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PROBING HIGH SCHOOL STUDENTS' COGNITIVE STRUCTURE ABOUT PHYSICAL AND CHEMICAL CHANGES THROUGH WORD ASSOCIATION TEST

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ABSTRACT: The aim of this study is to investigate high school students' cognitive structures and to identify their learning difficulties in physical and chemical changes through word association test (WAT) and to compare at different students grades. The study was comprised of 167 students who are attending at ninth (88 students) and tenth grades (79 students). The WAT was used as data a collection instrument developed by the researcher. Before WAT is developed, the physical and chemical change topic placed in high school chemistry curriculum was examined to select the stimulus words of WAT. The WAT comprised of eight total stimulus words, among them *chemical reaction*, *energy*, *chemical property*, and *physical property*, is used to probe students' cognitive structures. At the end of the study, it was found that differences in the students' cognitive structures at ninth and tenth grades make it clear that instruction affects the cognitive structure. On the other hand, it was also concluded that students from both grades cannot associate with the concept of energy with other concepts of the subject.

Key words: High school students, cognitive structures, physical and chemical changes, WAT

INTRODUCTION

The examination of students' cognitive structure is important for probing what learners know about a topic before their instruction. In addition, visualizing students' cognitive structures is essential for understanding how students understand a previously taught subject. Fisher (2004) has indicated that all learners construct knowledge in their conscious working memory, and store that knowledge in long-term memory. The knowledge students acquire in science classrooms is stored in long-term memory in a hierarchically organized form, and can be represented as a cognitive structure in their memory (Tsai, 2001; Kalyuga, 2006). The cognitive structure comprises learners' existing experiences and knowledge that will lead to their reconstruction and information processing of the incoming stimuli (Nakiboğlu, 2008).

Determining students' cognitive structure is important for assessing what a learner knows about the subject knowledge. Therefore, knowing students' prior knowledge can guide teachers to design appropriate teaching strategies in their classless. There are several techniques that researchers can use to gain insights into students' cognitive structure. A word association test (WAT) is one of the most common methods for mapping cognitive structures (Bahar et al. 1999; Cachapuz and Maskill, 1987; Nakiboğlu, 2008). WAT provides wide-ranging lists of concepts that are associated with the concepts in the students' minds (Gussarsky and Gorodetsky, 1988). The underlying assumption in a WAT is that the order of responses reflects at least a significant part of the structure within the semantic memory, and between concepts (Shavelson, 1972). WAT has been frequently used to observe changes before and after instruction in various science disciplines (Nakiboglu 2008; Shavelson 1973).

Of particular interest to this study are students' understandings about the physical and chemical changes. The subject of the physical and chemical changes is one of the basic and essential issues of high school chemistry curriculum and also is related to daily life. To add, the subject is taught at the middle school level. On the other hand, it is stated that students have learning difficulties and misconceptions concerning the identification of the physical and chemical changes. Although so many studies of specific learning problems and students' misconceptions concerning the physical and chemical changes have been reported, there is not known about students' cognitive structure about the physical and chemical changes. The research question which provided a focus for the research reported in this study is:

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How do students' cognitive structures, as related to the physical and chemical changes, change according to students grades?

METHODS

The study was comprised of 167 students who are attending at ninth (88 students) and tenth grades (79 students). The WAT was used as data a collection instrument developed by the researcher. Before WAT is developed, the physical and chemical change topic placed in high school chemistry curriculum was examined to select the stimulus words of WAT and to establish the content validity of the WAT (Gay and Airasion, 2000, p. 163). The WAT comprised of eight stimulus words and they were *chemical change*, *physical change*, *chemical reaction*, *energy*, *chemical property*, *physical property*, *matter*, and *reaction equation*. The students were provided with a booklet, each page containing each page of which contained one of the eight stimulus words. For each stimulus word, students were asked to write down within 30 seconds as many response words as they could think of in association with each stimulus word. To obtain inter-judge reliability of the analysis, after the same WAT was applied, all WATs were analysed and a concept map drawn from the WAT results twice by the author in the different times.

There are several ways of scoring the data provided by a WAT. One way of representing the cognitive structure is by drawing a map. A number of different types of the map of KS can be produced (Preece, 1978) It is possible to draw a map using response frequencies for looking for relations used by Bahar et al. (1999). Researchers have claimed that counting the number of responses to each stimulus word is also one method of summarizing the WAT data (Shavelson, 1974; Bahar et al., 1999). Nakiboğlu (2008) has also suggested another mapping method by using response frequencies. In the present study, two response frequencies' map methods were used for WAT analysis developed by Bahar et al. (1999) and Nakiboğlu (2008). The number of responses to each stimulus word was tabulated for 9th and 10th grades firstly and then maps were drawn taking into account these tables. In Nakiboğlu's method, the thick lines represent the strongest interconnections between both two stimulus words and a stimulus word and a response word, while the thinner line between two stimuli words or a stimuli word and a response word indicates a weaker relation in the graphic representations of the cognitive structures.

RESULTS and FINDINGS

The maps of students' cognitive structures were drawn from the frequency tables by using both Bahar et al. (1999) and Nakiboğlu (2008) methods. Only the maps which drawn according to Nakiboğlu's method (2008) were presented in Figures 1 and 2 for 9th and 10th grades, respectively. Because the highest frequency range was 41≤ f≤49, this value was selected as the beginning frequency range for mapping. The lowest frequency range was found as 16≤ f≤20 for 9th grade and 13≤ f≤20 for the 10th grade since all stimulus words were appeared in this range for both grades.

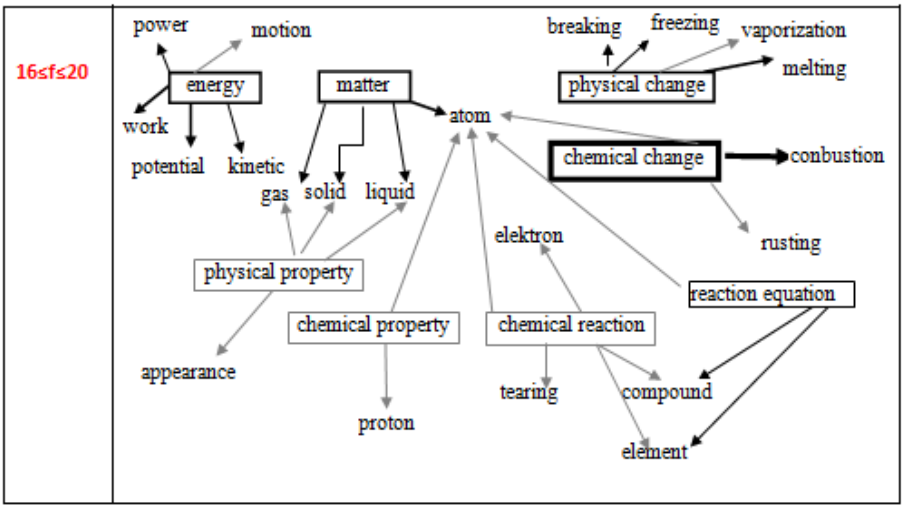

Figure1. The 9th Grade Students' Cognitive Structure

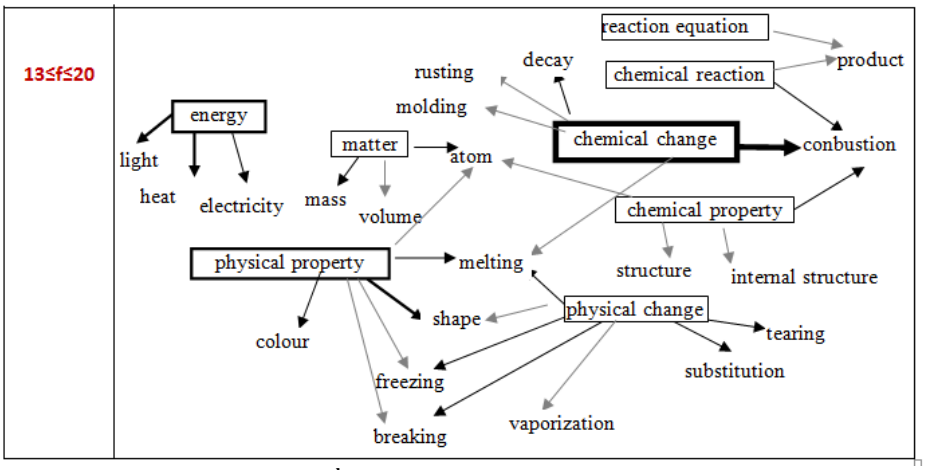

Figure2. The 10th Grade Students' Cognitive Structure

The comparison of 9th and 10th grades students' cognitive structures shows that while all stimulus words appeared and were added to the map at the frequency range 16≤f≤20 and three separate islands in Figure 1, not all stimulus words appeared at the same frequency range in Figure 2. In the case of 9th grade that before teaching the physical and chemical changes topic there were more disconnected ideas in the students' minds. The five stimulus words (*matter, chemical change, reaction equation, chemical reaction, and chemical property*) were connected to each other via only atom concept. While two stimulus words (*matter and physical property)* were connected to each other via three concepts (gas, solid, and liquid), two stimulus words (*reaction equation* and *chemical reaction*) were connected to each other via two concepts (element and compound). In the case of 10th grade, all stimulus words appeared at the frequency range 13≤ f≤20 and two separate islands were placed in Figure 2. There were more connections between stimulus words. While three stimulus words (*matter, chemical property* and *physical property*) were connected to each other via the atom concept, three stimulus words (*chemical change, physical property* and *physical change*) were connected to each other via the melting concept. The stimulus words *physical property* and *physical change* were connected to each other via the concepts shape, freezing and breaking concepts. While three stimulus words (*chemical change, chemical reaction, and chemical property*) were connected to each other via the combustion concept that is very significant connection among these tree stimulus words, the stimulus words *chemical reaction* and *reaction equation* were connected to each other via the concept of product meaningfully.

CONCLUSION

In this study, the word association test (WAT) was applied successfully in identifying conceptual organization of the cognitive structure of two student groups (9th and 10th grades) about the physical and chemical changes. It was concluded that there were differences between these two grades and the instruction did produce a significant difference. It can be said that instruction clearly has an influence on students' cognitive structure about the physical and chemical changes.

The method of analysis developed by Nakiboğlu (2008) was used for atom topic first time and in her study Nakiboğlu found that this method enabled the detection of strongly and weakly related concepts within a conceptional organization. Similarly in this study, the same method was also used to analyze the WATs and found out that strongly and weakly related concepts within the conceptional organization concerning the physical and chemical changes could be identified.

RECOMMENDATIONS

As suggested constructivist theory, meaningful learning can take place only when the learner is able to relate the new knowledge provided by a teacher to their existing knowledge. The examination of students' cognitive structures is important for probing what learners know about a topic before their instruction. Therefore, to gain students' cognitive structures before instruction can guide the design of the teaching process, which may lead to the construction of the desired knowledge. For this reason, the first recommendation of this study is that the teachers should gain information about their students' prior knowledge before the instruction that so they can find to chance to reconsider their teaching strategies. So many techniques can be used for probing students' prior knowledge and the WAT can also be suggested to use before the instruction to gain the students' prior concepts in students' conceptual structure.

REFERENCES

Bahar M., Johnstone A. H. and Sutcliffe R. G., (1999), Investigation of students' cognitive structure in elementary genetics through word association tests, *J. Biol. Educ.*, **33**, 134-141.

Cachapuz A. F. C. and Maskill R., (1987), Detecting changes with learning in the organization of knowledge: use of word association test to follow the learning of collision theory, Int. J. Sci. Educ., 9, 491-504.

Fisher K. M., (2004), The importance of prior knowledge in college science instruction, in D. W. Sunal; J.

Gay L. R. and Airasion P., (2000), *Educational research: competencies for analysis and application,* Prentice Hall, New Jersey.

Gussarsky E. and Gorodetsky M., (1988), On the chemical equilibrium concept: constrained word associations and conception, *J. Res. Sci. Teach.*, **25**, 319-333.

Kalyuga S., (2006), Rapid cognitive assessment of learners' knowledge structures, *Learn. Instr*., **16**, 1-11.

Nakiboglu C., (2008), Instructional misconceptions of Turkish prospective chemistry teachers about atomic orbitals and hybridization, *Chem. Educ. Res. Pract*., **4**, 171-188.

Preece P. F. W., (1978), Exploration of semantic spaces: review of research on the organization of scientific concepts in semantic memory, *Sci. Educ*., **62**, 547-562.

Shavelson R. J., (1973), Learning from psychic instructions, *J. Res. Sci. Teach.*, **10**, 101-111.

Shavelson R. J., (1972), Some aspects of the correspondence between content structure and cognitive structure in physics instruction, *J. Educ. Psychol.*, **63**, 225-234.

Shavelson R. J., (1974), Methods for examining representations of a subject matter structure in a student's memory, *J. Res. Sci. Teach.*, **11**, 231-249.

Tsai C. C., (2001), Proping students' cognitive structures in science: the use of a flow map method coupled with a meta listening technique, *Stud. Educ. Eval.*, **27**, 257-268.