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The effect of concept mapping on meaningful learning of Atom and bonding

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Abstract

This study investigates the effect of hypermedia-hypertext and paper-pencil type concept maps created in the Basic Chemistry I course for the subject of atom and bonding on students' meaningful learning. The research was conducted with a total of 30 students enrolled in Basic Chemistry I at Hacettepe University, Faculty of Education. An atom-bonding knowledge test and concept maps were used as data collection tools in this study. It was established that concept maps created using the hypermedia-hypertext technique contribute to the students' meaningful learning.

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Keywords: Concept mapping, hypertext, hypermedia, paper-pencil concept map, meaningful learning, atom-bonding .

1. Introduction

According to Novak, “Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures” (Plotnick, 1997). A concept map stimulates this process by requiring the learner to pay attention to the relationship between concepts. Concept mapping techniques are interpreted as representative of students' knowledge structures (Mintzes, Wandersee, & Novak, 1997; Novak and Godwin, 1984; Yin et al., 2005). A concept map includes nodes (terms or concepts), linking lines (usually with a unidirectional arrow from one concept to another), and linking phrases that describe the relationships between nodes. Linking lines with linking phrases are called labeled lines. Two nodes connected with a labeled line are called a proposition. Moreover, concept arrangement and linking line orientation determine the map's structure (e.g. hierarchical or non-hierarchical) (Yin et al., 2005).

Researchers have suggested that people can be divided into meaningful and non-meaningful learners. Meaningful learners construct concept maps containing more concepts, more relationships and more branching than rote learners (Pearsall, Skipper and Mintzes, 1997; Carnot, Dunn und Canas 2007). With developments in computer technology and the World Wide Web becoming a powerful medium for disseminating information, hypertexts and

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hypermedia are used for drawing concept maps (Plotnick, 1997). The term “hypermedia” derives from “hyper” in the word “hypertext” and the “media” in the word “multimedia” (Reed, Ayersman and Lui, 1996). Hypertext is a navigation process that allows hypermedia users to branch out when seeking additional information related to a target word or phrase. Multimedia refers to the availability of the information in various media forms, such as text, photo and sound (Reed and Oughton, 1998). The structural correspondence between hypertext design and concept maps makes concept mapping a suitable tool for designing the conceptual structure of hypertext (Conklin, 1987).

Ferry (1996) gave pre-service teachers a HyperCard based tool to create and modify concept maps about science related subject matter. He found that this type of concept map construction enhanced pre-service teacher thinking about effective teaching. Rojer and Rojer (2004) compared the use of paper-pencil and computer tools for creating concept maps with 9th and 10th grade biology students. At the end of the study it was found that the group using the computer created more complex maps than the group that used paper-pencil method. In another study Lin et al. (2004) compared the use of computer-based concept mapping with paper-pencil concept mapping in a writing class. They observed that the students who generated paper-pencil concept maps scored better.

1.1. Aim of the Study

The aim of the present study is to establish the effect of concept maps prepared using different techniques in the Basic Chemistry I course for the subject of atom and bonding on students' meaningful learning.

Problem Statement

What are the effects of concept maps, prepared using different techniques, on the meaningful learning of students in atom and bonding?

Secondary questions

1. What are the effects of concept maps prepared using the hypertext-hypermedia concept mapping technique (HM-HT-CM) on meaningful learning of atom and bonding in Group I?
2. What are the effects of concept maps prepared using the paper-pencil concept mapping technique (PP-CM) on meaningful learning of atom and bonding in Group II?
3. Do the concept maps prepared using two different techniques for the subject of atom and bonding exhibit significant differences according to groups?

1.2. Sample of the Study

The study was conducted with the participation of 30 Basic Chemistry I students studying at Hacettepe University, Faculty of Education, Department of Computer Education and Instructional Technologies (Group I) and Department of Biology Education (Group II). 15 students from each department took part in the study.

2. Method

2.1. Data Collection Tool

The Atom-Bonding Knowledge Test and the concept maps prepared by the students were used as data collection tools in the study.

Atom-Bonding Knowledge Test: The test is comprised of 10 open-ended questions. The questions were prepared by the researchers and their reliability was established by chemistry education experts. Each item in the test was evaluated out of 10 points. The maximum possible score is 100.

Concept Maps: In the study, Group I students draw their concept maps using the hypertext-hypermedia technique and Group II students used the paper-pencil concept mapping technique. Concept maps prepared using these two methods were evaluated on a 100-point scale.

In the concept maps prepared using hypertext-hypermedia, all sorts of media accessible through the Internet were utilized such as text, graphics, audio, moving images. The paper-pencil concept mapping technique is the traditional method using paper and pencil.

2.2. Procedure

At the beginning of the study, basic information on the subject of atom and bonding was explained to the students. Then the knowledge test on atom and bonding was conducted as a pre-test in order to assess the knowledge level of the students and to include students at the same level of knowledge in the study sample. Concept mapping and how to prepare concept maps were explained to the students in both groups, providing examples. Atom and bonding was explained to the students in Group I using concept maps prepared in a computer environment using hypertexts. The subject was explained to the students in Group II using concept maps prepared with the paper-pencil method. Afterwards the students were asked to prepare their own concept maps regarding these concepts.

2.3. Analysis of the Data

In data analysis, a dependent sample t-test was used to evaluate the difference between the groups' atom and bonding knowledge test, pre-test and post test results, whilst an independent sample t-test was used for inter-group comparisons. For the evaluation of concept maps, the following scoring method developed by Novak and Gowin (1984) was used:

Relationships: one point for each valid proposition

Hierarchy: five points for level of hierarchy

Cross-Links: ten points for each valid cross link

General to Specific Example: one point for each valid example.

3. Findings

The dependent t-test results relating to the atom and bonding knowledge test of Group I and Group II students are shown in Table 1.

Table 1: Dependent t-test results relating to the atom and bonding knowledge test in Group I and Group II

Study Group		N	Mean	sd	t	p
1.Group HM-HT-CM	Pretest	15	58,20	19,59	4,83	.000
	Posttest		80,20	15,67		
2.Group PP-CM	Pretest	15	62,60	13,66	2,04	.061
	Posttest		71,40	15,44		

On analyzing Table 1, when the pre-test and post test results of the students in Group I were compared, a significant difference in favor of the post test was observed ($X_{\text{pre-test}} = 58,20$, $X_{\text{post-test}} = 80,20$ $t=4.83$; $p<0.05$). In Group II no significant difference was found between the pre-test and post test results ($X_{\text{pre-test}} = 62,60$, $X_{\text{post-test}} = 71,40$ $t=2.04$; $p>0.05$).

The independent t-test results of the concept maps prepared using two different techniques are shown in Table 2.

Table 2: Independent t-test results of the concept maps prepared using two different techniques

Study Group	N	Mean	sd	t	p
1.Group (HM-HT-CM)	15	65,87	16,96	4,62	.000
2. Group (PP-CM)	15	42,00	10,61		

The mean score of the concept maps prepared using HM-HT-CM was $X=65.87$, and the mean score of the concept maps prepared using PP-CM technique was $X=42.00$ (Table 2). A significant difference was identified in favor of the concept maps prepared using the hypermedia-hypertext concept mapping technique.

4. Discussion

In this study, which investigated the effects of concept maps on the students' meaningful learning of atom and bonding, it was determined that concept maps prepared using the hypermedia-hypertext concept mapping technique contributed to the students' meaningful learning. It was found that the mean scores of the concept maps of Group I students, who prepared their maps using HP-HT-CM, were higher than the mean scores of the Group II students, who prepared concept maps using PP-CM. In the study, it was observed that the number of correctly established relationships between concepts were higher on the maps prepared using HP-HT-CM compared to the maps prepared using PP-CM. It is probable that the picture, audio and visual information, and examples on the links placed on the concepts in the map, help students achieve lasting and meaningful learning. In the PP-CM technique, only relationships between concepts can be established on the maps. It was observed that the concept maps prepared using PP-CM were very complicated. According to the results of the knowledge test, a significant difference was observed between the pre-test and posts test mean scores of the Group I students. It can be stated that the concept maps prepared using HP-HT-CM were effective in the occurrence of this difference. It is thought that the HP-HT-CM technique helps establish correct relationships when creating concept maps. The advantage of this technique is the use of technology. It motivates the students and helps increase their success. The difference between the pre-test and post test results was not significant in Group II students. This is due to the fact that in concept maps prepared using the PP-CM technique, if the student does not have adequate knowledge when indicating the link between any two concepts, he must read the entire chapter in order to find the required information. The student who is reluctant to read the entire chapter is unable to completely learn the link in question. These findings are congruent with findings obtained in studies by Ferry (1996) and Rojer and Rojer(2004) that compare computer aided concept mapping using the hypermedia technique with concept maps prepared using a paper-pencil technique.

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