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The Effects of Internet-Assisted Chemistry Applications on Prospective Chemistry Teachers' Cognitive Structure

Özge Özyalçın Oskay [a], Sinem Dinçol [a] *

[a]*Faculty of Education, Hacettepe University, Ankara, 06800, Turkey*

Abstract

The aim of this study is to determine the effects of internet-assisted chemistry applications" on prospective chemistry teachers' cognitive structures. Students were requested to answer two open ended questions. Answers by each student were gathered and evaluated by flow map method. "Bonding and hybridization" subjects were taught to control group with traditional teaching method and to experimental group besides traditional method internet-assisted applications were conducted. The same open-ended questions were given to both groups and their cognitive structures were examined once more. The differences between control and experimental groups' cognitive structures were examined.

Keywords: Internet-assisted chemistry applications; flowmap ; bonding and hybridization; cognitive structure, prospective chemistry teachers.

1. Introduction

How students think, organize knowledge and how they learn are among the greatest area of interest of education researchers. Each person uses different methods and techniques in organizing knowledge. Cognitive structure is an presumptive structure indicating the organization of concepts in students' long-term memories and the relationships between them (Shavelson, 1974, Selvi and Yakışan, 2005). A great majority of students try to memorize a lot of knowledge and their cognitive structures consist of isolated knowledge sets. Students with weak cognitive structure have the ability to process weak knowledge and adapt knowledge to new conditions and daily events (Tsai and Huang, 2002). Determining cognitive structure help teachers know the knowledge structures, pre-knowledge and misconceptions in their students' minds. As a result of this, teachers can arrange learning strategies in an appropriate way and realize conceptual change. Analyzing cognitive structures of students provides them with seeing how their learning takes place and thinking about alternative concepts and contributing their conceptual development (Tsai and Huang, 2002).

The internet is a computer network that connects databases and computers in all over the world. Pedagogical internet sites can be defined as a compilation of web pages prepared with the aim of education or training that provides the required pedagogical sources or can directly participate in education (Buissoon, Chaynes, Delestre, Dumoulin, Lebescond, 2004). In many studies it was determined that, use of internet with the aim of education increased students' interests, changed teacher-student relationship, contributed to shaping and analyzing thoughts (Hubert,Petit, Demily, Detroz and Denis, 2001, Pichault, 2001, Küçükcankurtaran, 2008). The animations and simulations presented by the internet provide understanding microscopic and dynamic processes and natural cycles

* Sinem Dinçol. Tel.: +90-312-2976787.
E-mail address: sinemdincol@hacettepe.edu.tr.

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and expensive experiments and activities that are difficult to be realized in the class environment. Information technologies such as internet supported education and computer supported education developed cognitive skills in students by providing educational tools that can be used in lessons. The feature of animating and visualization abstract scientific events in the class makes these subjects easier to understand (Para and Ayvaz Reis, 2010).

Anderson and Demetrius (1993) developed the method of flow maps different form concept maps and semantic network diagram in order to determine cognitive structure. The basic sense underlying flow map process is to expose the thoughts observed by the answerer from his expressions or defining the phenomenon he created in his memory. In this process, the expressions of the answerer recorded in the interviews are analyzed and the rank and place of the thoughts and the relationships between them are mapped in a diagram. According to the process of creating flow map developed by Anderson and Demetrius (1993), written expressions are transformed into flow maps in the following way:

1. Exposing the knowledge of the student 2.Transforming the expressions of the student into flow map 3. Indicating the flow of thought as connective expression lines via arrow marks 4. Indicating the related expressions with recurrent arrow marks 5. Numbering each expression and recording the time passing during the process of memorizing knowledge (Selvi and Yakışan, 2005).

In their study Tsai and Huang (2001) determined 5th grade students cognitive structure about "reproduction" subject using flow maps and interviews. Also Bischoff (2002) used flow maps to determine prospective teachers' cognitive structure about magnetism and electricity. In another study Selvi and Yakışan (2005) aimed to examine students' cognitive structure about the subject carbon cycle. At the end of the study it was observed that students had lack of knowledge while recall and constructing relationship between concepts. And also they observed that students could not write the basic steps of the carbon cycle. Within this study flow maps were used in order to determine the effects of internet assisted applications on students' cognitive structure about the subject hybridization and bonding. In some studies students stated hybridization and bonding as an abstract and difficult subject (Gabel, 1996, Levy Nahum, Hofstein, Mamlok-Naaman & Bar-Dov, 2004). For this reason hybridization and bonding is chosen as research subject.

1.1 Aim of the study

The aim of this study is:

1. To determine the cognitive structures of prospective chemistry teachers about hybridization and bonding before the application by using flow maps, 2. To determine the cognitive structures of the prospective chemistry teachers in experimental and control groups about hybridization and bonding after the applications by using flow maps, 3. To determine whether there is a significant statistical difference between cognitive structures of the prospective chemistry teachers in experimental and control groups about hybridization and bonding after the applications.

1.2 Research Questions

Research questions of this study have included:

1. What are the cognitive structures of prospective chemistry teachers about hybridization and bonding before the application? 2. What are the cognitive structures of prospective chemistry teachers about hybridization and bonding after the application? 3. Is there a significant statistical difference between cognitive structures of the students in experimental and control groups about hybridization and bonding after the applications?

2. Method

2.1. Sample

The sample of the study consisted of 36 prospective chemistry teachers attending Hacettepe University, Faculty of Education, the Department of Chemistry Education in 2010-2011academic year and taking Basic Chemistry I lesson. In the study, students were separated into experimental and control groups according to their pre-cognitive structures.

Data collection tools

Flow maps

In the study, flow maps were used in order to determine the cognitive structures of prospective chemistry teachers about the subjects of hybridization and bonds. Two open-ended questions were asked the prospective chemistry teachers in relation to the subject and pre-flow maps were prepared by the researchers depending on the written answers given to these questions according the procedure of Anderson and Demetrius (1993). The numbers of linear and recurrent connections in the flow maps were calculated and students' flow map scores were determined. These scores were accepted as the indicator of conceptual achievement. After the applications, the same two open-ended questions were asked the prospective chemistry teachers and post flow maps were prepared in same way according to the written answers. Then post conceptual achievements were determined. In addition, a flow map about the subject was prepared by the researchers. According to this, the maximum score that can be obtained from the flow map was determined as 36.

Reliability of flow map method

The reliability of the flow-map method was determined by a second independent researcher who is an expert in chemistry education to code conceptions from the students' narratives according to Anderson and Demetrius' procedure(Anderson and Demetrius, 1993).The Pearson correlation coefficient (r) for each student for linear linkages ranged from 0.71 to 0.96.

2.2. The implementation steps of the study

Two open-ended questions were asked prospective chemistry teacher in relation to the subjects of "bonding and hybridization" in order to determine their cognitive structures and conceptual understandings. These questions are:

What is hybridization? How does it occur? What are the hybridization types? Please explain it.

What is chemical bond? What are the chemical bond types? How does a chemical bond occur? Please explain it.

The written answers given by prospective chemistry teacher to the open-ended questions were collected and flow maps were prepared for each prospective teacher. The numbers of linear and recurrent linkages in the flow maps were determined and prospective chemistry teachers' last flow map scores were determined. In the light of data obtained from flow maps, the students having low, medium and high cognitive structures and conceptual understanding were determined. Students having cognitive structures from all levels were distributed to the groups equally and experimental and control groups were constituted. The subject was explained to the students in control group via traditional method. However, the subject was explained to the prospective chemistry teachers in experimental group via three-dimensional presentations, figures and animations by using data in

http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/hybrv18.swf
http://people.southwestern.edu/~footezm/GenChemTutorials/vseprquiz/vsepr_quiz2.html
http://www.mp-docker.demon.co.uk/as_a2/topics/shapes_of_molecules/index.html web pages in the internet environment along with traditional method. In addition, prospective chemistry teachers applied various exercises and quizzes on the internet.

After the applications, the same two open-ended questions were asked to the prospective chemistry teachers in both groups once again and written answers were collected. Post flow maps were prepared for each prospective chemistry teachers by the researchers, the numbers of linear and recurrent linkages were calculated and last flow map scores were determined. Whether there was a statistically significant difference between the last flow map scores of the prospective chemistry teachers in experimental and control groups, and thus between their conceptual understandings or not was determined.

3. Findings

The resulting findings were examined in line with the research questions of the study. With regard to the first research question of the study, the prospective teachers' cognitive structures related with "hybridization and bonding" before the applications were examined with flow maps. To this aim, the flow-maps prepared by the researchers for control and experimental groups were individually analyzed. Table 1 shows the average linear linkage number calculated by means of flow-maps.

Table 1. The mean number of the linear linkage estimated through flow-maps before the applications of control and experimental groups

Groups	N	Minimum	Maximum	Mean	Std. Deviation
Control Group	18	1	16	8,50	4,09
Experimental Group	18	2	17	7,55	3,64

The research revealed that the prospective teachers in both groups established only linear linkage on "hybridization and bonding". Therefore, only linear linkage average was used during the analysis. As Table 1 shows, the mean linear linkage number in the flow-maps for control group is $\bar{X}$=8.50, it is $\bar{X}$=7.55 for Experimental Group. It has been determined that the linear linkage number developed by the prospective teachers is approximately minimum 1 and maximum 17. Therefore, it has been seen that the prospective teachers has confined knowledge and conceptual understanding on "hybridization and bonding", poor cognitive structures and they put the relevant statements in a linear order.

In regard to the second research question, the prospective teachers' cognitive structures related with "hybridization and bonding" after the applications were examined with flow maps. To this aim, the flow-maps prepared by the researchers for control and experimental groups were individually analyzed. Table 2 shows the average linear linkage number calculated by means of flow-maps.

Table 2. The mean number of the linear linkage estimated through flow-maps after the applications of control and experimental groups

Groups	N	Minimum	Maximum	Mean	Std. Deviation
Control Group	18	3	21	13,88	5,37
Experimental Group	18	9	28	19,94	5,68

As Table 2 shows, the mean linear linkage number in the flow-maps for control group is $\bar{X}$=13,88 it is $\bar{X}$=19,94, for Experimental Group. It has been determined that the linear linkage number developed by the prospective teachers in control group is approximately minimum 3 and maximum 21 and for experimental group minimum 9 and maximum 28.

To mention the third research question of the study; independent samples t-test analysis was carried out in order to investigate the relation between the prospective teachers' success level and whether there is a significant statistical difference between cognitive structures of the prospective chemistry teachers in experimental and control groups about hybridization and bonding after the applications. Table 3 shows independent t-test results.

Table 3. Independent t-test results of the students in experimental and control groups about hybridization and bonding after the applications.

Study Group	N	Mean	sd	t	p
Experimental Group	18	19,94	5,68	3,28	.002
Control Group	18	13,88	5,37		

The mean score of the Experimental group was X=19, 94, and the mean score of the Control group was X=13, 88.(p<0,05). A significant difference was identified in favor of Experimental group was observed.

4. Discussion

Although for determination of students' cognitive structure, studies related with computer assisted education, internet assisted education or studies about hypermedia applications effects have been done; in such kinds of studies for determination of cognitive structure generally concept maps have been used. Liu, Chen and Chang (2010) investigated the effects of computer assisted applications on students' cognitive structures and found that computer assisted concept maps improved students success in English lectures. Similarly, Kim, Yang and Tsai (2005) analyzed the positive effects of online collaborative concept maps and found that internet is a good learning tool for co-constructing knowledge. But there are not so many studies investigating the effects of internet assisted education on students' cognitive structure by using flow maps. With this point of view, within this study the effects of internet-assisted chemistry applications" on prospective chemistry teachers' cognitive structures was investigated.

36 flow-maps that were prepared by the researchers through the answers of the prospective teachers to the open ended questions regarding "hybridization and bonding" and that aims to discover the students' relevant cognitive structures have been analyzed. The linear linkages have handled since the prospective teachers had developed only linear linkages. The number of the linear linkage average developed by the prospective teachers before the applications has been found 1 at minimum and 17 at maximum and after the applications has been found 3 at minimum and 28 at maximum . These values have been considered to be extremely low; for, it had been assessed in the flow-maps formulated by the researchers that the linear linkage is 36. Accordingly, it has been concluded that that the prospective teachers has confined knowledge and conceptual understanding on "bonding and hybridization", poor cognitive structures and they put the relevant statements in a linear order. These findings are in consistent with the results of study held by Selvi and Yakışan (2005).

Independent t-test results revealed that a significant difference in students' cognitive structure was identified in favor of Experimental group. Approving Para and Ayvaz Reis' (2010) thoughts these results show that supporting the lecture with animations and visualizing bonding, hybridization, and bond formation made the subject easier to understand and improved students' cognitive structure.

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