European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.1156414 Volume 4 | Issue 1 | 2018

REVEALING STUDENTS' COGNITIVE STRUCTURE ABOUT PHYSICAL AND CHEMICAL CHANGE: USE OF A WORD ASSOCIATION TEST

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Abstract:
The current study aimed at examining the utility of a word association test in revealing students' cognitive structure in a specific chemistry topic through a word association test. The participants were 153 6th graders in a western Turkish city. The results revealed that the word association test serves a useful purpose in exploring the students' cognitive structure with regard to physical and chemical change and identifying their misconceptions about this topic. Some students gave irrelevant responses to stimulus words and seemed to have difficulty with distinguishing between physical and chemical changes. Implications for teacher education were discussed.

Keywords: chemistry education, physical change, chemical change, word association

1. Introduction

Cognitive structure can be defined as patterns of human thinking processes (Kinchin & Hay, 2000). Since learning takes place as a function of complex and continuous interaction among existing structures in students' mind, it is necessary to identify their cognitive structure for effective instruction (Kurt & Ekici, 2013). Cognitive structure is important because it makes learning meaningful, helps establish connections among ideas, retrieve information when necessary (Ceylan, 2015) determines whether new information is meaningful and related to existing information in mind (Ausubel, 1963; as cited in: Joyce & Weil, 2003) assist people in differentiating messages (Davidson, 1977).

Since cognitive structure can be thought as a "black box", it might not be easy to observe it and to understand how students make connection between concepts and

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experience conceptual change (Özatlı, 2006; Kurt & Ekici, 2013). Nevertheless, many methods such as flow maps, word association test, concept maps, structured grid and Vee diagram are available to reveal people's cognitive structures (Ceylan, 2015). Among these, word association tests were one of the oldest and widely used tests (Özatlı & Bahar, 2010) and their effectiveness on learning and revealing existing cognitive structures was well-established (Hovardas & Korfiatis, 2006).

1.1 Word Association Tests in Chemistry Education

Originally proposed by Bahar, Johnstone, & Sutcliffe (1999), these tests have become valuable tools to assess cognitive structure of students and understand whether they make meaningful connections among concept, and thereby have been widely used in science education (Atabek Yiğit & Ceylan, 2015; Bahar, Johnstone & Sutcliffe, 1999; Bilgin, Coşkun, & Aktaş, 2013; Bilgin, Aktaş & Çetin, 2014; Derman & Eilks, 2016; Dikmenli, 2010; Ekici & Kurt, 2014; Ercan, Taşdere & Ercan, 2010; Nakiboğlu, 2008; Özata Yücel & Özkan, 2015; Taştan Kırık & Kaya, 2014; Timur, 2012). Nakiboğlu (2008) indicated that these tests may guide instructional activities in the classroom as they are effective in revealing students' cognitive structure in the beginning of teaching.

The use of word association tests has received considerable attention in the field of chemistry education. For example, in a study conducted with thirty, 14 year-old students in an English comprehensive school (Maskill & Cachapuz, 1989), the stimulus word Equilibrium was found to reveal the interfering concepts such as 'static balance', 'reversing as physical movement' and 'equilibrium when everything is equal' which hindered learning. In another study, 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. Using a sample of 256 students in the age of 14 and 15 in Scotland, Johnstone and Moynihan (1985) found a significant correlation between cognitive structure as measured by word association tests and performance in an achievement test in a chemistry class.

The use of word association tests in chemistry education attracted the interest of many researchers in Turkey. Some researchers (Atabek Yiğit, 2016; Derman & Eilks, 2016; Nakiboğlu, 2017) used word association tests to reveal students' cognitive structure in specific chemistry topics, assess their conceptual understanding and identify misconceptions. Other researchers seemed to focus on whether students had conceptual change as measured by word association tests as a result of using a specific teaching method (Bilgin, Aktas & Çetin , 2014; Bilgin, Çoşkun & Aktaş, 2013) .

Atabek Yiğit (2016) examined cognitive structures about atom, ion, element, compound and molecule and found that pre-service science teachers seemed to grasp the relationship between compound and molecule well but had difficulty with understanding the concept of ion. Derman and Eilks (2016) asked 11th graders to write a sentence regarding a number of chemistry concepts including solvent, soluble, concentration, dissolution, solubility, temperature and pressure concepts and found that students had diverse cognitive structures regarding these concepts including many poorly developed concepts. Nakiboğlu (2017) examined 8th grade students' cognitive structures about energy, reaction equation, chemical property, chemical reaction, physical change, chemical change, matter, physical property and found that students could not associate with the concept of energy with other concepts of the subject.

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.

Although word association tests seemed to have been extensively used in specific chemistry topics and chemistry was taught employing different instructional approaches, the researcher of the current study has determined only one study which examined cognitive structure of secondary school students regarding the topic "physical and chemical change" using word association tests.

1.2 Research on Teaching Physical and Chemical Change

Since the topic of physical and chemical change is taught from elementary school to university, many research studies were conducted on this topic using students at different levels of education. These studies seemed to focus on examining students' level of knowledge and possession of alternative concepts in their mind (Demircioğlu, Özmen & Demircioğlu, 2006; Demircioğlu, Ayas & Kongur, 2012; Gönen & Akgün, 2005; Johnstone, 2000; Mirzalar Kabapınar & Adik, 2005; Kıngır & Geban, 2014; Kibar & Ayas, 2010; Khurshid & Iqbal, 2009; Stavridou & Solomonidou, 1989; Sökmen, Bayram & Yılmaz, 2000; Tsaparlis, 2003; Uluçınar Sağır, Tekin & Karamustafaoğlu, 2012), the degree to which their knowledge and alternative concepts changed as a function of utilizing different instructional approaches (Ardaç & Akaygün, 2004; Atasoy, Genç, Kadayıfçı & Akkuş, 2007; Ayvacı & Şenel Çoruhlu, 2009; Çayan & Karslı, 2014; Kıngır, Geban & Günel, 2013; Kolomuç, Özmen, Metin & Açışlı, 2012) , how these concepts are taught in textbooks (Palmer & Treagust, 1996) and proposing experimental interventions (Ergül, 2014).

Results emerging from experimental studies on this topic revealed that using a specific instructional approach was more effective in enhancing students' understanding of this topic than using a traditional way of teaching. For example, teaching this topic through collaborative learning (Atasoy, Genç, Kadayıfçı & Akkuş, 2007), explanatory story (Ayvacı & Şenel, 2009), science writing heuristic approach (Kıngır, Geban & Günel (2013), problem based learning (Çayan & Karslı, 2014) and 5E learning model (Kolomuç, Özmen, Metin & Açışlı, 2012) were found to be more influential in removing misconceptions than teaching this topic in a traditional way.

Studies with a focus on identifying student knowledge and alternative concepts revealed that students had difficulty explaining physical and chemical change (Adbo & Taber, 2009; Kıngır & Geban, 2014; Papageorgiou, Stamovlasis & Johnson; 2012; Zan Yörük, 2003) understanding the difference between the two (Hesse & Anderson, 1992; Kıngır, Geban & Günel, 2013; Kıngır & Geban, 2014). They seemed to give relevant real world examples regarding these concepts but did not understand theoretical and scientific reasons behind these events (Buyruk & Korkmaz, 2016; Demircioğlu, Özmen & Demircioğlu, 2006; Sökmen, Bayram & Yılmaz, 2000; Uluçınar Sağır, Tekin & Karamustafaoğlu, 2012).

Students seem to have a number of criteria for deciding whether a change is physical or chemical. Alternate events seemed to be perceived by a physical change while irreversible events seemed to be seen as a chemical change (Atasoy, Genç, Kadayıfçı & Akkuş, 2007; Buyruk & Korkmaz, 2016; Gönen & Akgün, 2005; Kıngır & Geban, 2014; Meşeci, Tekin & Karamustafaoğlu, 2013; Mirzalar Kabapınar & Adik, 2005; Stavridou & Solomonidou, 1989; Sökmen, Bayram & Yılmaz, 2000). If a new substance emerges and there is a color change, they tend to see it as a chemical change. If not, they see it as a physical change (Çayan & Karslı, 2014; Palmer & Treagust, 1996; Ergül, 2014; Stavridou & Solomonidou, 1989; Tsaparlis, 2003).

Those who use the criteria "if a new substance emerges, it is a chemical change" seemed to perceive water and ice as different substances and thereby mistakenly thought the event of ice melting as a chemical change. Those who look at color change as a criteria seemed to mistakenly think that when the color of a substance changes as a result of a resolution, it is a physical change in some situations and is a both physical and chemical change in other situations. Researchers (Ben-Zvi, Eylon & Silberstein, 1986; Demircioğlu, Özmen & Demircioğlu, 2006; Demircioğlu, Ayas & Kongur, 2012; Gönen & Akgün, 2005; Hesse & Anderson, 1992; Johnstone, 2000; Johnson, 2000; 2005; Kıngır & Geban, 2014; Stavridou & Solomonidou, 1989; Sökmen, Bayram & Yılmaz, 2000; Tsaparlis, 2003; Uluçınar Sağır, Tekin & Karamustafaoğlu, 2012) attributed students' difficulty with differentiating physical and chemical change to their efforts to explain events at macro level instead of micro-level.

1.3 Purpose and Significance of the Current Study

To date, research studies on the topic of "physical and chemical change" and word association tests revealed that

- Students have difficulty understanding physical and chemical change and differentiating between the two.
- Utilizing a specific method instead of traditional ways of teaching helps students better understand physical and chemical change.
- Word association test is a useful tool that can be used in chemistry education to uncover interrelationships among chemical concepts in students' mind and help detect misconceptions.

Nevertheless, there seems to be only one study investigating the role of word association tests in understanding the students' cognitive structure with regard to physical and chemical change. As indicated earlier, this topic is an important topic in chemistry education taught in different levels of education. More importantly, students seem to face a number of difficulties in understanding this topic and possess many misconceptions. Using a word association test helps understand students' cognitive structure and thereby gives an opportunity to identify their prior knowledge and misconceptions regarding this topic before and after instruction.

The main purpose of the current study was to explore the effectiveness of a word association test in revealing students' cognitive structure. To meet this purpose, three research questions were addressed in the current study:

1. Is a word association test useful in revealing students' cognitive structure regarding physical and chemical change?
2. Does a word association test help identify students' misconceptions?
3. The degree to which students write a sentence involving scientific knowledge regarding physical and chemical change?

2. Method

2.1 Participants and Their Educational Background

Physical and chemical change is included in a unit called "Substance and Change" in a science class. Students start receiving science courses in the 3rd grade in Turkey. From 3rd grade to 5th grade, students are expected to characterize substances according to their physical properties, classify them as solid, liquid and gas, compare them on the basis of their phases and define them in terms of mass and volume. In addition, they are expected to give scientific explanations for a number of events such as melting, freezing, boiling, condensation, evaporation, sublimation and heat exchange, classify substances as pure and mixture, separate mixtures by sieving, filtering and magnetizing and explain expansion and contraction which occurs in the process of warming and cooling. In the 6th grade, they are expected to compare changes occurring in substance in a unit called "the granular structure of matter/substance and change", classify substances as physical and chemical and understand that substance consists of moving particles (molecules, atoms or ions) (MEB, 2013).

The participants consisted of 153 6th students (67 female, 86 male) in different 8 secondary schools in Kütahya, Turkey. The current study was conducted in a week when students studied the unit the "particle structure of matter/substance and change". The researcher explained purpose of the significance of this research to participants. All of the participants voluntarily took part in the current study.

2.2 Research Instrument

A word association test was employed to reveal students' cognitive structure regarding the topic of physical and chemical change. To achieve this goal, the researcher came up with 8 key words related to this topic and conducted a pilot study with 20 7th grade students. The results revealed that two words (chemical reaction and conversation of mass) were not understood by the students well. Thus, they were removed from the test, resulting in a final test with 6 words (substance, particle, physical change, chemical change, physical property and chemical property). One faculty member working the department of chemistry education and a secondary school science teacher reviewed the stimulus words and indicated that these words were relevant to examine the cognitive structure regarding physical and chemical change.

These six keywords served as a stimulus in the word associated test and thereby were called stimulus words. Each stimulus word is written on a separate page and students were asked to write as many words as possible that come to their mind. As Figure 1 illustrates, stimulus words were written on a single page several times in order to prevent chain-reaction effect. In addition, the students were asked to write a sentence regarding each stimulus word at the end of each page and were given a total of 8 minutes to complete the word association test.

Physical change...

Physical change ....

Physical change ....

Physical change ....

Physical change...

Related sentence:
....
....

Figure 1: Sample Page from the Word Association Test

2.3 Data Analysis

To begin with, students' responses to each stimulus words were examined and a frequency table for each different response was created. Based on the frequency table and cut-off point technique (Bahar, Johnstone & Sutcliffe, 1999), a concept network was created. Since the current study was conducted with a relatively high number of students and many responses were produced, 8 to 10 points below the response word, which is the most repeated answer for the given stimulus word, were used as a basis for determining cut-off points. Thus, the concept network consisted of seven levels: (1) Cut off point 65 and over, (2) cut-off point 55-64 (3) cut-off point 45-54, (4) cut-off point 35-44, (5) cut-off point 25-34 (6) cut-off point 15-24, (7) cut - off point 5-15.

In the second stage of analysis, the participants' sentences for the given stimulus words were examined. Based on the coding system developed by Ercan, Taşdere and Ercan (2010), sentences were categorized as sentences containing scientific knowledge, sentences containing non-scientific and superficial knowledge and sentences containing misconceptions. A section intended to contain a detailed description of all the methods, materials, collaborators and participants at the study. The protocols used for data acquisition, techniques and procedures, investigated parameters, methods of measurements and apparatus should described in sufficient detail to allow other scientists to understand, analyze and compare the results. The study subjects and participants should be described in terms of number, age and sex. The statistical methods should be described in detail to enable verification of the reported results. This section could contain a separate sub-section that comprises the explanation of the abbreviated terms used on the study.

3. Results

Table 1 shows the frequency of stimulus words written by students. All of the stimulus worlds were written as a response 2106 times. The stimulus word of substance was the most given response (f= 474) to the all of the stimulus worlds, followed by particle (f = 458) while physical property (f = 158) was the least given response.

Table 1: Number of Stimulus Words Written By Participants as a Response

Stimulus Word as a Response	f	%
Substance	474	22.51
Particle	458	21.75
Physical change	344	16.33
Chemical change	424	20.13
Physical property	158	7.50
Chemical property	248	11.78
Total	2106	100

Table 2 shows the most given responses to each stimulus word. Solid was the most written response to the stimulus of words of substance and particle. Cutting was the most written response to the stimulus words of physical change and physical property. Burning was the most common response to the stimulus words of physical change and physical property. In other words, students tended to associate substance and particle with solid, chemical change and chemical property with burning, physical change and physical property with cutting.

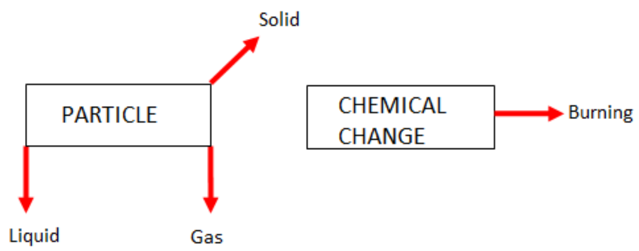
Table 2: The Most Written Response to Each Stimulus Word

Stimulus words	Response word	f	%
Substance	Solid	54	15.4
Particle	Solid	73	20.9
Physical change	Cutting	63	18.0
Chemical change	Burning	93	26.6
Physical property	Cutting	26	7.40
Chemical property	Burning	41	11.7

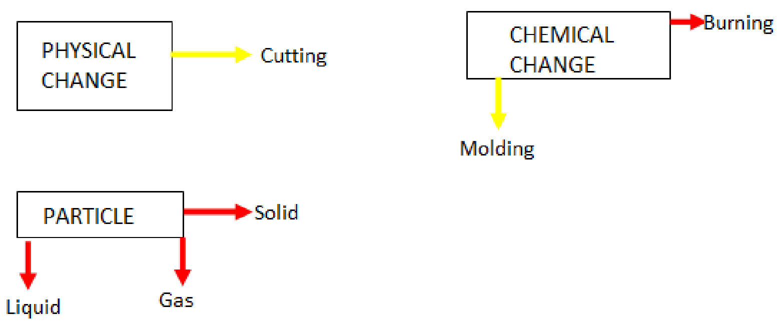
A frequency map was created to display the associations between the stimulus words and their associated words. The map has seven different frequency range categories. Figure 2 shows the students' cognitive structures emerged from the map from the strongest to the weakest associations. Since the stimulus words of particle and chemical change and responses including solid, liquid, gas and burning appeared more than 65 times they were placed in the highest (first) category.

In the second category, in addition to particle and chemical change, the stimulus word of physical change and its associated word "cutting" emerged. All of the stimulus words emerged in the fifth category (cut-off value between 25 and 34). At the lowest level (cut-off value between 5 and 14) all of the concepts appeared in students' responses in the word association test emerged.

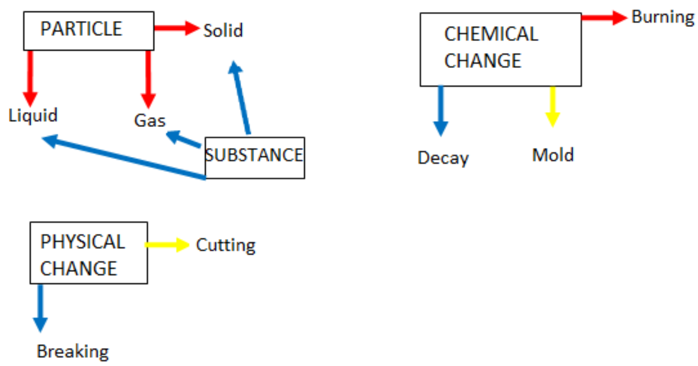
Cut-off point 65 and over



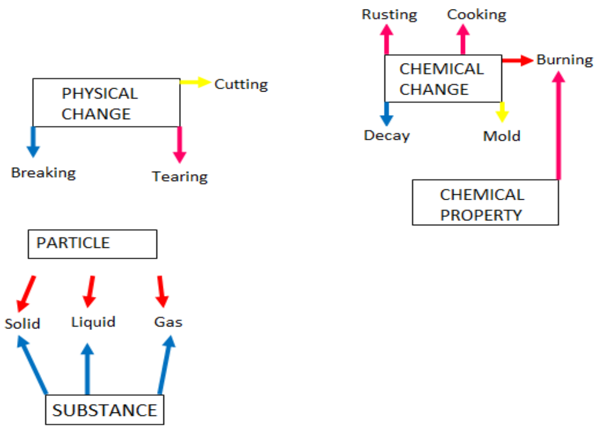
Cut-off point 55-64



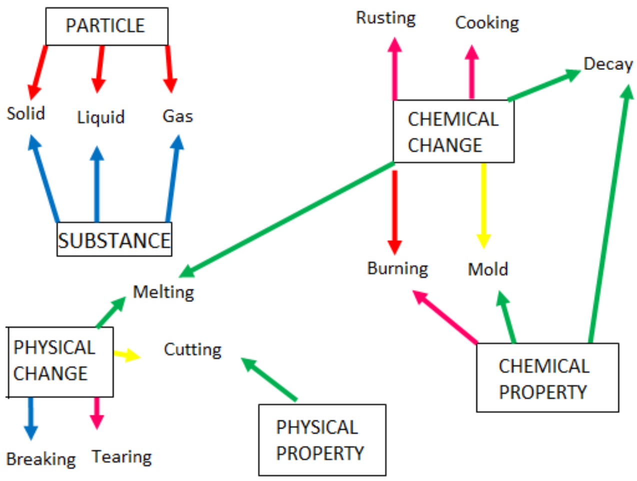
Cut-off point 45-54



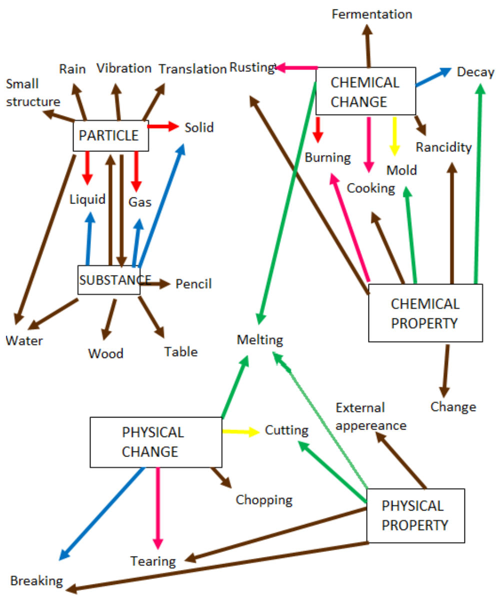
Cut-off point 35-44



Cut-off point 25-34



Cut-off point 15-24



Cut-off point 5-14

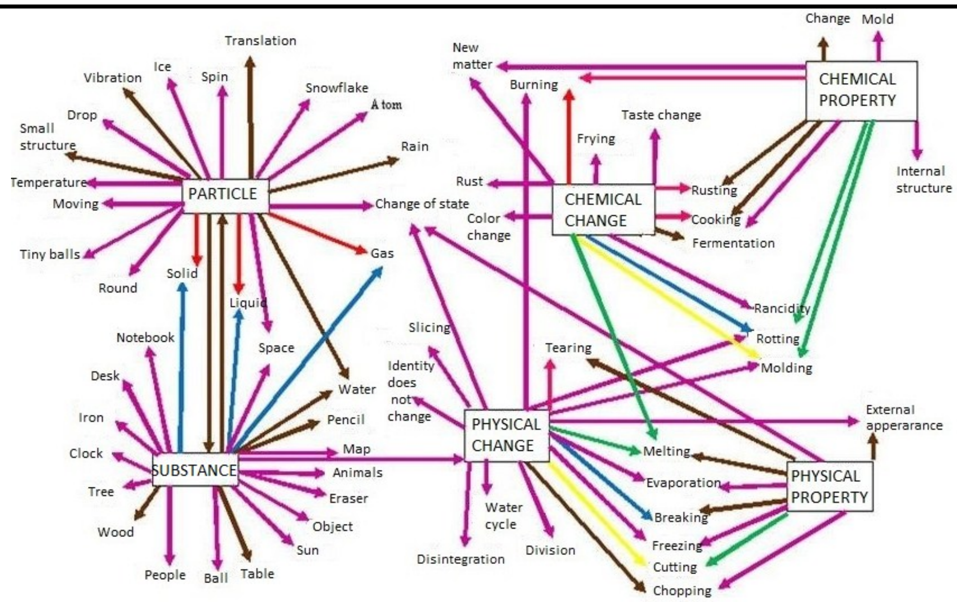


Figure 2: Concept Network Based on Stimulus Words

Table 3 shows the number of types of written sentences on the given stimulus words. A total of 741 sentences were produced by the students. Of these sentences, the majority (f= 431, 58%) were sentences containing non-scientific or knowledge. The total number of empty responses was found to be 177 (19%). The highest number of written sentences was found to be in the substance category (f = 129); however, the majority of sentences in this category (f = 93, 72%) was non-scientific. The highest number of empty responses (f = 41, 26%) was found to be in the chemical property category.

Table 3: Types of Written Sentences for the Stimulus Words

Stimulus words	Sentences containing scientific knowledge	Sentences containing non-scientific or superficial knowledge	Sentences containing misconceptions	Total Number of Produced Sentences	Empty
Substance	27	93	9	129	24
Particle	36	81	9	126	27
Physical change	72	39	15	126	27
Chemical change	88	25	10	123	30
Physical property	15	101	9	125	28
Chemical property	13	92	7	112	41
Total	251	431	59	741	177

The highest number of sentence containing scientific knowledge was found to be in chemical change (f=88) followed by physical change (f=72) categories. The number of sentences containing scientific knowledge in physical property (f=15) and chemical property (f=13) categories was found to be low. The highest number of sentences containing non-scientific or superficial knowledge was found to be in physical property (f=101) followed by substance (f=93) categories. Of the 741 sentences, 59 included misconceptions regarding the stimulus words with physical change has the highest number (f= 15, 25%). Table 4 presents examples of the students' responses to the stimulus words.

Table 4: Examples of Sentences Produced by Students

Stimulus words	Examples of sentences containing scientific knowledge	Examples of sentences containing non-scientific or superficial knowledge	Examples of sentence containing misconceptions
Substance	The substance is composed of particles.	We studied the solid, liquid and gas state of the substance.	Only inanimate substances are made up of atoms.
Particle	When the substance is solid, its particles only make a vibration motion.	In science lesson, we learned what the particles are.	The particles may be solid, liquid and gaseous.
Physical Change	In physical change, the internal structure of the substance does not change. So the substance still has the same properties.	I like to eat apple by cutting.	Ferment of yoghurt is physical change.
Chemical Change	In chemical change, identity of the substance change.	The wood became ash in the stove.	Breaking of the pen is chemical change.
Physical Property	Physical property is the external feature of the substance.	My physical properties are very beautiful.	Molding of bread is an example for physical property.
Chemical Property	Chemical feature is a property related to the internal structure of the substance.	There is chemistry lesson at high school.	Changing of state is related to chemical property.

4. Conclusions and Discussion

The main purpose of the current study was to examine the cognitive structure of students about a specific topic in chemistry through a word association test. The results revealed that the word association test created for this topic is useful in revealing the students' cognitive structure and help identify their misconceptions. Stimulus words, which the researcher proposed, helped reveal concepts that students have in their mind and uncover their interrelationships with each other. Thus, future researchers and chemistry or science teachers can utilize this test as an assessment tool to understand their students' learning or knowledge about physical and chemical change.

To begin with, the most striking finding of the current study was that the stimulus words of particle and chemical change emerged at the highest level of students' hierarchy of cognitive structures, but substance emerged at the third highest level. In addition, students seemed to erroneously associate particle with solid, liquid and gas. It was expected in the current study that the stimulus word of substance would emerge at the highest level and students associate this word with solid, liquid, gas. Unexpectedly, the stimulus word of particle emerged at the highest level and students linked this word to solid, liquid and gas. This may indicate that the students also think that the physical properties of the substance are also in their particles. Likewise, there are other studies that have raised students' thoughts that the macroscopic properties possessed by the substance are also present in the micro-particles (Çökelez, 2009; Çökelez & Dumon, 2005; Ebenezer, 2001; Johnstone, 2000).

This unexpected and striking finding has an implication for textbook writers and chemistry teachers. When teaching substance and particle, it should be emphasized that solid, liquid and gas are states of substance, not particles. The substances are composed of particles called atoms. Using visual elements that help students understand the difference between substance and particle and emphasize that substances, not particle, has three phases might provide a solution to this misconception.

Another important finding was that students tended to associate the concept of physical change with the words of cutting, breaking, tearing and melting. It seems that they relate physical change with some events that they encounter in their daily lives. This finding was consistent with another study (Buyruk & Korkmaz, 2016), which found that students develop everyday metaphorical forms of physical change, such as "cutting something", "cutting a paper", "breaking glass" and "dividing a crop". Like physical change, students connected the stimulus word of physical property with "cutting, melting, tearing and breaking'', which showed that students make a connection between physical change and physical property in their mind. On the other hand, some students associated physical change with burning, decay and mold, which suggested that they had a number of misconceptions about physical change.

Results also revealed that students tend to associate chemical change and chemical property with some words including "burning, mold, decay and rusting". It seems that they relate chemical change and chemical property with some events that they encounter in their lives and with what they learn in chemistry classes. On the other hand, some students linked chemical change to "melting", which showed that they had a misconception in their mind.

The weak link between particle and chemical change deserves attention. Students seemed to have difficulty with connecting these two words in their mind. Chemical change is the rearrangement of atoms microscopically (Stavridou & Solomonidou, 1998) and changes take place at the particle level. It seems that students do not think chemical change at the particle level. Rather, they seemed to try to make a connection between these two words at macroscopic level, which seemed to cause misconception.

Students may have difficulty understanding changes in substances since they are abstract. To address this problem, meaningful learning should take place through providing students with both theoretical and practical knowledge by means of experience and practice (Demircioğlu et al., 2012). Thus, teachers should benefit from visual materials that show physical and chemical changes at the particle level, enables students to make experiments, ask them to explain real- life events at the particle level and to show their understanding through visual materials such as concept map.

It is important to note that the current study was conducted in only 8 schools in a western city of Turkey. Convenience sampling method was used to recruit participants. 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 physical and chemical change in different settings.

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 through a word association test. Chemistry teachers and science teachers may benefit from the outcomes of this study. If students were not thought physical and chemical change before, teachers can administer this test at the beginning of teaching this topic. This point is important because it provides the teachers with a starting point and baseline for their teaching activities. On the other hand, if the students possess prior knowledge about this topic, the teachers administer this test to the students before and after instruction to explore if the students showed growth in giving relevant real-world examples regarding physical and chemical change and grasping the difference between the two.

Acknowledgements
This research was supported by Balıkesir University Scientific Research Projects (BAP) with the project number 2016/167.

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Appendix: The Frequency Table Used to From the Concept Network

	Stimulus words					
Response words	**Matter**	**Particle**	**Physical change**	**Chemical change**	**Physical Property**	**Chemical Property**
Matter	-	21	-	-	-	-
Particle	22	-	-	-	-	-
Chemical change	7	-	-	-	-	-
Physical change	7	-	-	-	-	-
Solid	54	73	-	-	-	-
Liquid	51	67	-	-	-	-
Gas	48	69	-	-	-	-
Wood	23	-	-	-	-	-
Water	17	21	-	-	-	-
Ice	-	7	-	-	-	-
Table	20	-	-	-	-	-
Object	11	-	-	-	-	-
Eraser	13	-	-	-	-	-
Pencil	19	-	-	-	-	-
Clock	12	-	-	-	-	-
Map	11	-	-	-	-	-
Vibration	-	23	-	-	-	-
Rotation	-	12	-	-	-	-
Translation	-	22	-	-	-	-
Snowflake	-	13	-	-	-	-
Rain	-	15	-	-	-	-
Small structure	-	16	-	-	-	-
Space	6	11	-	-	-	-
Cutting	-	-	63	-	26	-
Breaking	-	-	47	-	20	-
Tearing	-	-	40	-	21	-
Chopping	-	-	24	-	9	-
Slicing	-	-	11	-	-	-
Freezing	-	-	12	-	9	-
Melting	-	-	32	15	23	-
Evaporation	-	-	10	-	5	-
State changing	-	6	12	-	6	-
The identity does not change	-	-	10	-	-	-
The identity changes	-	-	-	-	-	-
Burning	-	-	8	93	-	41
Molding	-	-	5	60	-	29
Rusting	-	-	-	39	-	20
Decay	-	-	7	52	-	32
Rancidity	-	-	-	19	-	18
Fermentation	-	-	-	19	-	7
Frying	-	-	-	13	-	-
New matter	-	-	-	10	-	12
Cooking	-	-	-	38	-	17
Physical appearance	-	-	6	-	17	-
İnternal structure	-	-	-	-	-	12
Change	-	-	-	6	-	19

People	6	-	-	-	-	-
Animals	7	-	-	-	-	-
Ball	5	-	-	-	-	-
Temperature	-	8	-	-	-	-
Sun	6	-	-	-	-	-
Tree	7	-	-	-	-	-
Notebook	8	-	-	-	-	-
Iron	6	-	-	-	-	
Desk	7	-	-	-	-	-
Atom	-	5	-	-	-	-
Drop	-	8	-	-	-	-
Moving	-	7	-	-	-	-
Round	-	7	-	-	-	-
Tiny balls	-	5	-	-	-	-
Break into pieces	-	-	9	-	-	-
Corrugation	-	-	5	-	-	-
Division	-	-	5	-	-	-
Water cycle	-	-	7	-	-	-
Color change	-	-	-	6	-	-
Taste change	-	-	-	6	-	-
Rancidity	-	-	-	8	-	-
Mold	-	-	-	-	-	5
Rust	-	-	-	5	-	-