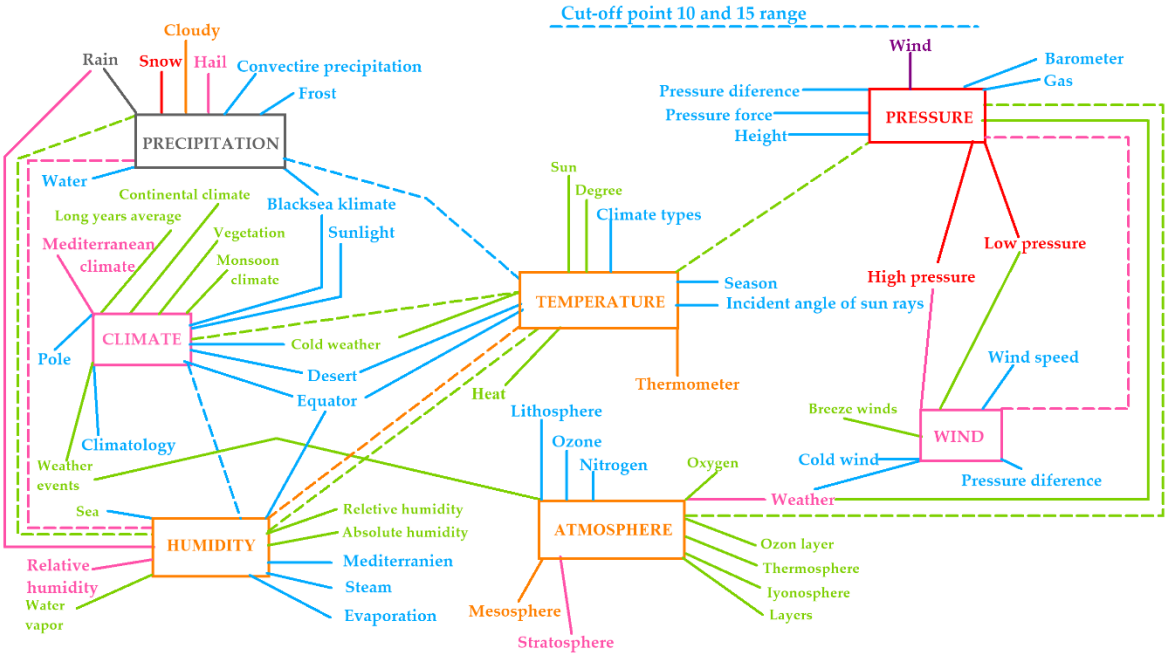

Figure 7. Concept network constructed according to key concepts (Between cut-off point 10-15)

CONCLUSION AND DISCUSSION

This study aimed to reveal basic concepts related to the atmosphere and climate subject in the 9th grade natural systems unit of the geography curriculum and the relationship between these concepts. For climate, atmosphere, temperature, pressure, wind, humidity, and precipitation, which were selected as key concepts, concept networks were created by evaluating the answer words inferred by the participants. Thus, it was attempted to determine which concepts came to the fore in the minds of the students in relation to the subject, how many students wrote these concepts, and at what level was the answer word related to which key concept emerged. When the obtained data were analyzed, the students were observed to produce a large number of answer words related to the key concepts. However, not all the answer words were included in the concept networks. Some of these concepts were written by a few students, and their frequencies were low. Therefore, it is not possible to create a cut-off point and construct a concept network with all answer words. Therefore, the lower level of the cut-off point was formed from answers that were repeated 10 times.

The upper cut-off point level was determined as 46 and above. In this range, n=49 students wrote the answer phrase "rain," and the key concept of precipitation emerged for the first time. Thus, only one key concept emerged at this level. According to this result, it is seen that students cannot produce enough answer words at this level in the subject of weather and climate, and it can be said that their cognitive structures are not at the desired level. According to Aydın and Güngördü (2016), teachers can check whether concepts can be understood by observing the number of answers given to the key concepts in memory (it is assumed that the meaning increases as the words given as answers increase) and word type (is it related to the key concept or not?).

The answer word "rain" constitutes the most important liquid form of precipitation among the forms of precipitation. Therefore, the fact that this answer was given by more than

half of the participants reveals that the key concept was understood correctly. In their study, Dere and Aktaşlı (2022) stated that students intensively associate the key concepts of precipitation with the words rain, snow, and hail.

The low-pressure (n=44) and high-pressure (n=45) expressions written in response to the pressure stimulus words in the range of 40 and 45 caused this concept to emerge. These answer words were written by almost the same students. The relationship between these answer words and the key concepts was not yet established at this level. In addition, the answer word snow (n=43) for the key concept of precipitation also emerged at this level. These two key concepts are among the most important topics in climatology, so they must occur at this level. Although no relationship was established between precipitation and pressure systems, the fact that most students had written them is suggestive in terms of revealing which concepts their cognitive structures consist of. In short, at this level, students still consider many of the words they produce as independent of each other. This indicates that students do not have sufficient knowledge of the subject and have difficulty in remembering some concepts.

Between cut-off point 34 and 39, only the answer term wind (n=36) was associated with the concept of pressure. However, the fact that there are no answer words to establish a relationship between both key concepts and that the key concepts are independent and disconnected from each other indicates that the cognitive structures of the students in this subject are not yet at the desired level.

At cut-off point 28 and 33, 3 more key concepts emerged in addition to the two previously mentioned concepts. These are the key concepts of temperature, humidity, and atmosphere. Students wrote the answer words thermometer (n=29) for the key concepts of temperature and mesosphere (n=28) for the key concept of atmosphere. In addition, temperature was written as the answer word for the key concept of humidity, and a direct relationship was established between humidity and temperature. In other words, two stimulus words were associated with each other, and a connection was established between key concepts for the first time at this level. Although it is seen that 5 key concepts emerged at this level, it is noteworthy that not enough answer words were written for these concepts. According to Atasoy (2004), the more answers to the keyword, the better the comprehension is.

All the key concepts emerged between cut-off point 22 and 27. The concepts of wind and climate were included in the 5 key concepts at the upper level. Although there is a partial increase in the number of answer words, there is also an increase in the relationship established between the concepts. At this level, basic concepts related to the atmosphere and climate began to emerge. These answer words represent not only the key concepts but also the characteristics of words to be written in common for the key concepts. In addition, at this level, a relationship was established between the key concepts of precipitation, humidity, pressure, and wind, and a relationship network started to form. However, common answer words were not used for the key concepts of atmosphere and climate at this level. The frequencies of the response words written for the stimulus concepts are low and the relationships established for the key concepts are not sufficient.

There was a remarkable increase in the number of answer words between cut-off point 16 and 21. However, the frequency of these answer words also decreased gradually. Although very few students wrote the answer words, there is an increase in the diversity of

the answer words. We can say that students' cognitive structures begin to be clearly observed at this level. In this range, many common answer words were written for the key concepts, and relationships were established between them. The number of answer words specific to each key concept.

Cut-off point 10 and 15 constitute the lower cut-off point level. In this interval, key concepts increased compared to the upper level. The relationship between concepts emerged more clearly in this interval. More answer words were produced, but these were written by fewer students. In other words, these low-frequency answer words caused the key concepts of precipitation, temperature, climate, and humidity to be associated with each other and to form a concept network. This range shows a more complex characteristic. At this level, it can be seen that the answer words for the key concepts of pressure, wind, and atmosphere are independent answers specific to these concepts. In short, at this level, many new answer words were produced for the key concepts, and the cognitive structure was revealed more clearly.

When the sentence examples written by the students for the key concepts are analyzed, it is seen that the sentence examples containing scientific knowledge were in the majority. Among the sentence examples written for all key concepts, the number of sentences containing scientific knowledge was 309, the number of sentences containing non-scientific or superficial knowledge was 93, and the number of sentences containing misconceptions was 35. The total number of students who did not write answers to the key concepts was 46. The key concept for which most sentences containing scientific knowledge were written (n=50) was wind. The highest number of sentences containing non- scientific or superficial information was written for the key concept of temperature (n=23). Pressure was the key concept with the highest number of misconceptions was pressure (n=11). Even if some statements about pressure were correct as a subject of a physics course, they were considered as misconceptions because they were not directly related to the atmosphere.

These results reveal that students learn geography subjects mostly theoretically and, as a result, acquire knowledge through rote learning. Therefore, geography lessons should be supported with visual materials, and active learning methods and techniques should be applied in learning by doing and experiencing environments. According to Turan (2002), learning through rote memorization is far from providing complete learning and is contrary to the aims and principles of Turkish National Education. For this reason, while teaching concepts and terms in geography, it is imperative to avoid methods that will lead students to memorize as much as possible and to create a set of methods that will lead them to understand.

Examples of sentences containing a few misconceptions within the key concepts were written. These examples are mostly related to the key concepts of pressure, climate, and humidity. Most subjects related to the atmosphere and atmospheric pressure are especially abstract. This situation makes it difficult for students to make sense of the subject in their minds. Some students wrote answer words related to physics subjects for this key concept. In addition, it was observed that students mostly wrote sentences such as defining and explaining the meaning of key concepts. In other words, we can say that students have few examples of sentences at the level of analysis, synthesis, and evaluation. The reasons for all this should be revealed. First, if common topics and concepts between disciplines, it is very important for geography teaching to determine the level and framework of the relationship

between them and to handle them within the scope of the principle of holism. In short, in teaching abstract geography subjects, it is necessary to determine how students construct the basic concepts specific to the subject in their minds, what they understand, how they express them, with which examples they explain them, and whether they have misconceptions about the subject. For example, Kılınç and Tuna (2013) revealed how students described atmospheric pressure using a descriptive map. In the description map, basically 6 types of description ways were identified. These ways are defining it as the pressure in the atmosphere, explaining it as various properties in the atmosphere, its association with the effect on living things and humans, defining it as the force on the earth and beings, explaining it as the weight of the air, and defining it as one of the elements of weather and climate. According to Demirkaya and Tokcan (2007), before teaching concepts related to the immediate environment to their students, teachers should take into account that their students may have incorrect knowledge about the concepts to be learned. While teaching geography-related information to students in primary, secondary, and university education, experience-based teaching should be applied.

According to Görgülü Arı and Aslan (2020), to create awareness about climate and climate changes in individuals, to provide individuals with the necessary awareness, and, most importantly, to provide an effective climate-oriented environmental education, it is necessary to reveal the deficiencies of students regarding climate and climate literacy. Thus, in line with the deficiencies determined by individuals, the education that can be provided can be shaped, and the most accurate education path can be created. In this way, it is possible to shape individual-specific environmental education and transfer it to the most appropriate method.

In this context, the cut-off point can be used as a technique to determine the characteristics of the concepts in the subject, which concepts the subject consists of, and how the concepts are understood by the students. In this way, the type and frequency of the students' answer to the key concepts, what they understood about the subject and briefly their cognitive structures can be revealed. In successful education, it is necessary to determine the cognitive structures of students in relation to any subject. According to Abdelhalim (2019), students' cognitive structures should be considered when teaching languages. This helps teachers know how to present educational material, how to make lesson plans, and how to assess students' learning level.

In conclusion, the air and atmosphere are important components of natural systems. The fact that this subject is closely related to both academic life and contemporary life further increases its importance. In addition, this subject is rich in basic concepts. Most of these concepts are abstract, it is difficult to construct in the mind. Despite this property, the results show that students' knowledge of this subject is correct but not at the desired level. Because the frequency of most of the words that the students made associations was low and they appeared at lower levels. The connection words between the key concepts were mostly concentrated at lower levels and in answer words with low frequency. There was also an increase in the number of answer words specific to key concepts at these lower levels. When the concept networks are examined, it is noted that most of the answer words for the key concepts were independent. In other words, each answer word is specific to a certain key concept and is not associated with other key concepts. The fact that common answer words for key concepts appeared mostly at lower levels reveals that students lacked aptitude for

atmosphere and climate.

RECOMMENDATIONS

The subjects belonging to the units in the geography curriculum have a rich variety of scientific concepts. In teaching these concepts, concept teaching techniques should be employed, and relationships between concepts related to the subject should be established; thus, conceptual learning should be ensured.

Misconceptions, if any, should be identified with appropriate techniques. Their reasons should be revealed, students should be made aware of their misconceptions and efforts should be made to eliminate these misconceptions. Only in this way can the correct structuring of knowledge in the mind be ensured, and mental contradictions can be reduced.

If common topics and concepts belong to other disciplines, they should be emphasized in the lessons; interdisciplinary relations should be revealed by giving examples; the meanings of the concepts in the discipline should be explained; similar and dissimilar examples should be given especially for the concepts; and the relationship of the related concepts and topics with geography should be explained.

With this technique, similar studies can be conducted by determining the basic concepts of ecosystem characteristics, global environmental problems, disasters, the structure of the world and the issues related to its formation process (internal forces and external forces).

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