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INVESTIGATION OF CLASSROOM TEACHER CANDIDATES' COGNITIVE STRUCTURES ON SOME BASIC SCIENCE CONCEPTS

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Abstract:
In this study, it was aimed to investigate the cognitive structures of classroom teacher candidates on some basic science concepts. Word association test (WAT) technique was used to gather data. Twelve keywords related to basic physics, chemistry, and biology concepts were determined and used in the formation of WAT's. Forty-three classroom teacher candidates studying at 2nd classes at an education faculty were the participants of this study. Data obtained by WAT were examined by using number of different responses given to each keyword, and by drawing concept maps according to both frequencies and relatedness coefficients. A cut-off point technique was used when drawing the concept maps. Because of this study, it can be said that participants have moderate cognitive structures on the investigated science concepts and their cognitive structure was strongest on chemistry concepts and weakest on biology concepts.

Keywords: cognitive structure; classroom teacher candidates; science concepts; word association tests

1. Introduction

Most of the students describe "science" as a difficult and boring course to learn mostly because they think it is an abstract knowledge needs to be memorized. However, science is even in the center of everyday life. Many everyday situations and problems can be solved by knowing some basic scientific phenomenon. If someone knew the scientific fact that "peppery is solved in oil", for instance, then he/she would eat butter spread bread instead of drinking water.

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Science can be defined as systematic exploration of nature and phenomena and effort to predict events before they happen. Since every phenomenon is the subject of science, it is a vital component of life (Aydoğdu and Kesercioğlu 2005). Science teaching is an important issue for the future of societies and it is remarkable that developed countries show great interest to science teaching in their education system. New techniques and improvements have been planned to improve the quality of the education.

In Turkey, science courses have become a part of 3rd grade of elementary school curriculum with the amendment in 2013. The main goal of this course is given as "to inform students about the main concepts in biology, physics, chemistry, astronomy, environment, health and act of God" (MEB 2013). Therefore, it can be understood that students face to science concepts for the first time in their educational lives in this course. It is very important for students to learn the true basis of the scientific concepts in order them to build their expanding knowledge and interpret the real world's phenomenon. Science course in elementary 3rd grade is thought by classroom teachers. Hence, the sophistication of classroom teachers about basic scientific concepts is crucial. If the teacher had misconceptions, about the subject, this would probably transfer to his/her students and they would learn incorrectly (Ginns and Watters 1995). The main aim of this study is to explore the cognitive structures of classroom teacher candidates about some basic scientific concepts.

In literature, there are studies about the misconceptions about science concepts of classroom teachers and classroom teacher candidates. Bayram et al (1997) has investigated the misconception of classroom teacher candidates about some science concepts by using multiple choice and fill-in-the-blanks tests. According to the results of their study teacher candidates, have difficulties in differentiating the concepts such as element-compound, matter-substance, melting-solubility, physical and chemical change, heat-temperature, evaporation-boiling and mass-weight. In another study, Demircioğlu et al (2004) have examined the understandings of classroom teacher candidates on some chemistry concepts. They conducted clinical interviews with the participants on the nature of matter, dissolving, physical and chemical change, boiling, evaporation, and condensation concepts. According to the researchers, participants have many misconceptions on the studied concepts and especially they have difficulties for the abstract concepts. In other studies misconceptions of primary school teachers about heat and temperature (Kaptan and Korkmaz 2001), acids and bases (Brodley and Mosimege 1998), greenhouse effect (Cin 2005), global warming (Kahraman et al. 2008), diffusion and osmosis (Artun and Costu 2011) have been investigated.

Cognitive structure or structural knowledge can be defined as how someone organizes and relates terms and concepts in his mind (Selvi and Yakışan 2005; Tsai and

Huang 2002; Tsai 2001). It has been an important topic for educators to study on in recent years. In literature, there are many techniques like word association tests (Bahar et al. 1999; Ercan et al. 2010; Hovardas and Korfiatis 2006; Ozata-Yucel and Ozkan 2015), tree construction (Tsai and Huang 2002), concept maps (Assaraf et al. 2013; Cildir and Sen 2006; Jonassen et al. 1997), and flow maps (Author 2015; Tsai 1998) in order to investigate the cognitive structure of individuals. Word association test, which is the most common used and oldest technique, has been used by many researchers (Bahar et al. 1999; Kostova 2008; Nakiboglu 2008). The basis of this technique depends on the assumption that order of response retrieval from long-term memory reflects at least a significant part of the structure within and between the concepts (Bahar et al. 1999).

In a word, association test respondent is given a keyword and asked to respond that keyword with the first word that come into his/her mind in a given period. The degree of overlap of response hierarchies is a measure of semantic proximity of the keywords in a word association test. Thus by examining the response words, individuals' cognitive structure about the keyword can be drawn into concept maps and visualized. In this study, word association tests were used to gather data.

2. Method

Since it was aimed to explore the cognitive structures of classroom teacher candidates on some basic science concepts, survey method was used. Survey methods aim to depict any situation as its own existence in the past or current (Karasar 2004).

2.1. Participants

Participants of this study were forty-three classroom teacher candidates (33 female and 10 male) studying at a university located in northwest of Turkey. The participants of the study were chosen as sophomores since there is a course named "Basic Science Concepts" in the second year curriculum of classroom teacher education. In this course, students were taught the basic physics, chemistry and biology concepts. After this course there is no other courses related to science concepts in the curriculum. Data of the study were collected at the end of the course since it was aimed to explore how the classroom teacher candidates formed their cognitive structures about basic science concepts.

Students of Basic Science Concepts course were informed about the study i.e., aim, design and procedure of the study, and were asked if they would be participated to it. Forty-three out of sixty-five students accepted to be in this study voluntarily and the data were collected from them.

2.2 Data Collection Instrument

Word association tests were used as data collection instrument in this study. A list of basic physics, chemistry and biology terms was formed by science professors and the elementary school curriculum was examined with regard to the existence and the importance of those terms in the curriculum. Therefore twelve keywords (motion, inertia, unit of constant, velocity, glucose, vitamin, respiratory, flower, compound, matter, atom, and element) were determined. Each keyword was written ten times down to a page and blanks were left for the responses to those keywords. Participants were told to write down the first word that comes into their minds for the keyword. Each keyword was written ten times down to the page in order to prevent the chain effect in which a response might be seen as a keyword for the next response (Bahar et al. 1999; Özata-Yücel and Özkan 2015). For instance if a participant responded to the keyword "reflection" with the words "light-mirror-beauty-cosmetics", then it can be said that there would be chain effect. Another blank area at the end of the page was left for a related sentence for each keyword and the participants were told to write a sentence related to that keyword.

2.3 Data Collection and Procedure

Firstly, all the participants were informed about word association test technique. They were said to respond to the keywords with the first word that come into their minds for that keyword. They were warned about the chain effect and said to think about the keyword every time they respond. In order the participants to understand the data collection procedure and technique; a sample word association test (with a keyword "tree") was used as pre-administration. After completing this period and all the participants were done, actual administration was accomplished. There were 12 keywords and every keyword was written ten times down on a separate page. There was also "related sentence" row at the end of each page. Participants were told to respond every separate page in 1 min. time period and the administrator did the timing. Each page was given to the participants separately. A total of 12 min. has spent for the administration of the instrument.

2.4 Data Analysis

Following procedure was accomplished in order to analyze the data obtained through word association tests.

- Responses for each keyword were examined and a response list for each keyword was formed. In this list all the different responses to that keyword were written with the repetition numbers.

- Then a frequency table was formed.
- Keywords were grouped as physics related keywords, chemistry related keywords, and biology related keywords since it would be more meaningful to interpret the findings.
- The indicator of the commonality of two keywords is known as "relatedness coefficient" and it is very instructive in the examination of cognitive structure (Naiboglu, 2008). Therefore, relatedness coefficients for each participant and each pair of keywords were calculated. The formula for calculation of relatedness coefficient by Garskoff and Houston (Bahar et al. 1999) is given below:

$$Relatedness\ coefficient(RC) = \frac{\sum A.B}{\sum n^2 - 1}$$

where,
A is the rank order of occurrence of words under A which are in common with B.
B is the rank order of words in B, which are shared in A.
n is the number of responses under A or B which has more responses.
An example for the calculation of relatedness coefficient was given below. The response words for the keywords "element" and "atom" for a participant were given in Table I.

Table I: Response words and rank orders for the keywords "element" and "compound" for a participant

Stimulus word: Element		**Stimulus word: Compound**	
Response	**Rank order**	**Response**	**Rank order**
Magnesium	9	Matter*	7
Matter*	8	Element	6
Electron**	7	Atom****	5
Proton	6	Electron**	4
Chemistry***	5	Water	3
Periodic table	4	Salt	2
Compound	3	Chemistry***	1
Atom****	2		
Potassium	1		

*/**/***/**** Overlapping responses for two keywords

Calculation of relatedness coefficients was done as follows: Firstly, the rank orders of the response words were determined and the lower one was considered as 1. The maximum value of the rank order can be 10 since participants were asked to write down ten responses to each keyword. Then overlapping responses (i.e., matter, electron, chemistry, and atom for this example) were determined for these keywords. After that, they were multiplied and summed. The result was divided by the maximum number of responses under these keywords. Therefore, the relatedness coefficient for element and compound keywords that were given in Table I, was given below:

$$RC = \frac{(8x7) + (7x4) + (5x1) + (2x5)}{(9^2 + 8^2 + 7^2 + 6^2 + 5^2 + 4^2 + 3^2 + 2^2 + 1^2) - 1} = 0.348$$

- Then overall relatedness coefficients were determined by taking the averages for each pair of keywords of each participant's.
- Cognitive structures of the participants were visualized by drawing concept maps. These maps were drawn according to the frequencies of the response words as well as the relatedness coefficients that were calculated for each pair of keywords. A cut off point technique as suggested by Bahar et al (1999) was used to draw the concept maps. According to this technique a number that is 3-5 less than the most frequent response to any keyword is chosen as cut off point and then the frequencies bigger than that number are drawn in the map. Then cut off point is lowered step by step until all the keywords show up in the map.
- The "related sentences" were analyzed by categorizing them into three categories as correct scientific knowledge (CSS), i.e., correct definition or use of the term, misconception (MC), i.e., incorrect scientific explanation; and irrelevant (IR), i.e., sentences that are off-topic. For instance for the keyword *respiratory* a participant's sentence "respiratory is the common feature of livings" was categorized into CSS. A participant replied for the keyword *inertia,* as "Inertia is the conservation of mass" and this sentence was categorized into MC while another sentence for the keyword *atom* as "I'm as fast as an atom" was categorized into IR.
- Sentences in each category were counted and a frequency table was formed.

2.5 Validity and Reliability

When determining the keywords to be used in the study three instructors, one of them hold PhD degree in physics, other in chemistry and another in biology, discussed and also the elementary science course curriculum was examined and the keywords checked for the content validity. For the calculation of relatedness coefficients, another researcher, other than the authors, was asked to calculate RC's for twenty-five participant's keywords. A 98% inter-coder agreement, which is substantially high, was calculated in between his and author's calculations. Another researcher was asked to categorize participants' related sentences and 96.5% inter-coder agreement was calculated between his categorization and authors'. According to Miles and Hubermans' criterion (Miles et al. 2014) a consistency value above 70% is acceptable. Therefore the reliability of the calculations can be acceptable.

3. Findings

After examining the responses to each keyword, a list of responses to the keywords with repetition numbers was formed. Number of different responses to each keyword was given in Table II.

Table II: Number of different responses to each keyword

	Keyword	Number of different responses
Physics	Velocity	105
	Unit of constant	65
	Inertia	106
	Motion	110
Chemistry	Element	83
	Matter	118
	Atom	114
	Compound	94

Number of different responses for a given word would give a clue or sign that the meaning of that word understood by a person (Bahar et al. 1999). For the keywords in this study, a total of 773 different responses were determined. The keyword "matter" has the highest number of different responses (118 different response) while the keyword "unit of constant" has the lower number of different responses (65 different response). From this result, it can be said that participants structured "matter" better.

In the determination of cognitive structures of the participants, besides the number of different responses to the keywords, it is also important to enlighten the relations between keywords. Therefore the relatedness coefficients i.e., the semantic proximity of keywords, were calculated for all the participants for each pair of keywords and then overall relatedness coefficients were obtained by averages. The results were given in Table III, IV, and V for physics, chemistry, and biology related keywords, respectively.

Table III: Relatedness coefficients of physics keywords

	Unit of constant	Inertia	Motion
Velocity	0.076	0.033	0.195
Unit of constant	-	0.055	0.142
Inertia	-	-	0.088

Table IV: Relatedness coefficients of chemistry keywords

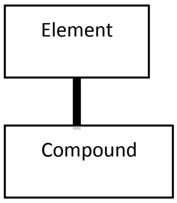
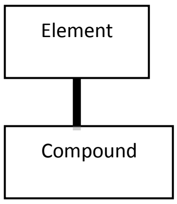
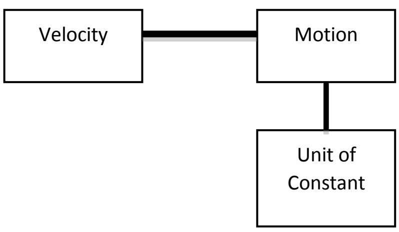
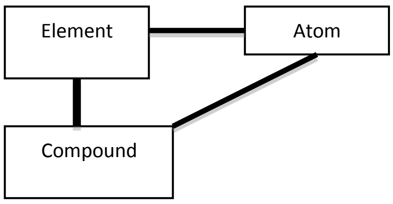
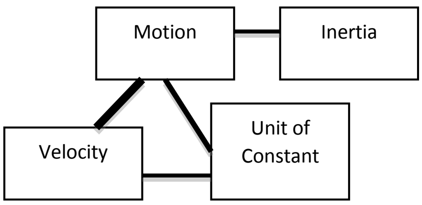
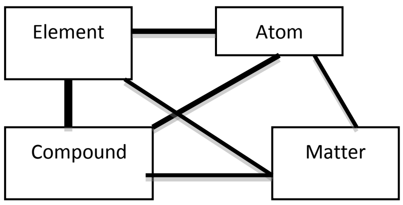
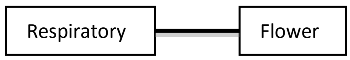
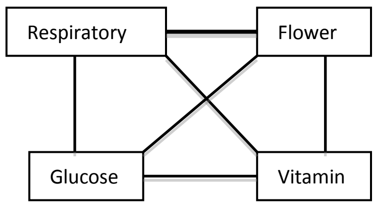
	Matter	Atom	Compound
Element	0.102	0.173	0.229
Matter	-	0.097	0.087
Atom	-	-	0.131

Table V: Relatedness coefficients of biology keywords

	Respiratory	Flower	Glucose
Vitamin	0.035	0.034	0.035
Respiratory	-	0.092	0.059
Flower	-	-	0.063

In order to better understand and interpret these findings concept maps were drawn according to cut-off point technique as supposed by Bahar et al. (1999). The first cut-off point was chosen as RC>0.225 since the highest RC was 0.229. The last cut-off point was 0.075>RC>0.025 since it covers all the RC's. Table VI shows the concept maps drawn by using RC's.

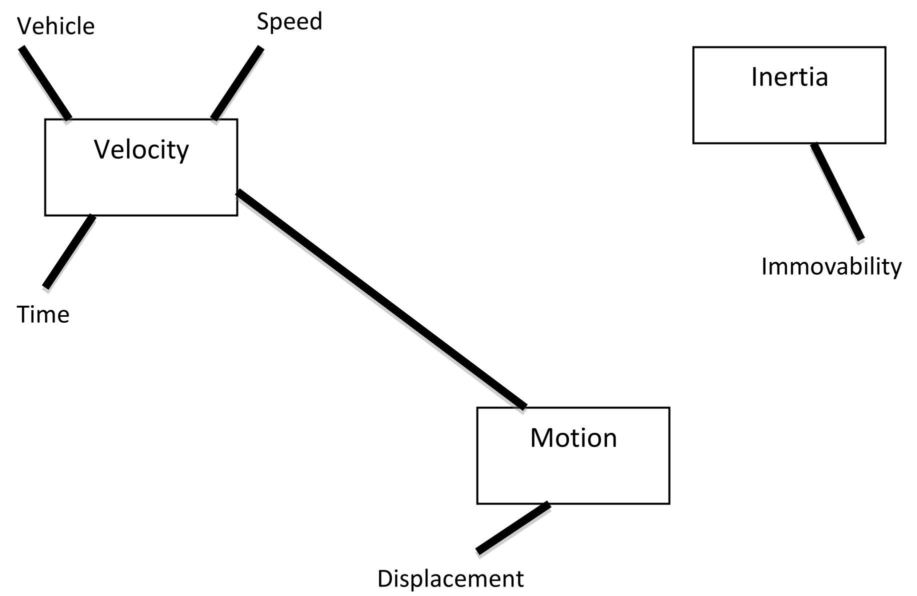
Table VI: Concept maps for the keywords drawn by using relatedness coefficients

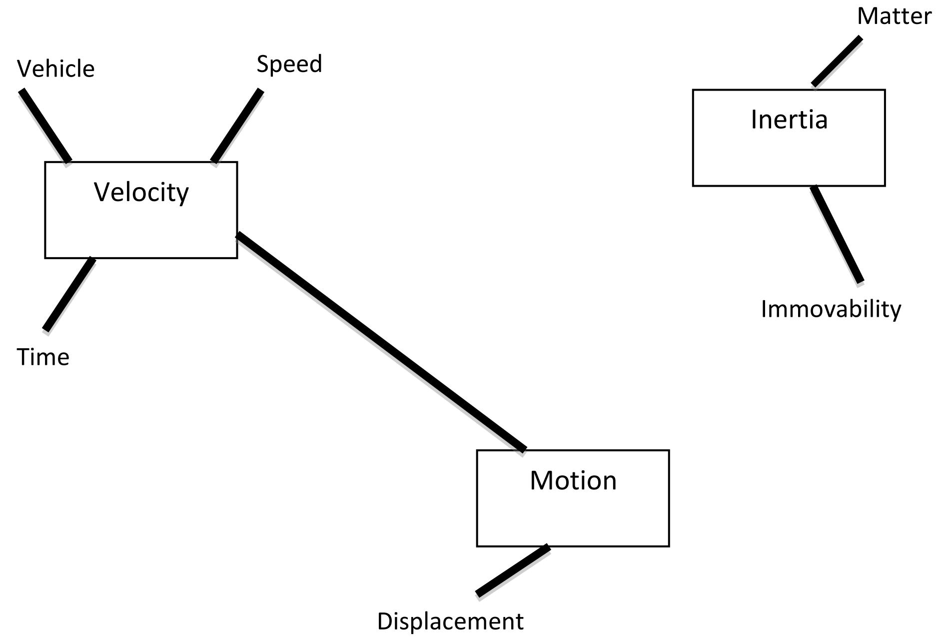
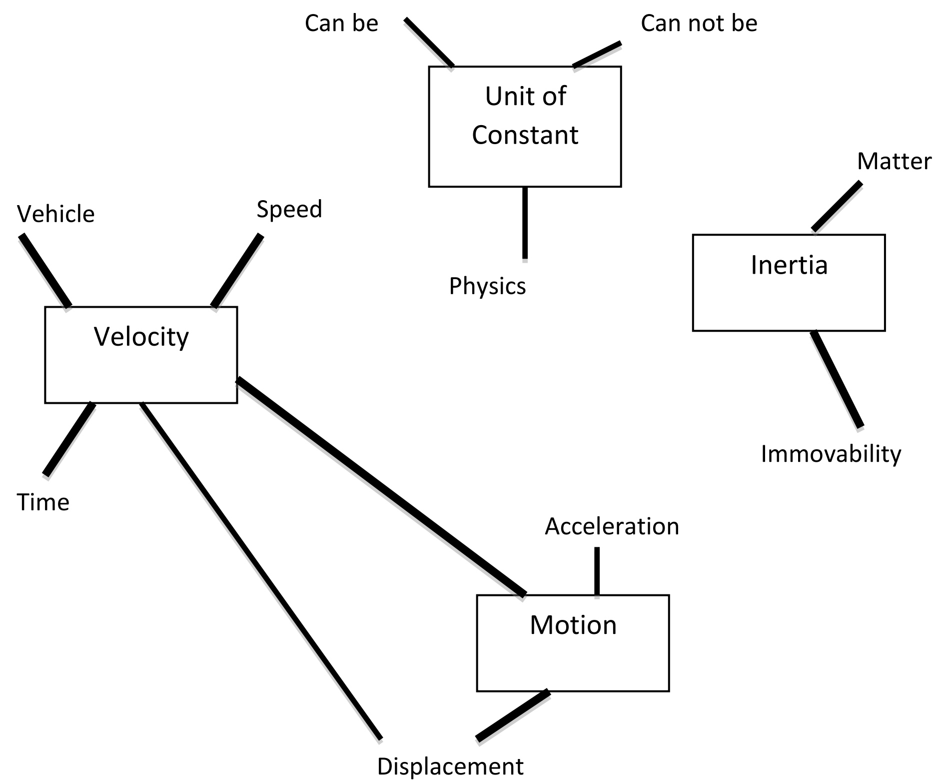
	Physics	Chemistry	Biology
RC>0.225			
0.225>RC>0.175			
0.175>RC>0.125			
0.125>RC>0.075			
0.075>RC>0.025			

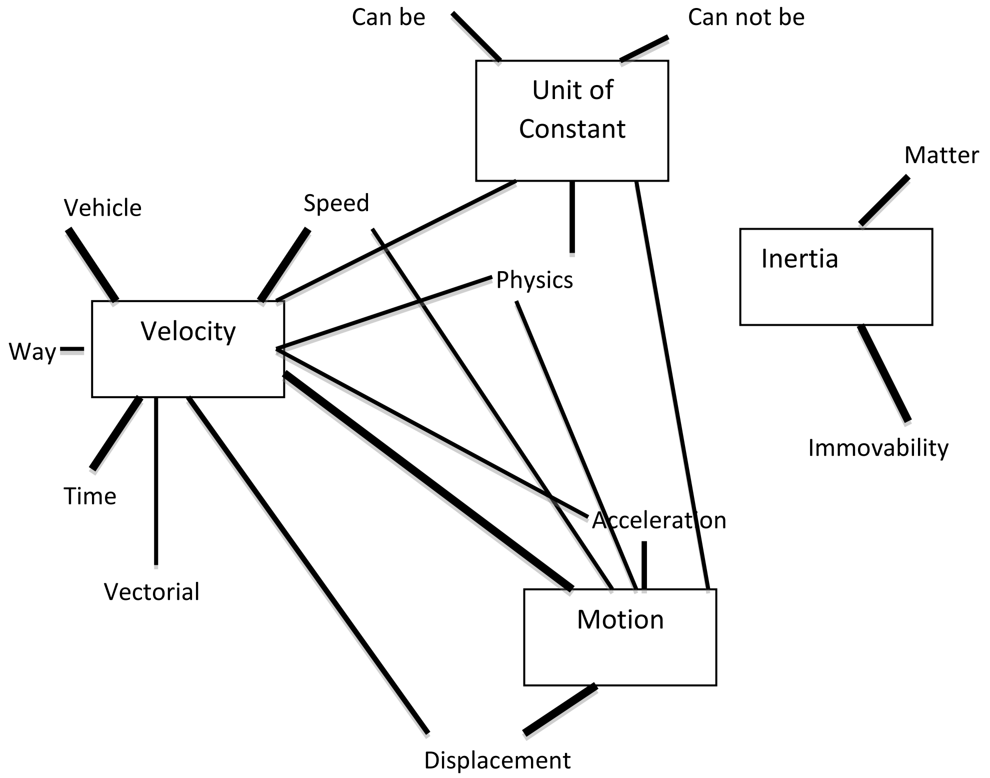
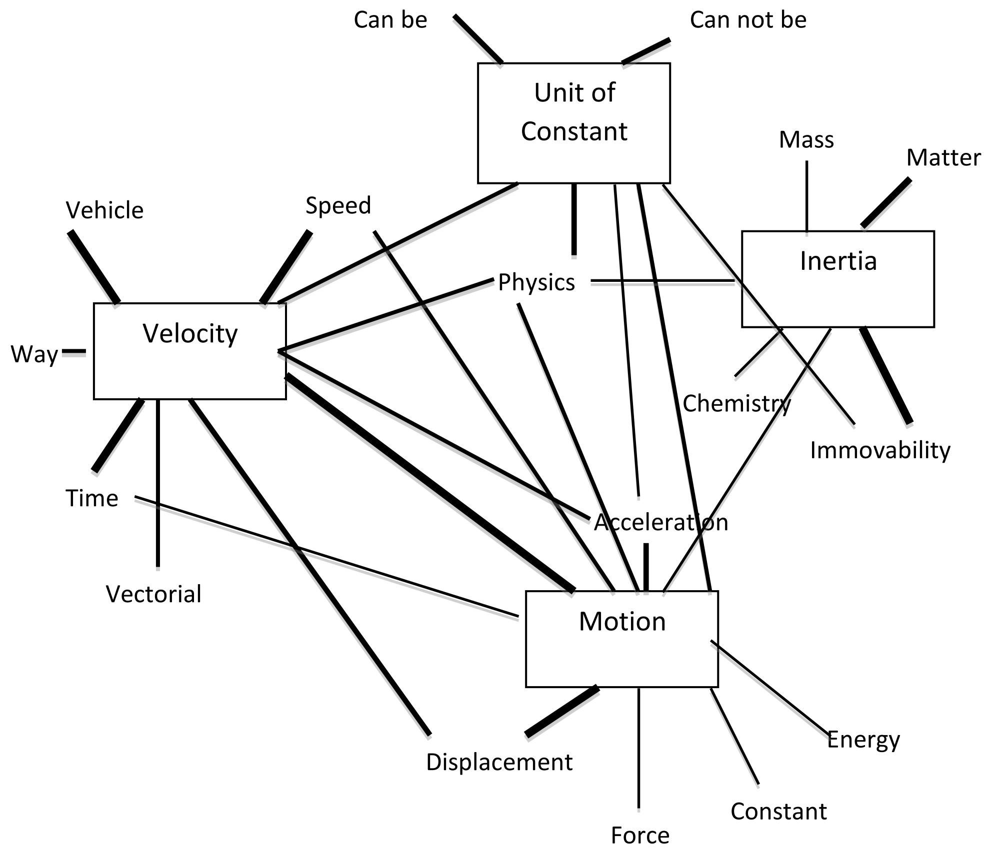
According to Table VI, participants structured the "element-compound" relation better in all the chemistry related keywords given. After that, "atom" joins to the structure and "matter" comes last in all the chemistry related keywords given. For the given physics related keywords, participants cognitive structure was better in "velocity-motion" relation, and the keyword "inertia" joins to the structure last. Participants' structured "respiratory-flower" relation better for the keywords related to biology, and "glucose" and "vitamin" join to the structure together. From these graphs, it can be said that participant's cognitive structures were strongest for chemistry keywords and weakest for biology keywords.

Although an investigation to the cognitive structures of the participants can be made by using concept maps drawn by using RC's, a better understanding and interpretation can be made by drawing concept maps by using frequencies (f) of the response words that were given for the keywords. Table VII, VIII, and IX show the concept maps drawn by using frequencies of the response words for physics, chemistry, and biology related keywords, respectively.

Table VII: Concept map drawn by using the frequencies of the response words for physics related keywords

Cut-off point	**Graph**
30	

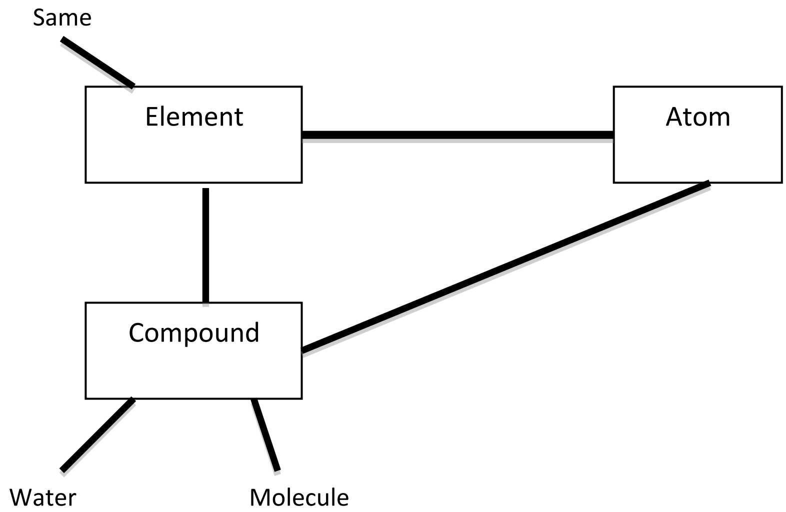
25	 Matter Vehicle Speed Inertia Velocity Immovability Time Motion Displacement
20	 Can be Can not be Unit of Constant Matter Vehicle Speed Physics Inertia Velocity Immovability Time Acceleration Motion Displacement

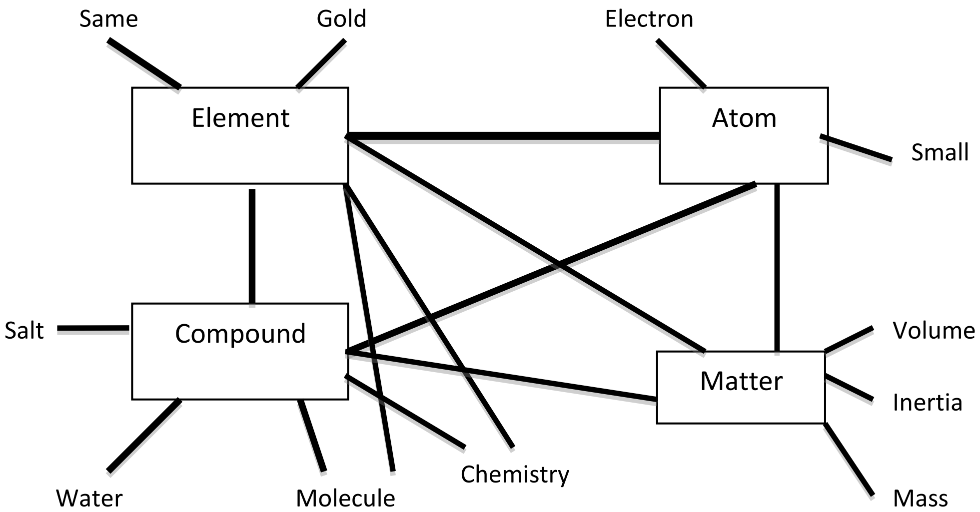
<table>
<tr><td>15</td><td>
</td></tr>
<tr><td>10</td><td>
</td></tr>
</table>

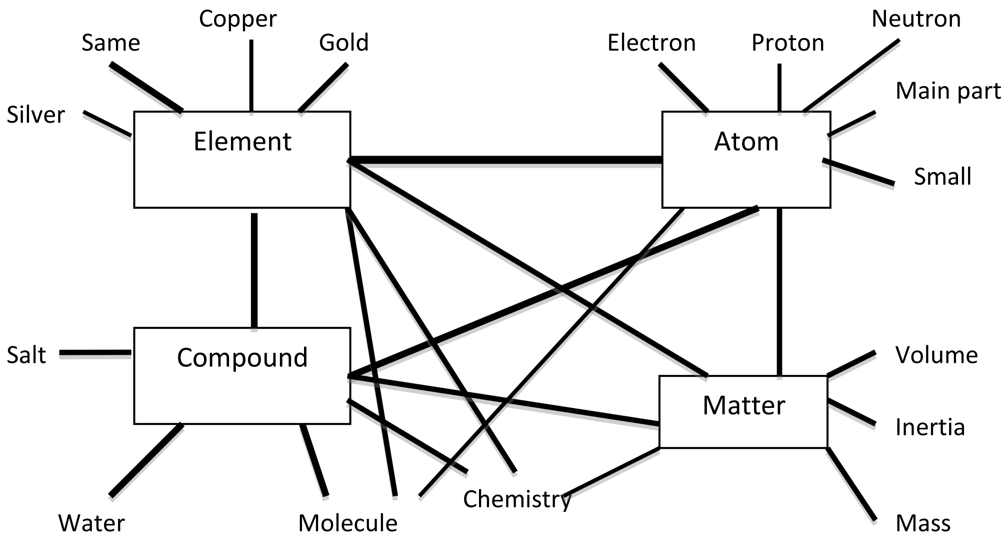
According to Table VII, for f>30, i.e., the strongest part of participants' cognitive structure, they structured "velocity" with relation to "speed", "vehicle", and "time". Their understanding of "motion" was related to "displacement", and "inertia" was related to "immovability". While they structured "velocity-motion" relation for this cut-off point, "inertia" appeared as a separate island i.e., with no relation to the other keywords appeared. For 30>f>25, "matter" joins to the structure with relation to "inertia". The other keyword "unit of constant" joined to the structure for 25>f>20, with the relation of "can be", "can not be", and "physics". At this level, a relation between "velocity" and "displacement" also showed up. "Acceleration" was also joined to the structure with relation to "motion" at this level. Although all the keywords appeared at this level, two more relaxation for the cut-off point was made in order to better investigate the understandings of the participants. At 15>f>20 level "unit of constant" related to other two keywords "velocity", and "motion" as well as to some response words. At this level the keyword "inertia" was still like separate island. At 15>f>10 level, i.e., the weakest part of participants' cognitive structures, "inertia" joined to the structure with relation to "unit of constant" and "motion". At this level, there were many relations between all keywords and most of the response words.

Table VIII: Concept map drawn by using the frequencies of the response words for chemistry keywords

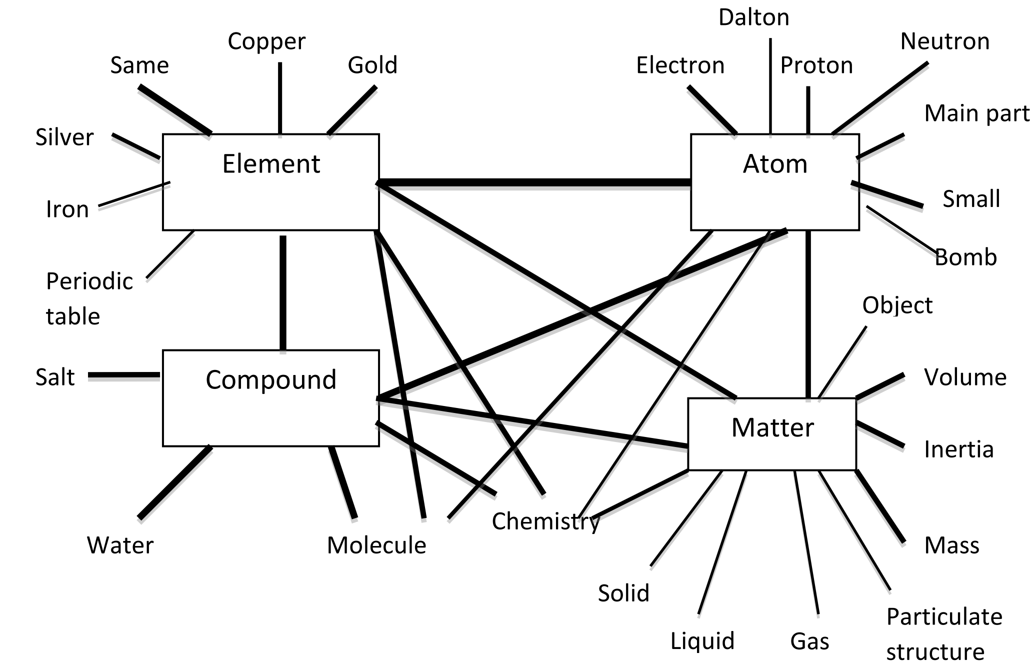
Cut-off point	Graph
30	

<table>
<tr><td>25</td><td>


</td></tr>
<tr><td>20</td><td>


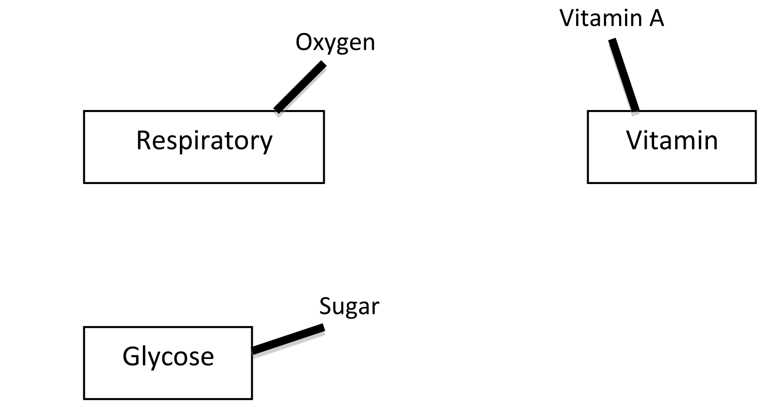
</td></tr>
<tr><td>15</td><td>


</td></tr>
</table>

10	

Participants' cognitive structures for chemistry keywords were strongest in "element" and "atom" relation, according to Table VIII. At 30>f>25 level "compound" appeared with relation to both "element" and "atom". Also, "same" for "element", and "water" and "molecule" for "compound" joined to the structure. When cut-off point relaxed to 25-20 level the last keyword "matter" appeared with relation to all the other keywords and "volume", "inertia", and "mass" attached to it. Also, "electron" and "small" for "atom, "gold" for "element" and "salt" and "chemistry" for "compound" showed up in the structure. Although all the keywords appeared in the structure at this level, two further relaxations of cut-off point were made in order to get a deeper insight to the cognitive structures of the participants. At level 20>f>15, participants added "proton", "neutron" and "main part" to "atom, "copper", and "silver" to "element". At 15>f>10 level, i.e., the weakest part of participants' cognitive structures, there were much more relations in between both the keywords and response words. From them, it can be said that participants added the states of matter (gas, liquid, solid) to "matter" and interestingly "periodic table" could take its part in relation to "element" barely at this level.

Table IX: Concept map drawn by using the frequencies of the response words for biology related keywords

<table>
<tr><th>Cut-off point</th><th>Graph</th></tr>
<tr><td>30</td><td>
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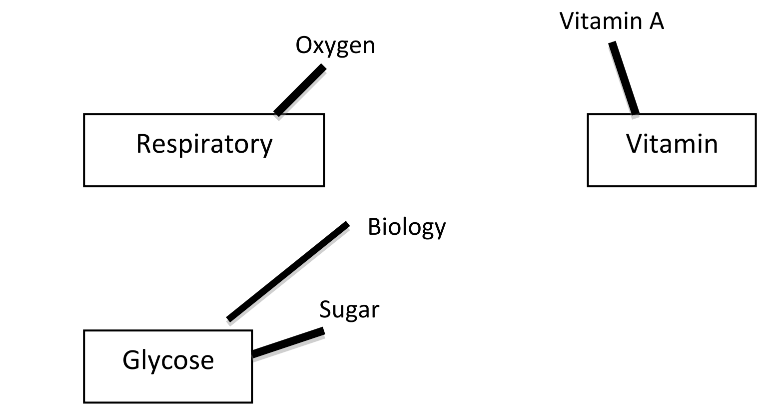
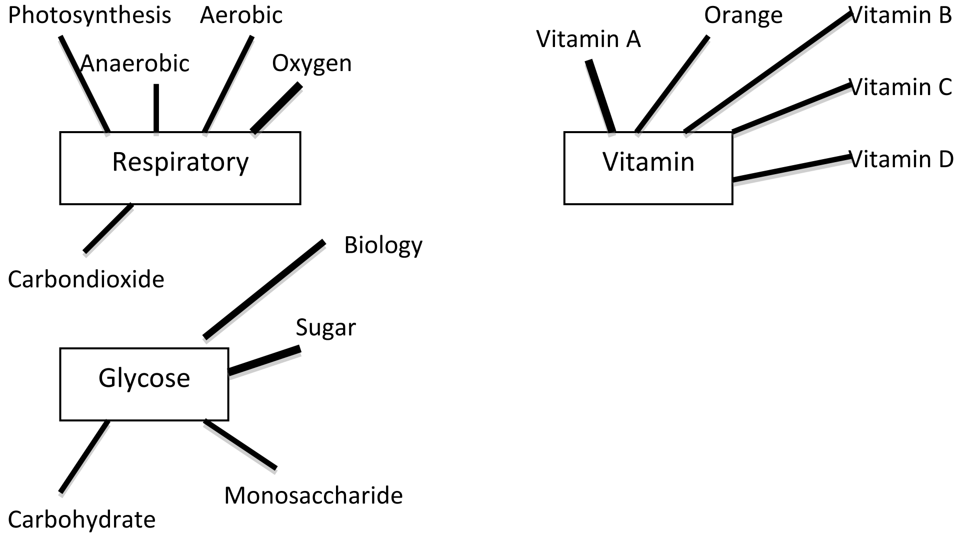
<tr><td>25</td><td>
</td></tr>
<tr><td>20</td><td>
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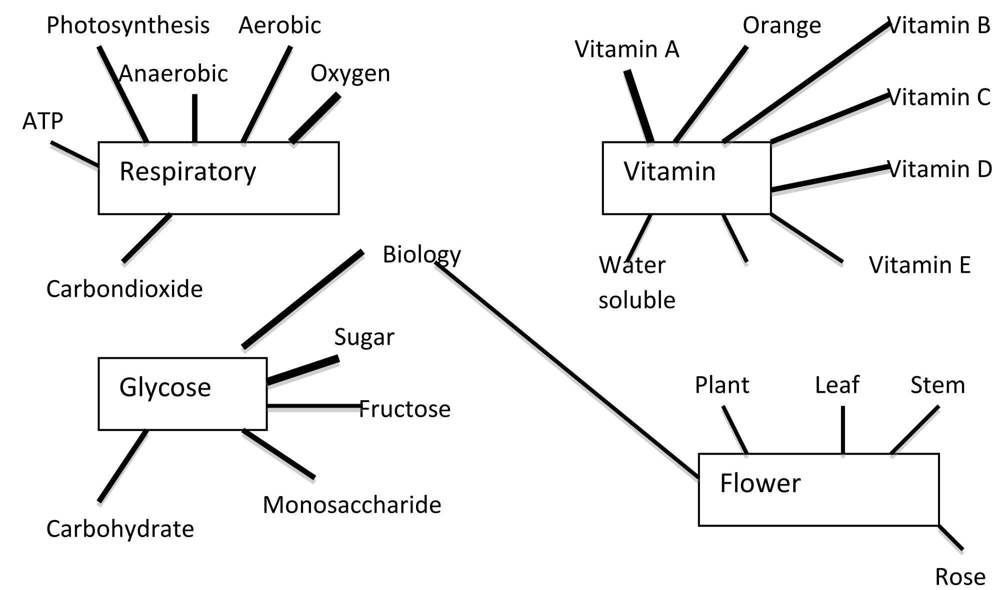

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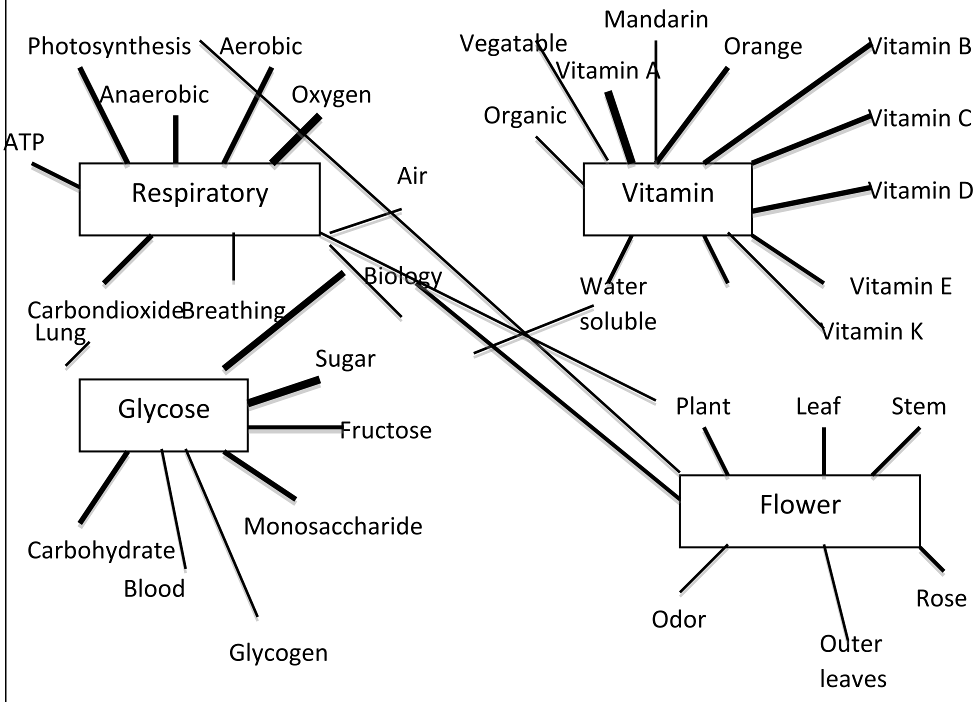

The concept map of participants' cognitive structure on biology keywords was given in Table IX. From this table it can be said that participants strongest part of cognitive structure i.e., f>30, related to these keywords appear firstly as separate islands with one response word attached to them. "Respirator", "vitamin", and "glucose" appeared at this level. When cut-off point was relaxed to 30>f>25 range they were still separate islands with a new response word, "biology", attached to "glucose". For 25>f>20 level, there were still three separate islands with many attachments to each of them. The keyword "flower" was first appeared in 20>f>15 level with relation to "biology" and with many other attachments as well. A further relaxation of cut-off point to 15>f>10 level revealed the interrelations between all four keywords. For physics and chemistry keywords it was enough to relax the cut-off point to 25>f>20 level while for biology keywords it was needed to be relaxed to 15>f>10 level.

Participants' related sentences for keywords were analyzed through categorizing them into correct scientific knowledge (CSS), i.e., "Velocity is a vectorial quantity" putted in this category, misconception (MC), i.e., "A compound composed of same types of elements" was thought to be in this category, and irrelevant (IR), i.e., "Flowers are beautiful" putted in this category. Findings were given in Table X.

Table X: Findings from "related sentence" analysis

	Velocity	**Unit of constant**	**Inertia**	**Motion**	**Element**	**Matter**	**Atom**	**Compound**	**Vitamin**	**Respiratory**	**Flower**	**Glucose**
CSS	6 (15.79)	19 (63.33)	7 (26.92)	4 (12.12)	25 (67.57)	34 (82.93)	29 (72.5)	16 (50)	34 (87.18)	29 (74.36)	10 (28.57)	25 (69.44)
MC	13 (34.21)	4 (13.33)	11 (42.31)	10 (30.30)	5 (13.51)	2 (4.88)	2 (5)	11 (34.37)	1 (2.56)	5 (12.82)	2 (5.72)	6 (16.67)
IR	19 (50)	7 (23.34)	8 (30.77)	19 (57.58)	7 (18.92)	5 (12.19)	9 (22.5)	5 (15.63)	4 (10.26)	5 (12.82)	23 (65.71)	5 (13.89)
Total	38 (100)	30 (100)	26 (100)	33 (100)	37 (100)	41 (100)	40 (100)	32 (100)	39 (100)	39 (100)	35 (100)	36 (100)

* Numbers in parenthesis were the percentages.

According to Table X, participants were able to write the most correct scientific knowledge (87.18%) for the keyword "vitamin" that was one of their strongest cognitive structure part for biology keywords according to the concept maps, and the most sentences that had misconceptions (42.31%) were for the keyword inertia, which was also appeared a separate island in their cognitive structure concept maps. "Flower" was the keyword that participants wrote mostly irrelevant sentences. When the table examined for physics keyword it can be said that participants wrote most correct scientific knowledge (63.33%) for the keyword "unit of constant", and had most misconception (42.32%) on the keyword "inertia". For chemistry keywords, participants were able to write the most correct scientific knowledge (82.93%) for "matter", and the most misconception (34.37%) was found on "compound". The most correct scientific knowledge (87.18%) for the keyword vitamin and the most misconception (16.67%) for the keyword "glucose" were detected for biology keywords.

5. Discussion

The primary education has a vital role in all educational progress (Unal 1993). Students firstly face to academic subjects and their success in their academic lives is very dependent to the primary education period. Any misconceptions forming in this stage of education level would affect the entire education process of an individual. Therefore, it is obvious that classroom teachers I.e., the teachers teach at primary education level, play an important role in an individual's whole academic life and success. Science has always seen as a difficult subject for many students mostly because they cannot relate the subject to the daily life and has seen it as utopic. Therefore, classroom teachers' role in teaching science can affect an individuals' success in science in his/her future academic career (Ozdemir 2008; Unal 1993). For this reason, it was aimed to investigate the cognitive structures of classroom teacher candidates on some basic science concepts.

In this study, findings were given in tables and graphs as physics related, chemistry related and biology related because it would be more meaningful to interpret. According to findings of this study it can be concluded that participants' cognitive structures were moderate, i.e., strongest in chemistry and weakest in biology. It is a very interesting finding because most of the studies in literature (Demircioglu et al. 2004; Taber 2001) reveal that students have difficulties in structuring abstract concepts, which exist mostly in chemistry between three of them, i.e., physics, chemistry and, biology. The reason of this finding might be their tendency to chemistry.
Number of different responses to any given keyword might be an indicator of how strongly that concept structured in someone's mind (Bahar et al. 1999). For physics related keywords "motion" was the keyword that had most different responses (110 different responses) and "unit of constant" had the least different responses (65 different response). From this finding, it can be concluded that participants structured "motion" better in their minds. For chemistry related keywords "matter" was the one that had most different type of responses (118 different responses) and "element" had the least different responses (83 different responses). Therefore, participants can be said to be structured "matter" better. For biology related keywords "flower" was the one that had most different responses (108 different responses) and "respiratory" had the least different responses (96 different responses). From these findings, it can be said that participants have structured "flower" better.

In order to better understanding the cognitive structures of the participants concept maps were drawn according to both the frequencies of the response words and the relatedness coefficients (RC's). The maps drawn by relatedness coefficients can show how strongly the participants relate the keywords each other while the maps drawn by frequencies can show how they relate the keywords with other concepts and words. For physics related keywords, participants related "velocity" with "motion" strongly (RC=0.195). "Inertia" was the weakest part of the participants' cognitive structure since it appeared lastly in the maps drawn by RC's (Table VI). It was also firstly showed up as a separate island i.e., with no relation to the other keywords, in the maps drawn by using frequencies (Table VII). According to Turker (2005), students have several misconceptions concerning force and motion, and especially they have difficulties in understanding the meaning of inertia.

For chemistry related keywords, participants related "element" and "compound" better (RC=0.229). From the concept map drawn by using frequencies (Table VIII) it can be seen that participant's strongest part of cognitive structure on chemistry related keywords was the "element" "atom" relation followed by their relations with "compound". According to Table VI participants added "matter" lastly to the concept map meaning that its relation with other keywords was weakest. It can also be seen from Table VIII "matter" joins to the structure lately.

For biology related keywords, participants calculated relatedness coefficients were smaller and the biggest one was in between "respiratory" and "flower" (RC=0.092), that is participants related "respiratory" with "flower" most in between the given keywords. According to Table VI three of the keywords (respiratory, vitamin and glucose) appeared firstly as separate islands. At very last relaxation, the relations between keywords could show up, meaning that participants mostly cannot relate the given keywords with each other.

When the response words examined it was found that "inertia" was the word that participants used most both for physics related keywords and chemistry related keywords. In other words, participants related physics and chemistry through inertia, which is a key feature of matter. Also, "motion" was found to be the common word between physics related keywords and biology related keywords probably because they thought the movement of livings.

Since writing "a sentence" is more complex and requires higher order thinking skills in comparison to "a word", it would give better inside to the cognitive structure (Ercan et al. 2010). In the examination participants' related sentences for physics related keywords, it was found that participants wrote most scientifically correct sentences for "unit of constant". This finding was probably because they gave the formal definition for "unit of constant", which should be counted as scientifically correct. However, it does not mean that even a participant can give the definition of a keyword he/she could structure that keyword strongly. Here in this study the number different responses given to "unit of constant" were the lowest. It was also firstly appeared in the concept map as a separate island.

The most misconception was found on "inertia", which was also proofed by the concept maps as the weakest part of their cognitive structures for physics related keywords. Participants wrote the most irrelevant sentences for "motion" and the percentages of their irrelevant sentences were higher than the other sentences for "motion" and "velocity". This finding can be explained, as since "motion" and "velocity" are the words most frequently used in daily life, participants preferred their daily life usages. For chemistry, related keyword participants wrote most scientifically correct sentences for "matter" probably with the same explanation for "unit of constant". Participants wrote the formal definition of "matter" but as it can be seen from concept maps (Table VI and Table VIII) "matter" was the last part attaching on the cognitive structure. The most misconceptions were found in the sentences related to "compound". Similarly in a study by Bayram et al (1997) classroom teachers and classroom teacher candidates understanding of some basic science concepts and they were also found that both classroom teachers and classroom teacher candidates could be able to give the right answer related to element and compound in a multiple choice test but they were not able to write down the reasons for their selections.

The most irrelevant sentences were written for "atom". "Atom" was an abstract concept and most studies in literature (Demirioglu et al. 2004; Demircioglu 2002; De Vos and Verdonk 1996; Ginns and Watters 1995; Nakhleh 1992) reveal that students have difficulties in understanding the abstract concepts because they cannot relate the macroscopic world with the microscopic concepts. This might be the reason of those irrelevant sentences. For biology, related keywords the most scientifically correct sentences were written for "vitamin" and the most misconception was found in the sentences related to "glucose", which was the most abstract one in the given keywords. Also, percentages of irrelevant sentences were higher than the other sentences for "flower". Participants mostly wrote types of flowers.

Overall results of this study reveals that participants haven't got strong cognitive structures on the given science concepts. This situation probably causes them to have struggle when teaching science concepts to their students in the future. According to a study by Cepni et al (2003), classroom teachers have difficulties in teaching science courses; they are not willing to make experiments in lab. Therefore their students have difficulty in understanding science and anxious about science. In the same study, it was also revealed that classroom teachers think that science courses should be given by science teachers at all levels. In another study by Kahyaoglu and Yangin (2007) it was found that from among pre service science, classroom and mathematics teachers, pre service science teachers have positive attitude to science courses and to teaching of science courses.

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