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Abstract

The purpose of this study was to determine the state of secondary school students' cognitive structures about argument and related concepts and to reveal the change in their cognitive structures regarding these concepts after the implementation of the argumentation-oriented approach in science lessons. This study was conducted in Grade 6, 7, 8 classes, including a total of 80 students. This study follows a pre-experimental one group pretest–posttest design. Students were administered a word association test (WAT) covering argument and related concepts prior to and following the lessons. The results obtained from the WAT show that the students' cognitive structures progressed from the pretest to posttest, with an increase in the number of response words and connections between words, and with a change in the nature of these connections. As a result of teaching science lessons through argumentation, it was detected that cognitive structures of students regarding argument and related concepts indicated changes in the right way.

Introduction

Cognitive structures are constructs that enable strings of information to be meaningful and to have an association among each item, rendering them recallable when they are required (Ceylan, 2015). According to Ausubel (1963), the existing cognitive structure of an individual is the most vital factor that determines whether the new information will be meaningful and to what extent it can be associated accurately (Ausubel, 1963; cited. Khurshid & Iqbal, 2009). Gilbert and Watts (1983) defines cognitive structure as the construct that is based on assumptions and symbolizes the associations among the concepts saved in the long-term memory (Gilbert & Watts, 1983; cited. Kurt & Ekici, 2013). It is not simple to identify cognitive structures that depict the mental connections between terms, concepts, and processes (Derman & Eilks, 2016). There are various ways to identify and reveal cognitive structures, and Word Association Tests (WAT), conceptual maps, and V-diagram are among them. WAT test which is a powerful technique to determine the number and type of the concepts in students' minds and whether the connections between them are accurate and meaningful is one of the oldest and the most common methods to research cognitive structures (Bahar, Johnstone & Stucliffe, 1999). These tests have been used by many researchers (Bahar, Johnstone & Stucliffe, 1999; Cachapuz & Maskill, 1987; Gorodetsky & Hoz, 1985; Hovardas & Korfiatis, 2006; Maskill & Cachapuz, 1989; Yıldırır & Demirkol, 2018). This study aimed at identifying cognitive structures of secondary level students regarding argument and related concepts.

When the literature on cognitive structures is reviewed, it is evident that several studies were conducted on the issue of identifying students' cognitive structures. In these studies, word association tests were used to investigate students' knowledge on a particular subject (Derman & Eilks, 2016), to detect the conceptual change following a treatment (Hovardas & Korfiatis, 2006), and to compare and contrast students' cognitive structures following the application of different learning approaches (Bilgin, Coşkun, & Aktaş, 2013). Considering the studies focusing on cognitive structures of students with the help of word association tests, research on the area of science (biology, chemistry, and physics) shows dominance in number. In the studies on the area of biology, students' cognitive structures regarding cell and biodiversity (Kostova & Radoynovska, 2008), immunity, enzyme, organisms (Kurt, 2013), diffusion (Kurt, Ekici, Aktaş & Aksu, 2013), genetics (Bahar, Johnston & Sutcliffe, 1999), basic ecological concepts (Hovardas & Korfiatis, 2006), and evolution (Önel & Yücel, 2016) were investigated. With regards to chemistry studies, researchers mostly focused on issues such as atomic structure (Nakiboğlu, 2008), saponification reaction (Baptista, Martins, Conceiçao & Reis, 2019), dissolvement (Derman & Eilks, 2016) and physical and chemical change (Derman & Ebenezer, 2018). Additionally, when it comes to physics, motion and force (Timur, 2012) and light (Özcan & Tavukçuoğlu, 2018) were the topics of interest while science related studies covered Sun, Earth and Moon (Bolat, Aydogdu, Uluçınar Sağır &

Değirmenci, 2014) and recycling subjects (Atabek Yiğit & Ceylan, 2015) in terms of students' cognitive structures.

Several researchers have conducted studies to detect the change and the development of students' cognitive structures following an intervention. For example, Cachapuz and Maskill (1987) used pre- and post-word association and achievement tests to measure students' understanding of collision theory. These researchers found that while low achiever students did not have conceptual changes, higher achiever ones showed conceptual structuring and growth.

Nakiboğlu (2008) investigated changes in students' cognitive structures about the atomic structure with a WAT. A WAT with ten stimulus words was used as a pretest and a posttest, before and following a unit of instruction on atomic theories. Results showed that the intervention was effective in developing pre-service teachers' cognitive structures on understanding of atomic structure. Nakiboglu (2008) has suggested that the WAT can be used before instruction to probe the prior concepts in students' knowledge structure as well as after instruction.

Bilgin, Aktaş and Çetin (2014) compared the cognitive structure of 5th grade students who received education utilizing, Student Teams-Achievement Divisions (STAD) technique and those who received traditional instruction. These researchers found that students in the STAD had more concepts and branching points in their cognitive structures regarding change of substance whereas those in the other group had simple cognitive maps in their mind. Bilgin, Coşkun and Aktaş (2013) compared 5E Model of Instruction with traditional teaching in enhancing 4th graders' cognitive abilities in a unit called, introduction to substance' and found that 5E model was more effective in helping students establish a relationship between related concepts than the traditional method of teaching.

Şendur and Toprak (2017) used the WAT to reveal the cognitive structures of 11th grade students (ages 15-16) in the context of the basic concepts taught in the unit on chemical equilibrium and to understand how these changed after the instruction. A WAT consisting of ten stimulus words was used in before and after the instruction. Results showed that after the intervention the students were able to form new connections that were associated with each other instead of offering isolated structures. These researchers emphasized that the cognitive structures of the 11th grade students with respect to "chemical equilibrium" changed positively after the instruction.

Derman and Ebenezer (2018) used the same method (WAT) to describe the effect of multiple knowledge representations of physical and chemical changes on the development of primary pre-service teachers' cognitive structures. The study adopted one group pretest-posttest design supported by qualitative data. A WAT with two stimulus words (physical change and chemical change) and Particulate Nature of Matter Diagnosis Questions (PNM-DQ) scale were used as a pretest and a posttest. These researchers found that intervention related to multiple representations of physical and chemical changes were effective in developing both groups of pre-service teachers' cognitive structures, low and high-level understanding of particulate nature of matter.

In another study, Baptista, Martins Conceiçao and Reis (2019) used the same method (WAT) to understand if there was effect on cognitive structures of 12^{th} grade students of the use of multiple representations about the saponification reaction. Results showed that after the intervention the participants had a deeper understanding of the concepts and were able to make more connections using new words among the four stimulus words. All these studies emphasized the effectiveness of word association tests with regards to determining the nature of relationships among the concepts students' cognitive structures harbored.

Literature about Argumentation

Argumentation is a process of discussion and social interaction in which scientific claims are supported by empirical or theoretical evidence to make a judgment (Jimenez-Aliexandre & Erduran, 2008). In this social process, students actively participate in discussion, challenge their peers, justify their claims by supporting them with evidence, and try to persuade the opposing views (Evagorou & Osborne, 2013). At the end of the process during which the argumentation takes place, students advocate their perspectives to put forward their products, namely their arguments (Kuhn & Udell, 2003). Toulmin (1958) proposed a Toulmin Argumentation Pattern (TAP) to provide a better understanding of the concept of argument. According to TAP, argument is made up by six constituents as claim, data, warrant, backing, rebuttal, and qualifiers. Claim is the statement that is discussed while facts and evidence used to prove an argument is referred to as data. In addition, warrant is the series of reasonable and general explanations mostly based on assumptions (and generally restricted) and serving as a

bridge between claim and data, and statements that support the warrants are called backing whereas counter arguments and statements that indicate the argument at hand is not valid is referred to as rebuttal. Qualifiers, on the other hand, are statements that limit the strength of an argument or suggest the conditions under which the argument is correct (cited by Wheeler, 2018).

Scientific argumentation has emerged as an important scientific practice because "it assumes a fundamental position in the collective process of making meaning and affecting learning" (Sadler, 2006, p. 325; cited. Knight-Bardsley & McNeill, 2016). Scientific argumentation is seen as an effective approach that can be used in science education. This approach provides that students work collaboratively in the problem-solving process, learn their responsibilities and understand the nature of science (Eichinger et al., 1991; cited. Boğar, 2019). In this process, students could develop their skills in scientific argumentation. They would firstly study and present some data, and the information presented is then criticized, debated and revised (Duschl & Osborne, 2002). Thus, students learn how science develops by experiencing the process of creating scientific knowledge. Moreover, argumentation can lead to changes in students' views on science, gains in conceptual understandings, and improvement in scientific writing (Knight & McKneill, 2012).

Osborne, Erduran and Simon (2004b) underlined that science education has a key role in developing young adults' argumentation skills since they need to understand the nature of argumentation to participate in scientific discussions and make important decisions. In relation, the contemporary science lesson curriculum published by Turkish Ministry of National Education (2018) suggests that students need to be included in a learning environment in which they discover information by discussions, make inquiries, generate arguments, and design products. In this process, a learning environment in which students freely offer ideas by supporting them with justifications and generate counter arguments should be provided. Teachers, therefore, should take on the roles of guide and facilitator in such learning process. As can be detected, in current science lesson curriculum, process of argumentation and argument as a product of this process are mentioned. In this sense, updated science lesson curriculum necessitates involving students in the argumentation process and creating a suitable environment for students' argument generation. The immense contribution of argument generation to students' learning is quite evident in the literature (Kind, Kind, Hofstein & Wilson, 2011). However, teachers insist on teaching in a traditional way by using instruction strategies in their classrooms. In such learning environments, students are regarded as blank blackboards to be filled with information and they receive information directly from the teacher, the books or other sources without questioning (Macbeth, 2003). Whereas, if students question the information presented to them defend their ideas, share ideas with their peers, and actively join discussions to form their arguments, they can improve their scientific knowledge and increase their conceptual learning (Cross, Taasoobshirazi, Hendricks, & Hickey, 2008; Duschl & Osborne, 2002; Niaz, Aguilera, Maza & Lienda, 2002). To ensure that students understand terms like argument, claim, evidence, and justification and the nature of argumentation by taking part in scientific discussions, it is crucial to construct learning environments in which argumentation is implemented (Osborne, Erduran & Simon, 2004b).

The literature highlights that argumentation makes many contributions to science teaching. On a related note, researchers underlined that argumentation is crucial in certain ways. First, argumentation elevates the chance of new knowledge to be permanent and conceptual comprehension to develop through interpreting the connections between old and new knowledge (Bell & Linn, 2000; Cooper & Oliver-Hoyo, 2016; Cross, Taasoobshirazi, Hendricks & Hickey, 2008; Duschl & Osborne, 2002; Jimenez-Aleixandre & Pereiro-Munoz, 2002; Venville & Dawson, 2010). Second, in teaching through argumentation, students use evidence to support their claims and acquire scientists' argumentative applications by evaluating emerging claims (Bell & Linn, 2000; Çetin, Erduran, & Kaya, 2010; Nussbaum & Bendixen, 2003; Simon, Richardson, Howell-Richardson, Christodoulou, & Osborne, 2009; Sandoval & Millwood, 2005; 2008). Last but not least, discussions that students participate in during obtaining scientific knowledge in a lab or during activities to solve scientific problems can develop their research skills (Katchevich, Hofstein & Mamlok Naaman, 2013; Kind, Kind, Hofstein & Wilson, 2011; Walker, Sampson, & Zimmerman, 2011). In the research conducted on argumentation in teacher training, it was noted that teachers need to be instructed towards argumentation as they apparently lack sufficient experience to teach science through research in their classrooms (Erduran, Ardaç, & Yakmacı-Güzel, 2006; Martin & Hand, 2009; Newton, Driver & Osborne, 1999; Simon & Johnson, 2008; Simon, Erduran & Osborne, 2006).

In addition to these, there are studies that focused on the perceptions (Kaya, Erduran & Çetin, 2010), experiences (Bell & Linn, 2000; Driver, Newton & Osborne, 2000; Garcia-Mila & Andersen, 2008; Jimenez-Aleixandre, Rodriguez & Duschl, 2000; Kuhn, Black, Keselman & Kaplan, 2000; Sandoval, 2003; Sandoval & Millwood, 2005), views of students, teachers, and pre-service teachers (Aktamış & Atmaca, 2016; Hiğde & Aktamış, 2017; Namdar & Tuskan, 2018) regarding argumentation. Hiğde and Aktamış (2017) reported that thanks to argumentation, pre-service teachers could express their ideas, ensuring permanent and effective

learning and encouraging them to do research and inquiries in spite of time constraints. In another study, they found that pre-service teachers regarded argumentation as a technique which centralizes students and promotes a respectful environment, yet they put forward some disadvantages such as the requirement of a more thorough preparation compared to other techniques and difficulties with implementation (Aktamış & Atmaca, 2016). Similarly, according to Yıldırır and Nakiboğlu (2013), students learn discussion by questioning scientific information during classes in which argumentation is implemented; however, they had problems with the implementation process due to reasons such as catching up with the plans, crowded classrooms, time constraints, and insufficient knowledge of students. Namdar and Tuskan (2018) stated that science teachers favored argumentation in science classes due to its motivational values, yet they thought that classroom management in such environment could be hard. Therefore, to support the use of argumentation in science classes, subjects within the boundaries of social sciences should be used.

Considering students' experiences in the process, Driver, Newton and Osborne (2000) noted that they fail to generate strong arguments because they do not have diverse perspectives on the subject and to propose effective counter arguments and rebuttals. Sandoval (2003), Sandoval and Millwood (2005), Bell and Linn (2000) and Garcia-Mila and Andersen (2008) revealed that students merely explain their own ideas, and fail to identify the relationship between proposal and data, to propose sufficient justification, and to consider alternative views so as to help disproving with basic claims and generating counter arguments. Jimenez-Aleixandre, Rodriguez and Duschl (2000) and Erduran (2008) proposed that majority of the proposals made by students were uncorrelated with other argument constituents in the discussion and that students attempted to defend their theses only when they were challenged. Regarding students' perceptions of argumentation, Kaya, Erduran and Çetin (2010) detected that students perceived argumentation under seven categories as follows: knowledge, application, comprehension, nature of science, student and teacher actions, classroom management, and argumentation is not important/ applicable. In the research, students perceived argumentation as a method with which credible information is obtained, discussions are made, classes are made enjoyable, and ideas are proven.

When the literature is reviewed, it can be deduced that there has been a number of studies on investigating the views and experiences concerning argumentation as well as the ones focusing on its contributions to teaching as a result of implementing it in science lessons. However, no studies have been found on students' cognitive structures regarding argument and related concepts, nor on the changes in students' cognitive structures after the implementation of argumentation in lessons. In this sense, it is evident that a study that investigates students' cognitive structures about argument and related concepts will make notable contributions to the literature. Thus, the research aims to determine the state of secondary school students' cognitive structures about argument and related concepts and the way their cognitive structures might change after the lessons where argumentations is implemented. In the light of these goals, questions presented below were sought answers:

i. Which structures do the students have about the arguments and related concepts in their cognitive structures?
ii. Do changes occur in the students' cognitive structures regarding argument and related concepts following the instruction? If so, what kinds of changes occur?

Method

Model of Research

The research investigating the states of cognitive structures of secondary school students regarding argument and related concepts and the extent of change in their cognitive structures after implementing argumentation in science lessons used one group pre-test post-test research design (Creswell, 2009). This design facilitates the comparison of students' cognitive structures, before and after a sequence of lessons on science, using argumentation.

Participants

In the research, 6^{th}, 7^{th}, and 8^{th} grade students from a secondary school located in the western part of Turkey. 25 students from the 6^{th}, 27 students from the 7^{th}, and 28 students from the 8^{th} grades, making up to 80 students in total were included in the study. Out of all sampling methods used to determine the grades to be included in the study, criterion sampling method was made use of. In fulfilling the sampling, certain criteria were taken into consideration as follows: argumentation has not been used before, class teacher and students volunteer for the study, students have a class culture enabling them to express their opinions freely.

Data Collection

A word association test was used to identify students' cognitive structures regarding argument and related concepts and to determine to what extent their cognitive structures changed after attending classes where argumentation had been implemented. To serve these purposes, WAT can look into students' prior knowledge as a pre-test administrated in the beginning of the process. Following the wrap-up of the process, a post-test can be used to detect changes in cognitive structures by making comparisons (Bahar, Nartgün, Durmuş & Bıçak, 2006). That is why, as the data collection tool, WAT was used both prior to and after the science lessons during which argumentation was implemented. In the pre-implementation process, *school* stimulus word was given to students to ensure that students comprehend WAT and the procedure. Following this, the stimulus word *book* was provided for students and their responses to WAT were examined to make sure they made sufficient repetitions to comprehend the procedure. Subsequently, the actual treatment process was put into motion.

Toulmin (1958) developed the Toulmin Argumentation Pattern (TAP) to help educators define the components and complexity of student arguments, particularly for science educators. Therefore, in the selection of the stimulus words presented in WAT, the argumentation process and TAP were considered (Toulmin, 1958). Six stimulus words as being *argument, claim, evidence, reason, discussion*, and *rebuttal* were chosen in this study. Due to the students' young age, the concept *reason* was chosen to replace the concepts *warrant* and *backing.* Besides, as students participate in scientific discussions based on evidence during the argumentation process, *discussion* concept was included in WAT. To provide the content validity of the WAT, an lecturer who teaching argumentation in science courses at master's level and two scholars who had used argumentation-oriented teaching approach in their classes were consulted and certified the suitability of stimulus words for this study. The students were provided with a booklet, each page of which contained one of the six stimulus concepts. The students were asked to write as many terms associated with the stimulus words as they could and to write sentence including each one of the stimulus words and their response words. Students were given separate 80 seconds for each stimulus word writing and sentence writing.

Treatment

The treatment process conducted by the researcher was carried out in three weeks. This study aims to determine students' cognitive structures regarding argument and related concepts and to investigate to what extent their cognitive structures have changed after implementation of argumentation-oriented approach. The objective is to enable students to experience argumentation process and know argument by attributing meaning to it. Students find it hard to participate in discussions and generate arguments when they lack sufficient prior knowledge about the subject (McKneill, Lizotte, Krajcik & Marx, 2006). Therefore, after interviewing the 6^{th}, 7^{th}, and 8^{th} grade science teachers, subjects where students already had prior knowledge were chosen. In accordance with science teachers' comments, States of Matter and Heat unit for the 6^{th}, Sun System and Beyond for the 7^{th}, and Earthquake and Weather unit for the 8^{th} grades were assigned to include argumentation. The implementations were conducted during each grade's normal time schedules in which they received science class on a regular basis.

Primarily, all grades were introduced the argument concept and qualities of a good argument with the help of various activities. Following the introduction of argument, science lessons based on argumentation-oriented approach were initiated. During argumentation activities, each student was given worksheets and asked to complete the activities individually. Subsequently, they were asked to share their ideas in groups of 4-5 by comparing them. As the result of discussions, through a selected spokesperson, each group presented their argument. During the presentations, teacher, in a guide role, encouraged students to generate counter arguments to question the ideas. At the end of the lesson, reviewing the generated arguments, a general classroom discussion was held to figure out how to generate accurate and strong arguments.

In lessons held for 6^{th} grades, a concept cartoon in which two different theories about heat insulation developed by Osborne, Erduran and Simon (2004a) were presented was used as the first activity. Students were asked to defend a claim about a theory they deemed to be true by including evidence statements. As for the second activity, students were provided with a concept map in which concepts about energy sources and fuels and their relations were presented. Students were asked to discuss if relations and concepts were scientifically true and to present their arguments regarding their choices. For the third activity, Producing Energy task in which students evaluated advantages and disadvantages of various energy sources developed by Osborne, Erduran and Simon (2004a) and defended their arguments. In the first activity of 7^{th} grade classroom, which included competing theories-ideas-evidence strategy, students were presented two different theories about meteor and star. For this,

evidence statements that respectively support one theory, other theory, both theories, and none of the theories were provided, and students were accordingly asked to evaluate each evidence statement to defend their claims. During the second activity that involved the concept map, students were given a concept map on which unit-related concepts and connections were available, and they were asked to discuss if those connections and concepts were scientifically correct by generating arguments to support their choices. The third activity in which the concept cartoon was used proposed three different claims concerning celestial bodies. Hence, students were asked to decide on which claim must be true, and then support their claims by data and justifications. Moreover, the last activity in which statements table was used eight different claims about celestial bodies within the solar system were presented in tabulated form. Students were asked to write if those statements were true, the reason why they thought that way, and evidences to support their thoughts. In the first activity of 8^{th} grade classroom, five statements about concepts related to earthquake in the form of statements table were given to students, and they were asked to make inquiries considering the correctness of these statements and to write down their arguments with evidence to support them. In the second activity, two theories as competing theories-cartoon with regards to the intensity and magnitude of earthquakes were provided. Students were asked to explain why they believed to a certain theory with discussions. In the last activity, the activity developed by Osborne, Erduran and Simon (2004a) for data interpretation and analysis was used for earthquake, aftershock, and foreshock concepts. This activity required students to interpret graphs of different earthquakes with discussions and to generate arguments in accordance with their claims.

Data Analysis

In data analysis, all answer sheets handed out as pre-test and post-test were numbered from 1 to 80 separately. The data gathered through WAT were analyzed descriptively. One of the methods used in data analysis was to determine the number of response words generated by participants. The number of response words to a concept is a direct indication of the "meaningfulness of the stimulus concept" and a word without associations has no meaning (Bahar, Johnstone & Sutcliffe, 1999). The WAT data analysis was performed based on the response frequency map method (Nakiboğlu, 2008). In this method, to obtain the concept maps from WAT analysis is drawn a map by using frequencies. In this case, a frequency table including stimulus and response words was formed and a cognitive map obtained according to the frequency values. On the map, the direction of the arrows and strength of associations are established by using the frequency tables. According to Nakiboğlu (2008), this method has power of the detection of strongly and weakly related concepts within a conceptional organization. In this study, firstly a content analysis was conducted to form the frequency table. A frequency table was constructed by counting the response words for each stimulus words. The stimulus words in the first row, the pretest and posttest in the second row, and the response words in the first column were placed in the frequency table. Taking into account the data presented in the frequency table, the students' cognitive structure maps were constructed prior to and after the science classes in which argumentation-oriented approach was used. For this, the highest frequency interval was initially established, which corresponded to $60 \leq f$ for pre and post-test. The lowest frequency level was set as $10 \leq f \leq 19$ for pre-test and $40 \leq f \leq 49$ for post-test, because all the stimulus words appeared in the maps at these frequency levels (Nakiboğlu, 2008). In the construction of the maps, while the stimulus words were placed in a frame, the response words were placed without frame. According to the frequency ranges created, arrows were drawn from the stimulus words to the response words. The width of the frames and arrows is regulated with the frequency value of the response word to the stimulus word. The thickness of the lines (both frame and arrow) shows the strength of the associations (Nakiboğlu, 2008). The thickest arrows show the highest frequency values and these words to be placed in the first cell. In this way, the direction of the arrows shows the direction of relations. According to Nakiboğlu (2008), these maps have potential to demonstrate both the power and the direction of associations, and to interpret the relationships between concepts in the students' cognitive structures.

To fortify the validity of research findings, certain points were taken into consideration such as consistent and significant findings, interpretations, assumptions, and evaluations based on findings, and a comfortable time period to conduct study without difficulties. To obtain intracoder agreement of the analysis, the analyses were made twice in a six-month interval and both analyses were compared by researcher. In order to compare the analysis, the criterion the counting of the total of different response words was used. Following Miles and Huberman (1994), the consensus between the analyses was higher than 90% for the pre-WAT and post-WAT (pre-WAT: argument 95%, claim 94%, evidence 94%, reason 95%, discussion 95% and rebuttal 96%; post-WAT: argument 95%, claim 95%, evidence 94%, reason 95%, discussion 95% and rebuttal 94%).

Sentences in the second section of the WAT were examined to reveal how students attribute meaning to the words they generated. For the analysis of the sentences about stimulus words, a suitable coding was designed

based on the coding system developed by Ercan, Taşdere and Ercan (2010) was used and a categorization was made. Sentences were categorized as follows: *definition related to stimulus word (DRSW), definition unrelated to stimulus word (DUSW), traditional definition related to stimulus word (TDRSW), sentence including superficial knowledge related to stimulus word (SSKRSW), sentence including superficial knowledge unrelated to stimulus word (SSKUSW),* and *meaningless (M).* In the analysis of sentences, certain criteria were taken into consideration. These were; relationship of students' sentences generated in response to stimulus word with the abovementioned stimulus word, whether they had the language of argument, and whether they were used accurately.

Sentences in the category *DRSW* are the ones students defined accurately in relation with argument language. For instance, a student's remark "argument is the sentences we generate to defend our ideas and to disprove opposing ideas with evidence and justifications" with regards to *argument* stimulus word was included within this group. Sentences categorized as *DUSW* are the ones that are not related to the concept's actual definition and generated with its wrong meaning without depending on argument language. For instance, sentences with regards to *argument* stimulus word like "argument is to run a word query in a designated time" or "argument is to translate words" are all categorized under this group. In addition, sentences in the category of *TDRSW* are true definitions that are based on students' prior knowledge and past experiences without being tied to argument language. For instance, a response related to *discussion* stimulus word like "discussion is an argument caused by disagreement. It is a yelling as a result of an incoordination" is included under this category.

Students' sentences that are bound by argument language and that are related to their past traditions and experiences in true meaning were included under the *SSKRSW* category. For instance, regarding *rebuttal* stimulus word, a response sentence like "Those who thought it was called the impact of the earthquake disproved the idea of those who thought it should be the magnitude of the earthquake with a string argument" was included under this group. In the *category SSKUSW,* sentences that are not bound by argument language and that are related to their past traditions and experiences in false meaning were inserted. For instance, with regards to *rebuttal* stimulus word, sentences such as "Knowledge of my friend's father decreased and he was no longer able to think due to his old age" and "His bad thoughts rummaged my ideas" were categorized under this group. In the category of *meaningless* sentences, there are sentences that are not relevant, carrying no meaning related to stimulus words whatsoever. In example, considering *claim* stimulus word, sentences such as "My mother took out the garbage" and "We will go out tomorrow" were placed under this group. To obtain intracoder agreement of the sentence analysis, the analyses were made twice in a six-month interval and both analyses were compared by author. As the consensus between the analyses was % 85, the analysis was considered as reliable (Miles & Huberman, 1994).

Results

Findings Related to Analysis of Stimulus Words in Pre-WAT and Post-WAT

This section primarily presents frequency and percentage tables, interpretations, and concept maps of response words that were associated with stimulus words within pre-WAT and post-WAT. Table 1 shows the number of response words generated as a response to stimulus words. Considering pre-WAT, students who participated in the study associated six stimulus words with 2803 response words whereas regarding post-WAT, they associated them with 3026 response words. When Table 1 is examined, the most associated stimulus word was evidence (f=554) whereas the least associated stimulus word with response words was argument (f=391) in pre-WAT. Considering post-WAT, on the other hand, the most frequently associated stimulus word was argument (f=592) while the least associated was rebuttal (f=452). Table 2 presents the information about mean scores of response words in pre-WAT and post-WAT distributed around each student and the rate of their change.

Table 1. Frequency Table of Response Words Related to Stimulus Words

Stimulus word	Pre-WAT		Post-WAT	
	Frequency (f)	Percent (%)	Frequency (f)	Percent (%)
Argument	391	13.95	592	19.56
Claim	515	18.37	495	16.36
Evidence	554	19.77	489	16.16
Reason	437	15.59	459	15.17
Discussion	498	17.77	539	17.81
Rebuttal	408	14.56	452	14.94
Total	2803	100	3026	100

Table 2. Average Number of Words per Student Regarding Response Words Associated with Stimulus Words

Stimulus word	Pre-WAT	Post-WAT	Change (%)
	Frequency (f)	Frequency(f)	
Argument	4.89	7.40	+51.3
Claim	6.44	6.19	-3.88
Evidence	6.93	6.11	-11.8
Reason	5.46	5.74	+5.13
Discussion	6.23	6.74	+8.19
Rebuttal	5.10	5.65	+10.8
Total	35.05	37.83	+7.93

When Table 2 is examined, it can be deduced that there was changes in the average number of words associated with stimulus words. Considering these changes, number of words associated with argument stimulus word showed an increase of 51.3% while the number of words associated with stimulus words of reason, discussion, and rebuttal indicated increases of 5.13%, 8.19%, and 10.8% in a respective order. On the other hand, the number of words associated with claim hinted a decrease of 3.88% whereas words associated with evidence showed an 11.8% decrease in number. The reason for this situation may be that students write fewer response words (such as win and clue) related to daily life for claim and evidence stimulus words in the post-WAT. Due to the large population of students participating in the study, a great number of words were generated. The words that were not considered related, that were not related to the other words, and that were repeated 1 times were not taken into consideration during the data analysis. Table 3 below displays the analysis findings of pre-WAT.

Table 3. Frequency Table of Response Words Generated in Response to Stimulus Words (Pre-WAT)

Stimulus Word	Response Words (f)	Total (f)
Argument	Knowledge (15), Learning (12), Lesson (9), Writing (8), Teacher (6), Evidence (5), Student (5), School (5), Teaching (3), Science (2), Education (2).	72
Claim	Money (36), Game (26), The lottery (26), Win (27), Lose (22), Horse race (22), Betting (20), Football (13), Race (13), Rivalry (12), Coupon (11), Gamble (9), Thought (8), Illicit money (7), Chance (6), Guess (5), Award (5), Ambition (4), Play (4), Ambition (4), Promise (2), Comparison (2), Discussion (2), Be sure (2).	288
Evidence	Police (29), Proof (29), Crime (22), Finger print (17), Dedective (16), Guilty (15), Proving (14), Homicide (14), Validation (13), Courtroom (12), Clue (11), Series(10), Weapon (9), Blood (8), Corpse (7), Magnifying glass (7), Scene (6), Search (6), Prison (6), Thief (6), Crime scene investigation (6), Movie (5), Investigation (5), Determination (5), Finalized (4), Camera record (4), Fear (4), Witness (4), Trace (4), Killer (4), Case(4), Judge (3), Lawyer (3), Justification (3), Knowledge (3), Knife (3), Autopsy (3), Punishment (2), Reality(2), Document(2).	330
Reason	Result (69), Cause (59), Objective (24), Scene (18), Question (10), Lesson (9), Idea (9), Excuse (9), Justification (7), Problem (6), Sentence (6), Fight (5), Answer (5), Teacher (4), How (3), Argument (3), Questioning (3), Explain (2), Evidence (2).	253
Discussion	Fight (84), Dialogue (18), Scene (16), Reason (12), Yelling (10), Idea (9), Disagree (9), Sadness (9), Bickering (8), Loudness (8), Snub (8), Heart-break (7), Quarrel (6), Conversation (6), Comparison (5), 2 or more people (5), Be angry (4), Informing (4), Angry (4), Human (4), Argument (3), Result (3), Punishment(2), Politics(2), Evidence (2), Explain (2), Be against (2), Claim (2).	254
Rebuttal	Thought (18), Destroying the accuracy of idea (17), Discussion (15), Lack of idea (11), Idea (10), New idea (9), Ignorance (8), Disagree (7), Bad idea (6), Wrong (7), Friend (4), Evidence (4), to not understand (4), Claim (3), Argument (3), Reason (3), Lose (3), Disrespect (3), Result (2), Knowledge (2), Mind (2), Scientist (2), Disregard (2), Better idea (2), Respect (2), Agree (2).	151

According to pre-WAT response words generated by students (Table 3), argument concept was most frequently associated with knowledge (15) whereas money was attributed to claim concept (36). In addition, evidence concept was associated with police (29) and proof (29), reason concept with result (69), discussion concept with fight (84), and rebuttal concept was most frequently associated with thought (18). In Figure 1 below, the concept map drawn for stimulus words in pre-WAT and associated words, and explanations regarding this map are presented.

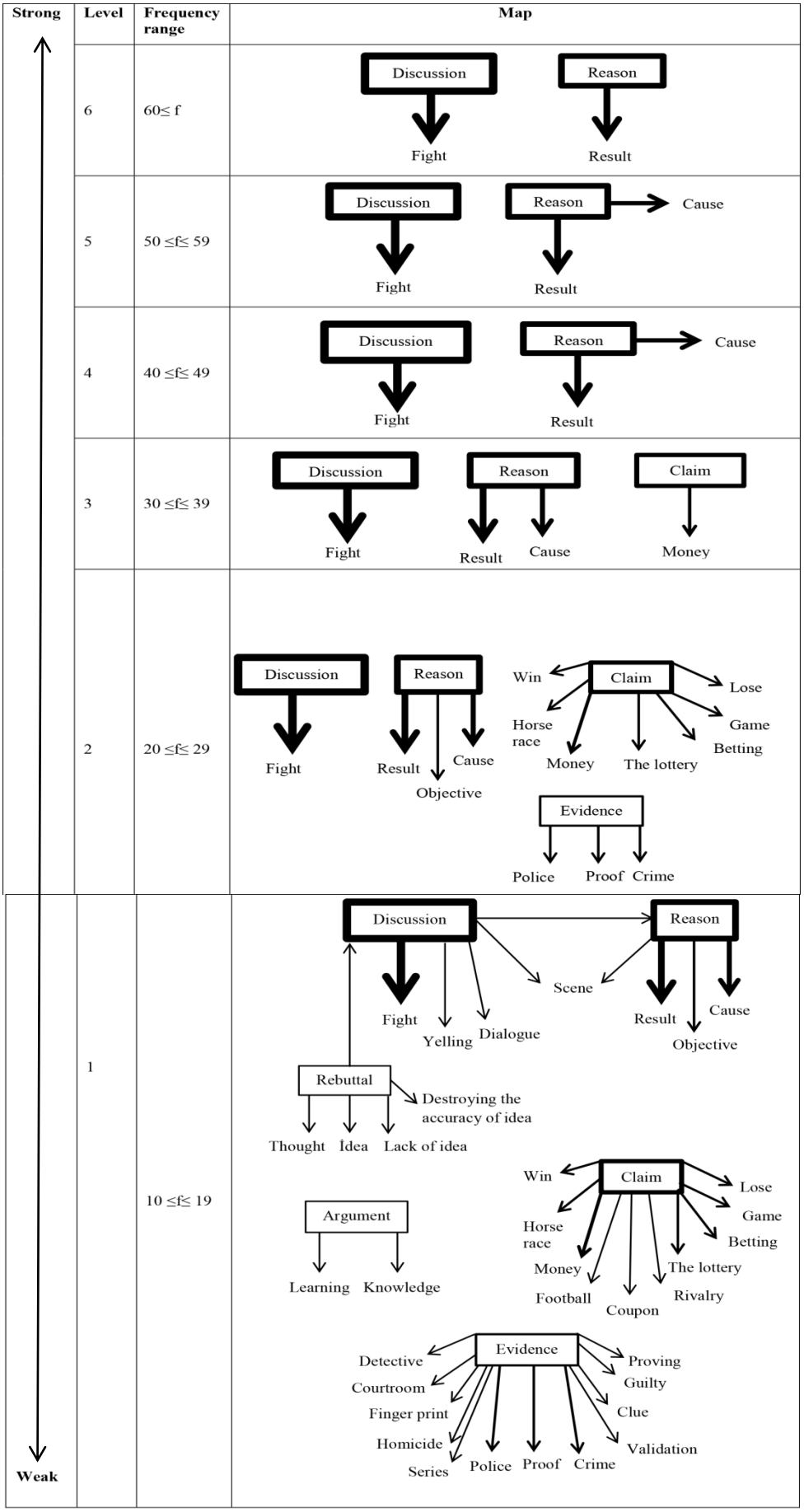

Figure 1. Concept Map Regarding Stimulus Words in Pre-WAT and Associated Words

In Figure 1, which refers to the students' cognitive structures at pre-WAT, there are six association levels. At the strongest association level of students' cognitive structures, in the 60≤f frequency range (Level 6), only discussion and reason stimulus words appear and there two separate islands. "Discussion" is associated with "fight" response word and "reason" is associated with "result" response word. The strongest association is between the stimulus word "discussion" and the response word "fight". At level 5 (50≤f≤59), the stimulus word "reason" is also associated with "cause". At level 4 (40≤f≤49), there is no change the stimulus and response words. At level 3 (30≤f≤39), "claim" stimulus word is added to these concepts, and students most frequently associated claim stimulus word with "money". There are three separate islands and there is no direct association between stimulus concepts. At level 2 (20≤f≤29), "evidence" stimulus word emerged, which was associated with "police", "proof" and "crime" and 4 out of 6 stimulus words surfaced on this level. At this level, it is revealed that students associated "reason" stimulus word with "objective", claim with "win", "lose", "game", "betting", "the lottery" and "horse-race" words. It is evident that the students associate the concept of claim with a game in which the results of football games in domestic and foreign leagues are predicted. In the frequency range 10≤f≤19 (Level 1), all stimulus words appear on the map, "rebuttal" and "argument" stimulus words emerged. Four separate islands occur at this level and students only related discussion stimulus word with reason and rebuttal stimulus words. "Discussion" and "reason" stimulus words are commonly associated with "scene" word. For the rebuttal stimulus word at this level, "lack of idea", "idea", "thought" and "destroying the accuracy of idea" words are added, and "detective", "guilty", "series", "finger print", "clue", "courtroom", "homicide", "proving", "validation" words are added to the stimulus word of evidence whereas "coupon", "rivalry", and "football" words are added for the claim stimulus word. Argument stimulus word emerging on the level 1 for the first time is associated with "knowledge" and "learning" words. Table 4 below displays the analysis findings of post-WAT.

Table 4. Frequency Table of Response Words Generated in Response to Stimulus Words (Post-WAT)

Stimulus Word	Response Words (f)	Total (f)
Argument	Rebuttal (62), Evidence (57), Claim (52), Discussion (46), Supporting the idea (43), Data (34), Idea (25), Qualifier (22), Justification (17), Statement (10), Knowledge (8), Result (8), Because (8), Defending ideas (8), Reason (7), Topic (7), Opinion (5), Explanation (5), Proof (5), Advantage (4), Proving (4), Thinking (4), Dialogue (4), Persuade (3), Argumentation (3), Learning (3), Group (2), Brainstorming (2), Competition(2), Objective (2).	462
Claim	Idea (51), Evidence (27), Data (23), Discussion (23), Argument (19), Rebuttal (19), Thought (18), Supporting the idea (12), Justification (10), Reason (9), Topic (8), Result (8), Money (8), Certainty (7), Win (7), Hypothesis (6), Qualifier (6), Gambling (6), Defending ideas (5), Lotto (5), Argumentation (4), Horse race (4), Lose(4), Competition(3), Thinking(3), Proving(2), Knowledge (2), Freedom of opinion (2).	301
Evidence	Proof (28), Claim (24), Supporting the idea (23), Argument (22), Data (21), Rebuttal (20), Proving (17), Idea (12), Finding (11), Crime (11), Homicide (11), Justification (10), Police (10), Numerical data (9), Scene (9), Research (8), Result (8), Detective (7), Discussion (5), Thought (5), Providing facts (5), Certainty (4), Real (4), Objective (4), Finger print (4), Courtroom (4), Magnifying glass (4), Argumentation (3), Reason (2), Right (2), Wrong (2), Defending ideas (2), Security camera (2).	313
Reason	Result (71), Cause (52), Justification (28), Evidence (19), Claim (17), Purpose (17), Discussion (16), Argument (15), Event (14), Idea (13), Because (12), Data (11), Turkish lesson (10), Rebuttal (8), Sentence (7), Supporting the idea (7), Thought (5), Argumentation (3), Research (2), Thinking(2), Mind(2), Query(2).	333
Discussion	Rebuttal (40), Fight (34), Idea (34), Evidence (30), Argument (25), Claim (23), Dialogue (19), Reason (18), Event (14), Issue (12), Result (11), Supporting the idea (9), Idea exchange (9), Justification (7), Win (6), Thought (5), Disputes (5), Heart-break (5), Persuade (4), Defending ideas (4), Rivalry (4), Sadness (4), Yell (4), People (4), Group (3), Teacher (3), Explanation (2), Thinking (2), Purpose (2), Freedom of opinion (2), To be right (2).	356
Rebuttal	Discussion (39), Evidence (36), Argument (31), Claim (29), Idea (28), Reason (21), Disproving the wrong idea (14), Counter idea (13), Supporting the idea (13), Better idea (12), Result (10), Justification (9), Thought (9), Dialogue (6), Justify (5), Defending ideas (4), Thinking (4), Explanation (4), Argumentation (3), Sharing idea (2), Knowledge (2), Correct (2), Comparison(2).	299

According to post-WAT words produced by students (Table 4), argument concept was most frequently associated with rebuttal (62) whereas idea was attributed to claim concept (51). Furthermore, evidence concept was associated with proof (28), reason concept with result (71), discussion concept with rebuttal (40), and rebuttal concept was most frequently associated with the word of discussion (39). In Figure 2 below, the concept map drawn for stimulus words in post-WAT and associated words, and explanations regarding this map are presented.

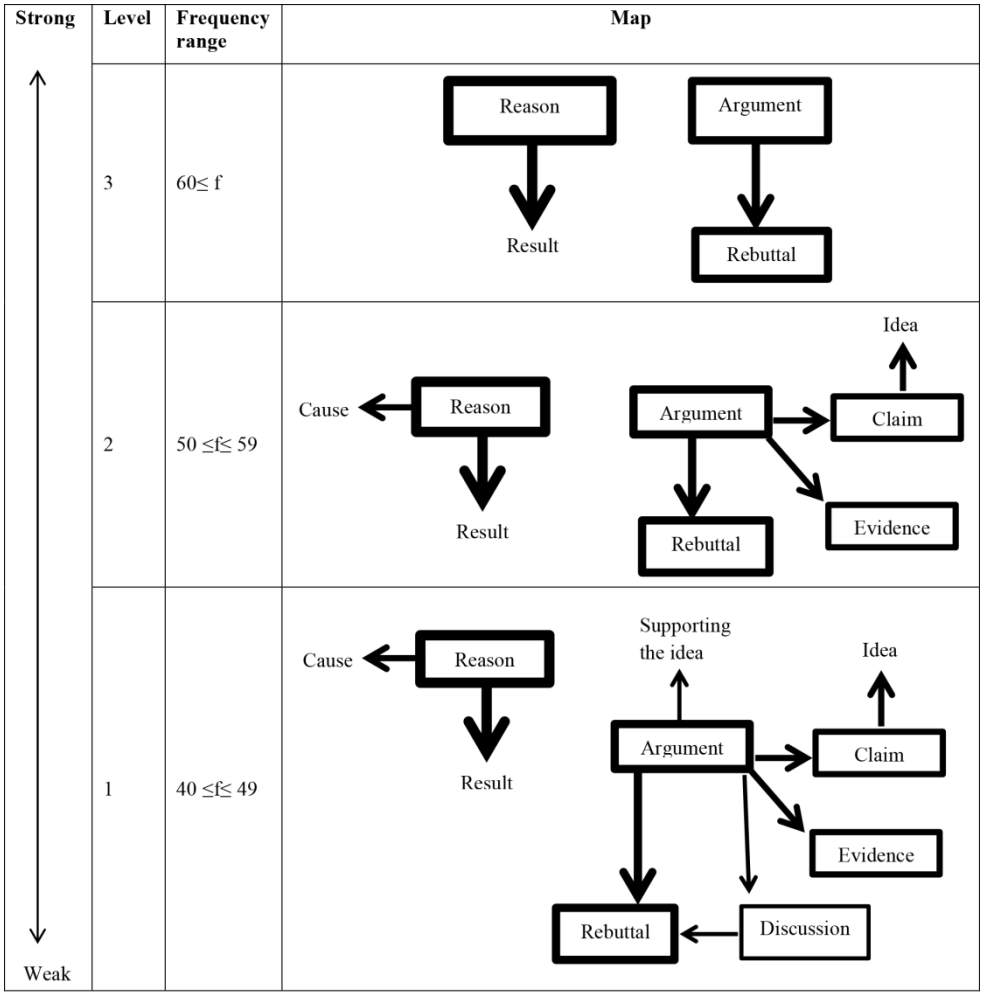

Figure 2. Concept Map Regarding Stimulus Words in Post-WAT and Associated Words

The cognitive structures of the students in the post-WAT are presented in Figure 2, it is clear that, when compared to the ones in the pre-WAT, and more stimulus words are connected. In Figure 2, there are three association levels and each of them is characterized by the presence of two isolated island. At the strongest association level of students' cognitive structures, in the 60≤f frequency range (Level 3), argument and reason stimulus words appear and there two separate islands. "Argument" is associated with "rebuttal" stimulus word and "reason" is associated with "result" response word. When pre-WAT and post-WAT is compared, it is very important that the students associate the concept of argument with rebuttal. The strongest association is between the stimulus word "reason" and the response word "result". At level 2 (50≤f≤59), the stimulus word "reason" is also associated with "cause" and the stimulus word "claim" is associated with "idea". In addition to pre-existing associations, on the level 2, it is detected that students associated "argument" with "claim" and "rebuttal" stimulus word.

Following the examination of concept map in Figure 2, it is revealed that all stimulus words emerged on the level 1 (40≤f≤49), and argument stimulus word was associated with evidence, claim, discussion, and rebuttal stimulus words. There are two separate islands and there is direct association among stimulus words except reason. It is observed that the students associated "argument" stimulus word with "supporting the idea" and "claim" stimulus word with "idea" in their cognitive structures. Besides, it is revealed that the students associated "discussion" stimulus word with "rebuttal" stimulus word.

Sentence Analysis Findings Regarding Stimulus Words Appearing in Pre-WAT and Post-WAT

This section provides insight about the findings based on the analysis of response sentences written for stimulus words that were included in pre-WAT and post-WAT. Table 5 presents the sentential analysis findings regarding stimulus words appearing in pre-WAT. After the thorough examination of sentences taking place in the pre-test, 18 students left argument stimulus word blank, and the number of unresponsive students was 6 for claim, 5 for evidence, 7 for reason, 1 for discussion, and 7 for rebuttal stimulus word. Moreover, it was noticed that 10 students responded as "I do not know" only for the stimulus word of argument.

Table 5. Frequency Table of Sentences Related to Stimulus Words (Pre-WAT)

Stimulus words	DRSW	DUSW	TDRSW	SSKRSW	SSKUSW	M	Total
Argument	7	12	-	3	12	**18**	52
Claim	4	**24**	-	21	21	4	74
Evidence	3	-	12	25	**33**	2	75
Reason	16	-	-	**55**	-	2	73
Discussion	7	-	9	11	**52**	-	79
Rebuttal	11	13	-	20	**29**	-	73
Total	48	49	21	135	**147**	26	426

Sentences generated by other students in response to stimulus words were categorized as seen in Table 5. Students produced 426 sentences for stimulus words in total. Considering Table 5 in terms of stimulus words, the highest number of unrelated sentences was written for argument concept; sentences including unrelated definition were written for claim concept; sentences including superficial knowledge were written for reason concept; and sentences including unrelated superficial knowledge were written for concepts of evidence, discussion and rebuttal.

Table 6 portrays findings of the sentential analysis regarding the stimulus concepts appearing in post-WAT. Considering the sentences in the test, it was observed that 3 students left argument stimulus word without an answer, and claim stimulus word was left blank by 4 students. Additionally, evidence, reason, and discussion stimulus words were each left blank by 4 students while rebuttal stimulus word was left unanswered by 5 students. Sentences generated by the remaining students were grouped as presented in Table 6.

Table 6. Frequency Table of Sentences Related to Stimulus Words (Post-WAT)

Stimulus words	DRSW	DUSW	TDRSW	SSKRSW	SSKUSW	M	Total
Argument	30	4	-	***40***	-	3	77
Claim	26	-	-	***38***	9	3	76
Evidence	21	-	-	***27***	25	3	76
Reason	11	-	3	***62***	-	-	76
Discussion	27	-	7	***29***	10	3	76
Rebuttal	27	2	-	***45***	-	1	75
Total	142	6	10	***241***	44	13	456

As can be noticed in Table 6, students produced 456 sentences about stimulus words in total. Majority of these sentences were the sentences including superficial knowledge related to stimulus words (f=241; 53%), the second most produced sentences were the definitions related to stimulus words (f=142; 31%). Table 6 revealed that students wrote sentences including superficial knowledge and definitions about stimulus words of argument, claim, reason, discussion, and rebuttal and that definitions and sentences including both related and unrelated superficial knowledge were close to one another in number in terms of the stimulus word of evidence. When Table 5 and Table 6 are to be compared and contrasted, it is evident that students' definitions of stimulus words and sentences including superficial knowledge showed an increase.

Comparison between Table 7 and Table 8 revealed that students produced sentences including accurate definitions and superficial knowledge in accordance with the language of argumentation with regards to stimulus words. For instance, in pre-WAT, students generated meaningless sentences for argument stimulus words whereas they wrote sentences and definitions including superficial knowledge for the concepts in post-WAT. Moreover, while they defined argument as translation from English to Turkish or as a historical document in pre-WAT, they accurately defined argument in post-WAT. Considering the sentences related to

claim, it was evidenced that students produced sentences associating claim with games of chance and winning money in pre-WAT, but in the pre-test, they comprehended it as the supported idea and wrote sentences accordingly. Similar dynamics were in effect for evidence stimulus word; in that, students wrote down evidence-related sentences in the context of TV crime series and news they see on television in pre-WAT as they tied the concept with them.

However, as presented in Table 8, students thought evidence to be the data that are used to support the ideas in the post-WAT, producing sentences in accordance with that. Reason stimulus word is a word with which students are familiar in both their daily lives and Turkish lessons; that is why, they produced sentences and definitions including superficial knowledge for the concept in pre-test. Considering post-WAT, on the other hand, they produced sentences in accord with language of argument. As evidenced in Table 7, many students regarded discussion as fight as a reflection of their daily experiences, and they formed up sentences including superficial knowledge and traditional definitions regarding the concept. However, even though they generated sentences and definitions regarding discussion with argument language after the science lessons in which argumentation was applied, a small number of participants still used sentences tied to the concept of fight.

Concept of rebuttal was a concept all students were familiar with, and as can be seen in Table 7, they came up with definitions and sentences including superficial knowledge regarding the concept. Besides, it was indicated that some students referred to rebuttal as belittling the opposing person's idea or as lack of ideas. In post-WAT (Table 8), number of sentences including superficial knowledge and definitions regarding the concept elevated while the number of unrelated definitions diminished, and sentences including unrelated superficial knowledge were completely eradicated. Table 7 exhibits exemplary sentences of stimulus words regarding pre-WAT whereas Table 8 displays the sentences with regards to post-WAT.

Table 7. Exemplary Sentences Regarding Stimulus Words (Pre-WAT)

Stimulus word	DRSW	DUSW	TDRSW	SSKRSW	SSKUWS	M
Argument	Informative writing plainly and fluently dependent on cause and effect.	Argument is translating from English to Turkish.	-	Say the arguments about this subject.	Get the arguments off the closet.	Teacher taught concepts such as term, homonym, etc.
Claim	Claims are thoughts that change according to person.	Betting, horserace, and scratching.	-	His claim about this hypothesis is very harsh.	He bet a lot of money to the game.	-
Evidence	Evidence is a proof. It is a certainty used to investigate a situation.	-	It is the process of police finding clues like fingerprint, blood, murder weapon in the body. These clues are evidence.	Scientists proved an important knowledge.	Having caught him red-handed, Sherlock Holmes requested life in prison for the perpetrator before the lawyer and judge.	A child crossing the road was hit by a car.
Reason	In Turkish, there are cause-effect sentences that are used to explain things.	-	-	She was accusing me for no reason.	-	His purpose is to cheat.
Discussion	Discussion brings fight to mind, but it is to propose different ideas and to try to explain them as effectively as possible.	-	Discussion is a fight caused by conflict. It is yelling as a result of a clash.	When my friend and I had disagreement, we talked about it.	After the intense discussion, an incident broke out and fight erupted. One kid got beaten. Having had a black eye, he filed a complaint about the other kid.	-
Rebuttal	Rebuttal is a term we use if we have a way to correct someone's inaccurate idea with proof.	Rebuttal is something about having a blank mind, inability to think and explain.	-	He rebutted his friend' idea by proving their incorrectness.	When my friend proposed a bad idea, everyone asked him why he had a bad idea.	-

Table 8. Exemplary Sentences Regarding Stimulus Words (Post-WAT)

Stimulus word	DRSW	DUSW	TDRSW	SSKRSW	SSKUWS	M
Argument	Argument is a discussion where people use claims, evidence, supporting ideas, and rebuttals about a topic.	Argument is to solve tests on space.	-	I supported the argument with numeric data.	-	It's going to rain today.
Claim	Claim is the idea that we support in argument.	-	-	My friend claimed that Neptune is a colder planet than Uranus.	When we play betting games, we deposit money and we become happy if we win.	I gave my friend chocolate.
Evidence	Data related to the subject to support our idea.	-	-	I obtained evidence by going through researching data and information about earthquake.	In the murder case I was investigating, I caught the criminal.	The man caused a scene.
Reason	To explain why we have the idea and why we think this way.	-	To cause, cause-effect, to be the cause, something that causes something.	The reason why I chose geothermal energy is its efficiency.	-	-
Discussion	-Discussion is brainstorming about a topic with various ideas. -It is a process in which we try to prove our idea by supporting it and disprove the opposing idea.	-	Disagreement, conflict, scene caused in a fight situation. I It is tension, anger and yelling.	They are discussing to disprove their ideas.	Yelling to his child, the father caused a scene starting with argument, then turning into a fight.	The man killed with a gun.
Rebuttal	It is to persuade opposing party by disproving their thoughts with claim, evidence and supporting ideas.	Rebuttal is to eliminate the thoughts.	-	Those who thought it to be earthquake's intensity disproved those who thought it to be the earthquake's magnitude with a strong argument.	-	My friend was swearing at everybody.

Discussion and Conclusion

In the research, it was aimed to determine the state of students' cognitive structures regarding argument and related concepts through WAT and to reveal the nature of change in their cognitive structures regarding these concepts after the implementation of the argumentation-oriented approach in science lessons. Considering this, in response the six stimulus words, pre-WAT included 2803 response words while post-WAT generated 3206 words in total. In a ratio between pre-WAT and post-WAT responses respectively, argument stimulus word generated 391/592 response words, while claim received 515/495, evidence 554/489, reason 437/459, discussion 498/539, and rebuttal 408/452 response word associations. From Table 1, which refers to the number of total response words to each stimulus word, it is evident that this much higher at post-WAT. Besides, the research determined the average number of response words provided for stimulus words per capita in pre-WAT and post-WAT as well as the change rate between the tests. These results indicated that the number of words associated by students with stimulus words of "argument", "reason", "discussion", and "rebuttal" elevated in number while the number of words associated with "claim" and "evidence" stimulus words decreased. Particularly, the number of words generated in response to "argument" stimulus word raised 50%. This result is vital as it shows the change in students' cognitive structures regarding "argument" stimulus word. It is seen that the stimulus words become more meaningful to the students by increasing the number and complexity of connections (Bahar, Johnstone & Sutcliffe, 1999).

The analysis of the maps of the students' cognitive structures in the pre-WAT (Fig. 1) and in the post-WAT (Fig. 2) shows that there were changes in the students' cognitive structures as a result of the instruction. Before the instruction, the students' cognitive structures were characterized by the presence of isolated islands at five frequency levels and there are no direct associations between stimulus words. Only at level 1, students related

"discussion" stimulus word with "reason" and "rebuttal" stimulus words. After the instruction, it can be seen that the map related to post-WAT (Fig.2) resembles a more structured arrangement, with argument, claim, rebuttal, evidence and discussion stimulus words inter-connected. All the stimulus words at pre-WAT only appeared at frequencies ranging from 10 to 19, while all the stimulus words at post-WAT (Fig.2) appeared at frequencies ranging from 40 to 49 and they were all connected except for reason. At level 3 ($60 \leq f$), the strongest level in terms of the association of the students' cognitive structures, the appearance of three out of the six stimulus words, strongly linked, can be seen: the strongest association is between the words ''reason'' and ''result'', followed by the association between ''argument'' and ''rebuttal''. The emergence of the "argument" stimulus word at the strongest level and its association with the "rebuttal" stimulus word is an important result.

When the maps in Figures 1 and 2 are compared, it is seen that there are significant changes in the cognitive structures of the students especially for the stimulus words of "argument", "claim", "evidence", "rebuttal" and "discussion". Before the instruction, it was revealed that students did not know the meaning of "argument", they associated "claim" stimulus word with betting games and "evidence" stimulus word with the police and crime-related phenomena. In addition, it was understood that the students comprehended the "discussion" as a fighting in their cognitive structures. The reason for these outcomes about "claim", "evidence", and "discussion" stimulus words might be a result of the phenomena they see, hear, come across or experience in television and real life.

Other than that, in addition to accurate words provided for rebuttal, it was observed that illogical words such as "lack of idea" and "destroying the accuracy of idea" were produced by some students. It was discovered that students were noticed to have written the same words for reason stimulus word as in "cause" and "result" in both tests. Words that students wrote down for the "reason" can be thought that they produced such words and sentences due to their familiarity with "reason" concept in their daily lives and in Turkish lessons. After the instruction, it was noticed that students associated with accurate words by writing "rebuttal", "evidence", "claim", "discussion", "supporting an idea" for "argument" stimulus word and "idea" for "claim" stimulus word. Similarly, when the qualitative analysis of sentences written by the students in the pre-WAT and the post-WAT are compared, the results showed that the students' understanding of the concepts related to the argument have changed. Following the argumentation-oriented science lessons, it was revealed that students used logical and accurate sentences in response to stimulus words in terms of their sentences in post-WAT. This circumstance indicates that students established considerable and significant associations among stimulus words in their cognitive structures.

Considering the literature, there has not been any studies focusing on how students perceived argument and related concepts except for one study merely (Kaya, Erduran & Çetin, 2010) investigating students' perceptions of argumentation process. In the study, it was explored that students perceived argumentation process as the series of stages in which discussions are made, ideas are proven, permanent learning is ensured, and the lessons become enjoyable. All results obtained in the research point out that after science lessons in which argumentation-oriented approach was implemented, students' cognitive structures regarding argument and related concepts showed remarkable and desirable changes. Argumentation is the discussion of people who apply science itself. Scientists make proposals and provide evidence, discussing them in a community only to re-examine and criticize them. This is the process in which scientific knowledge is constructed. When students deal with arguments, they will gradually understand how knowledge is shaped in science and what the language and norms of a scientific discussion are (Newton, Driver & Osborne, 1999).

To comprehend the way students speak and discuss about science concepts in science lessons and the way scientific knowledge is developed, we initially need to encourage students to learn scientific speech and argument. For students to learn and use argument and related concepts accurately and to establish correct connections among them, the most prominent responsibility falls on the shoulders of teachers. The reason is that students will easily learn the language of argument when teachers use argumentation-oriented approach. Teaching argumentation requires a fundamental change in the pedagogies used in the classrooms (Osborne, Erduran & Simon, 2004b). Therefore, teachers must receive professional supports so as to learn and employ such teaching approaches (Simon, Erduran & Osborne, 2006). When students learn about argument and discussion, they will be able to write and speak the language of science (Jimenez-Aleixandre & Erduran, 2008), become science literates capable of critical thinking (Scholtz, Braund, Hodges, Koopman & Lubben, 2008), and increase their conceptual comprehension (Newton, Driver & Osborne, 1999). Moreover, students who are capable of using argument and related concepts accurately and presenting arguments logically and consistently will be able to integrate with society completely (Dawson & Venville, 2010).

Recommendations

As the conclusion of the research, some recommendations can be provided as follows:

i. Teachers and researchers can benefit from the word association test used in this paper to determine students' cognitive structures regarding aforementioned concepts and to correct misunderstandings related to the issue.

ii. Using the language of argument in science textbooks starting from primary levels will serve as a great step to enable students to comprehend argument and related concepts accurately and to develop cognitive structures. Thus, teachers using such textbooks will have been encouraged to use the language of argument.

iii. This study investigated the changes in 6^{th},7^{th}, and 8^{th} grade students' cognitive structures regarding argument and related concepts by implementing an argumentation-oriented approach in their science lessons. Further research can focus on investigating the effect of scientific and socio-scientific discussions on students' cognitive structures regarding argument and related concepts after implementing argumentation-based lessons in scientific and socio-scientific subject areas. Furthermore, similar studies can be conducted with primary school, high school, and university students to investigate students' cognitive structures regarding argument and related concepts in terms of grade levels.

Limitations of the Present study

It is important to note that the current study was conducted in only 6^{th},7^{th}, and 8^{th} grade. Thus, it would be difficult to generalize the results of this study to other settings, which was the main limitation. In addition, specific stimulus words were used in the word association test. Future researchers might use the stimulus words in the current study or come up with new stimulus words to test the utility of word association test in revealing students' cognitive structure about argument and related concepts in different settings.

Another limitation is related to participants. The current study was conducted in one group pre-test post-test research design. Future researchers might conduct a study by semi-experimental pre-test post-test control group pattern. A qualitative analysis of the sentences written by the students was performed to understand the nature of the relationships that students establish between words, and to suppress the limitation of the WAT presented by Nakiboğlu (2008). However, the analysis of students' cognitive structures might complement with interviews in order to gather in detailed information about cognitive structures.

In spite of the limitations of our current study, it is valuable since it seems to be the first effort to understand students' cognitive structure about argument and related concepts through a word association test. Science teachers may benefit from the outcomes of this study. This point is important because in science classes, students need to learn the language of argument in order to structure and discuss scientific knowledge.

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