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THE EFFECTS OF NOTE TAKING IN SCIENCE EDUCATION THROUGH THE MIND MAPPING TECHNIQUE ON STUDENTS' ATTITUDES, ACADEMIC ACHIEVEMENT AND CONCEPT LEARNING

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Abstract. *The aim of this study is to determine the effects of note taking during their science courses through the technique of mind mapping by primary education students, on their attitudes, academic achievement and concept learning. In the study, both quantitative and qualitative research methods were used. In the quantitative research area, the pre-test and post-test assessment model with experiment and control groups was used. In the qualitative research area, document analyses were made. The research was performed on 81 randomly chosen 6th (ages 11 and 12) grade students from public schools in the district of Fatih, Istanbul during the scholastic year 2004-2005. The application period took 21 course hours in total. The reliability coefficient of the academic achievement test, which was one the three measurement instruments, was calculated as KR20=0, 73. The Cronbach of the scale for the attitudes towards science courses, developed by Akinoglu (2001). is α= 0, 89. The open-ended questions used in the research were qualitatively encoded by means of open-codification method. On the basis of the data obtained in the research, it was determined that there was a significant positive difference in students' concept learning, overcoming misconceptions, academic achievement and attitudes towards science courses by taking notes through the mind-mapping method.*
Key words: *constructivism, mind-mapping, taking notes, concept learning.*

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Introduction

Contemporary, international economic competition and social, scientific and technological innovations have substantially changed ways of life. Countries aiming to keep up with these challenges are aware of the critical role of science classes in achieving this ambitious goal (AAAS, 1990; AAAS, 1993; Hurd, 1997; Roberts & Östman, 1998; ITEA, 2003). Therefore, societies from all over the world are making intensive efforts and carrying out "educational reforms" to adapt to lasting changes (Cleminson, 1990; Bybee, 1997). Science education has faced many important problems, including that the internalization of concepts, the occurrance of misconceptions, and the lack of opportunities for learning by doing (Driver & Erickson, 1983; Harlen, 1985). When the attitudes of primary education children towards science classes are observed, it is evident that while students actually like these classes, they cannot reach the required level of achievement. This is caused by the fact that while science classes need active learning methods such as searching, implementation, experimentation, investigating or observation, the methodology adopted is characterized by lecturing and questioning-answering methods for several reasons. In this context, students take notes and write both what they think and what they are told by their teachers to increase recall of the knowledge being taught in classes.

For the constructivist learning approach, that makes special emphasis on the active learning, individuals form and construct knowledge by attributing personal meanings to it after analyzing their experiences, observations and logical inferences. According to this approach, individuals who have fulfilled learning personally reorganize knowledge (Brooks & Brooks, 1993; Von Glasersfeld, 1995). In science education, the knowledge or experiences acquired by students are internalized distinctively by each student (Tobin, 1993; Marlowe and Page, 1998; Matthews, 1998). In order to bring about effective science education, it is necessary to understand the concept organizations formed by students and to construct new knowledge on them (Ausubel *et al,* 1978; Bruner, 1996). Constructive learning theory emphasizes questioning, critical thinking and problem solving skills and active participation of individuals. In this theory, the class environment is a flexible and liberated place which enables students to be autonomous, to be willing to learn and to establish their own perspectives. Learners should be given the opportunity to exhibit and support their own points of views and to experience knowledge with various materials and approaches in appropriately established class environments (Slavin, 1995; Eggen and Kauchak, 1999; Driscoll, 2000).

Concept maps, which have recently become popular in many fields including the field of education, ensure the permanency of learning by connecting the subject matter-related concepts learned by individuals (Novak and Gowin, 1984). A concept map shows how knowledge is constructed in people's minds (Novak *et al,* 1983). With concept maps, the knowledge becomes meaningful by being internalized. Thus, students can connect new knowledge to what they learned before. Mind maps are similar to concept maps. However, in concept maps, students only focus on the definition of the concept learned the connections of this concept with other concepts. Conversely, in mind maps, students make learning more effective by connecting the main concept to other concepts by means of various symbols and images so as to facilitate recall of all these connections. Mind maps, developed by Buzan, are used to make note taking more effective and more pleasurable (Buzan, 1996). Taking notes by using colored pencils, key words, symbols and images makes the note taking activity more enjoyable for students, enables students to transfer concepts into their long-term memory and contributes to the constructive process in students' minds. The mind map is a diagram having a pictorial central part and illustrating semantic or other connections among knowledge and concepts. By using the mind mapping technique, a large body of knowledge can be organized and located in a relatively smaller area (Huba and Freed, 2000). Mind maps are used to form, visualize, conceive and classify thoughts in educational fields, organizational activities and problem-solving and decision-making processes. Through the mind mapping technique, both general framework and details of subject matter can be visualised, and thus this technique directs people towards convergent and divergent thinking. Substantially, mind mapping is the art of writing in a language that is understandable and conceivable for the brain.

Aim of the study

The aim of this study is to determine whether note taking by means of the mind mapping technique by 6th grade students in primary education in the course units titled "*What is there in our bodies?*" and "*How we perceive our environment?*" in their science studies classes significantly affects these students' academic achievement, attitudes towards science studies classes and concept learning. On the basis of this aim, the following hypotheses were developed:

Is note taking, using the mind mapping technique, by 6th grade students in primary education in their science studies classes

1. making significant differences in these students' academic achievement level?
2. constituting significant differences in these students' attitudes towards the mentioned classes?
3. having any effect on concept learning?

Methodology of Research

Model of the research

In the study, both quantitative and qualitative research methods were used (Creswell, 2003). In the quantitative research, the pre-test and post-test assessment model with experiment and control groups (ages 11 and 12) was used. Document analyses was the qualitative methodology adopted.

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Application

The research was performed with the participation of 6th grade (ages 11 and 12) students enrolled in public primary schools in the district of Fatih, Istanbul during the scholastic year 2004-2005. Students were following the framework of the course units titled "*What is there in our bodies?*" and "*How we perceive our environment?*" as part of the science studies curricula of the Turkish National Education Ministry. In the study, a primary school located in the mentioned district was chosen randomly. The 6th grade students of this school were given an academic achievement test prepared by the researcher and encompassing 40 questions, a concept knowledge measure involving 10 open-ended questions and "the scale for the attitudes towards science courses", developed by Akinoglu (2001) as pre-tests. Experiment and control groups having equivalent levels were formed. A total of 81 students participated in the research. Table 1 summarizes the characteristics of the sample.

Table 1. Characteristics of the study sample.

Experiment Group		Control Group	
Males	Females	Males	Females
20	16	22	23
Total: 36		Total: 45	

The steps taken by the researcher during the experiment are now summarized. Before teaching the main subject matter, information about mind maps was offered to students in the experiment group. These students were asked to prepare mind maps on any subject matter they had learnt previously. This students' preparation of mind maps took 2 class hours. After classes were lectured, students in the experiment group were asked to convey what they learned about the subject matter to paper by using the mind mapping technique. The mind maps of each student were then gathered and archived. Lectures were given to the control group students with traditional methods. The application period took 21 class hours, i.e. 7 weeks, in total. At the end of the research, both groups were re-given the academic achievement test, open-ended questions and attitude scale, and all the data obtained were assessed by the researcher.

Data collection and data analysis

In the research, three measurement instruments were used: the academic achievement test, open-ended questions and scale for attitudes towards science classes. The information about preparation, application and assessment of these measurement instruments is given below.

Preparation, application and assessment of the academic achievement test: The achievement test was prepared in conformity with the criteria set in the Primary Education Science Studies curricula for 6th graders with the aim of measuring the changes in students' academic achievement after taking the mentioned science classes. In preparing the test, forty five questions having four choices were composed by the researcher. After calculating validity and reliability of all questions in a pilot study and receiving the opinions of four experts: a curriculum development specialist, a professor in elementary science education specializing in biology education, and two elementary science teachers with 10-year teaching experience and Master's degrees in elementary science education. Some questions with low validity and reliability were removed from the test. The number of questions was reduced to 40 and the test was given in its final revised form. The reliability coefficient of the academic achievement test was found KR20= 0, 73 (0, 7338). This indicates that the reliability level of the test is 73%. The researcher was present in the classroom while the achievement test was being applied. Students were given 50 minutes to complete this test.

Preparation, application and assessment of the open-ended questions: Open-ended questions were prepared to measure the students' knowledge level about scientific concepts before and after attending the mentioned course units. Initially, fourteen open-ended questions were prepared by the researcher in accordance to the Primary Educational Science Studies curricula. Later on, by taking the opinions of the four experts: the number of questions was reduced to 10. These questions were used to determine whether students have learned the concepts meaningfully or not. Table 2 below shows the subject matter assessed by the open-ended questions:

Table 2. Subject matter addressed by the open-ended questions.

Question No.	Open-ended question	The subject matter being assessed
1	What changes do occur in your body when you watch a horror movie? Why?	Controlling and regulatory systems
2	To a patient who had seen a doctor for several health problems, it was said that her/his some hormones controlling blood sugar level do not function properly. What are the effects of these malfunctioning hormones to her/his body?	Controlling and regulatory systems
3	What are the roles of nasal hair and mucus secretion? What would happen if these structures did not exist?	How do we smell?
4	Please, draw a tongue and show taste perception sites on it.	How do we taste?
5	Why do not we perceive tastes of food when we have a cold?	How do we smell and taste?
6	What could be the problem if a person could not hear the voices around her/him?	How do we hear?
7	What would happen in a person's body if s/he did not have a nerve system or brain? Please, explain this by examples.	Controlling and regulatory systems
8	By drawing an eye, please explain what happens in our eyes after we notice an object and see it.	How do we see?
9	How and through which sense organs do we perceive an object in our hands when our eyes are closed?	How do we perceive our environment?
10	An oculist determined that Gül cannot see far, Gamze cannot see near, Gonca cannot see the objects clearly and Gizem cannot distinguish the colors of red and green from each other. What could be the diagnoses of this doctor for them? How could these eye disorders be cured?	How do we see?

The open-ended questions used in the study were encoded through the open-codification technique. The answers of all students were examined by the researcher. Answers were assessed by means of the classification of understanding levels, developed by Abraham and Williamson (1994). These assessment criteria are given in Table 3 below.

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Table 3. Assessment criteria used to classify understanding levels.

Level of understanding	Symbol	Score
Not understood	NU	0
There is a wrong concept	W	1
Partially understood, but there is a wrong concept	P / W	2
Partially understood	P	3
Completely understood	C	4

The researcher was present in the classroom while the open-ended questions were being answered. Students were given 40 minutes to answer these questions.

Preparation, application and assessment of the attitude scale: In the study, "the scale for attitudes towards science studies classes" developed by Akinoglu (2001) and composed of 20 items was implemented in order to determine the students' attitudes towards these classes. The reliability of the scale developed by Akinoglu is α=0, 89. The attitude scale is designed in Likert-5 type and composed of twenty positive and negative descriptive sentences for students' attitudes oriented towards science studies classes. Students were given 20 minutes to answer the statements in the scale.

Results of Research

The effects of taking notes through the mind-mapping technique on academic achievement

The findings obtained from the pre-test and post-test results of the experiment and control groups with the aim to examine the effects of note taking in science education via the mind-mapping technique on students' academic achievement are presented in tables and interpreted.

Table 4. The results of the unpaired "t" test applied to pre-test score differences between the experiment and control groups.

	GROUPS	N	X	Standard deviation	Standard error	Unpaired group "t" test		
						Sd	t	p
PRE-TEST	Experiment group	36	11,6944	4,10449	,68408	79	0,995	>0,05
	Control group	45	11,6889	4,30551	,64183			

As shown in Table 4, when the pre-test scores of the experiment and control groups are compared the arithmetic mean of the experiment group is 11, 6944 and the arithmetic mean of the control group is 11, 6889. This indicates that there is no significant difference between the pre-test scores of the groups at the critical value of 0,05. These results show that the condition concerning the equivalence of pre-knowledge levels of both groups before the research is being fulfilled.

Table 5. The results of the unpaired "t" test applied to post-test score differences between the experiment and control groups.

	GROUPS	N	X	Standard deviation	Standard error	Unpaired group "t" test		
						Sd	t	p
POST-TEST	Experiment group	36	21,8333	6,86398	1,14400	79	0,000	<0,05
	Control group	45	15, 8444	4,56745	0,68088			

As indicated in Table 5, when the post-test scores of the experiment and control groups are compared the arithmetic mean of the experiment group is 21, 8333 and the arithmetic mean of the control group is 15, 8444. There is a 6-point difference between the arithmetic means of the groups. Since p value is smaller than 0, 05, there is a significant difference between post-test scores of these groups at the critical value of 0, 05. This result demonstrates that note taking by means of the mind-mapping technique plays a significant role in academic achievement.

The effects of taking notes through the mind-mapping technique on attitudes towards science studies classes

The data about the pre-attitudes of the experiment and control group students are given below.

Table 6. The findings on the pre-attitudes of the experiment and control group students towards science studies class.

	GROUPS	N	X	Standard deviation	Standard error	Unpaired group "t" test		
						Sd	t	p
PRE-ATTI-TUDE	Experiment group	36	66,6389	15,75011	2,62502	79	0,831	>0,05
	Control group	45	66,0222	10,02608	1,49460			

As shown in Table 6, when the pre-attitude values of the experiment and control groups are compared with each other, the arithmetic means of pre-attitude scores of the experiment group and the control group are 66,6389 and 66, 0222 respectively. When the results of the unpaired t-test were examined, it was found that there is no significant difference between two groups at the critical value of 0, 05.

Table 7. The findings on the post-attitudes of the experiment and control group students towards science studies class.

	GROUPS	N	X	Standard deviation	Standard error	Unpaired group "t" test		
						Sd	t	p
POST-ATTITUDE	Experiment group	36	71,3889	13,61990	2,26998	79	0,019	<0,05
	Control group	45	63,9111	14,15952	2,11078			

Table 7 shows that when the post-attitude values of the experiment and control groups are compared the arithmetic means of post-attitude scores of the experiment group and the control group are

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71, 3889 and 63, 9111 respectively. The p value is smaller than 0, 05 indicating a significant difference between the post-attitude values of these groups at the critical value of 0,05. Consequently, it was determined that there was a positive escalation in science studies class-oriented attitudes of the experiment group students who took notes with the mind-mapping technique.

General assessment of the effects of the note taking in science education by means of the mind-mapping technique on concept learning in the light of the qualitative findings gathered from open-ended questions

The following findings were obtained when the answers given by the experiment and control group students to the 10 open-ended questions in both pre-test and post-test were assessed:

- Answers given to question 1 show that *complete conceptual understanding* level of the experiment group students was higher than the corresponding level of the control group students after the subject matter had been taught.
- Answers to question 2 reveal that *partial and complete conceptual understanding* level of the experiment group students was relatively higher than the corresponding level of the control group students after they had listened to the class lectures.
- Answers given to question 3 revealed a higher *complete conceptual understanding* level of the experiment group students than the control group students.
- Answers to question 4 showed that most of the experiment group students *completely understood* the concepts, but the control group students displayed lower understanding levels. Furthermore, while most of the experiment group students corrected their prior misconceptions, there was no much correction in misconceptions of the control group students due to the effects of pre-learning.
- Answers given to question 5 revealed that the *complete conceptual understanding* level was low in both groups, but the experiment group students were more successful in concept learning in comparison to the control group students.
- Answers to question 6 showed that although *complete conceptual understanding* level increased in both groups after the subject matters had been taught, there was a higher increase in the experiment group.
- Answers given to question7 revealed that the experiment group students learned the concepts more accurately than the control group students.
- Answers to question 8, it was observed that most of the experiment group students *understood* the subject matter *partially or completely*, but the control group students displayed lower understanding levels.
- Answers to question 9 indicate that the experiment group students had very few misconceptions.
- Answers given to question 10, showed that the level of understanding the concepts *partially or completely* was higher in the experiment group students than the control group students. In the light of these findings, it can be said that the students who took their own notes in science education through the mind-mapping technique had higher levels of conceptual understanding and very fewer misconceptions in comparison to the control group students.

Conclusion and Discussion

This study examined how the taking notes by primary education 6th grade students in their science studies courses through the technique of mind mapping positively affects their attitudes, academic achievement and concept learning. Based upon the research findings covering the effects of note taking in science education through the technique of mind-mapping on students' academic achievement, concept learning and attitudes towards science studies classes, it was determined that there were significant differences between the experiment group and control group after the comparisons of post-test results of the both groups with each other. In science education, the note taking by using the technique of mind-mapping has more positive effects on students' academic achievement, attitudes towards science studies classes, concept learning, and misconception correction levels than traditional methods. Findings from various studies performed on concepts are in parallel to these results (Pearsall and *et al,* 1996; Kinchin, 2002). Kiewra found that there was a positive correlation between the techniques of note-taking and reviewing and the level of academic achievement (Sutherland and *et al,* 2002, 379). For Fender (2003: 69). the skills to listen and to take notes are very critical for learning classes. Students who do not know how to take notes and to use their notes effectively face various problems (Wittrock, 1986; Fredericks and Cheesebrough, 1993; NRC, 1996).

In their study on the technique of mind-mapping which can be used as a technique of studying by students, Farrand *et al* (2002) found that there was a significant performance difference between the group which preferred studying alone and the group which used the technique of mind-mapping, on the condition that there had been no significant motivation and performance differences between these groups prior to the study. The notes taken by listeners enable these individuals to participate in the listening process actively (Simonet, 1995; Fender, 2003). If individuals who are in active listening process can convey what they have mentally constructed to paper, their knowledge recall and learning processes become easier (Osborne and Freyberg, 1985; Lehman *et al,* 1985; Okebukola and Jegede, 1988; Buzan, 2002). Balim *et al* (2006) found that the use of visual techniques such as mind-mapping helps students in constructing knowledge and in making necessary connections between their existing cognitive constructs and new knowledge. Budd (2004) determined that students focus on the content of subject matters when taking notes through the technique of mind-mapping and this contributes to active learning and cooperative learning. They also found that the use of colors and codes facilitates the perception by all brain sections (Woolfolk, 1993; Gardner, 1999). Mind maps enable people to see the various aspects of subject matter, and seeing all constituents simultaneously positively affects concept learning (Wyckoff, 1991; Meyers and Jones, 1993; McComas and Olson, 1999; Mintzes and *et al,* 1999; Buzan, 2002). Teachers can construct classes so as to see misconceptions and improper connections of students in relation to subject matter by using mind maps made at the beginning of or at the end of course units or subject matters.

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