THE EFFECTS OF CONCEPT MAPPING AND SOME OTHER VARIABLES ON LEARNING OF HUMAN EXCRETORY SYSTEM

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ABSTRACT

EFFECTS OF CONCEPT MAPPING AND SOME OTHER VARIABLES ON LEARNING OF HUMAN EXCRETORY SYSTEM

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The purpose of this study is to examine contributions of teaching method, students' attitudes towards biology, student's families' socioeconomical status, their Lycee 1 and Lycee 2 average grades and school types on achievement of students' understanding excretory system.

This study was done at fall semester of 1999-2000 at two Dersane. 146 students participated to this study. 76 out of 146 were belonging to experimental group and 70 out of 146 were belonging to control group. Human excretory system was taught to experimental group by making use of a concept mapping together with traditional lecturing. On the other hand, the teacher of the control group taught

human excretory system by using only traditional lecturing. Instruction on both group lasted two class hours, which equal 100 minutes.

Data related with students' lycee 1 and lycee 2 grades, school type that they have gone, age, gender, socioeconomical status of student's family were collected by a questionnaire, which consists 6 questions, and data related with attitudes of students towards biology were collected by an attitude towards biology scale consisting of 15 questions. Finally, excretory system achievement test consisting of 16 questions was used to evaluate students' understanding of human excretory system.

In this study, the statistical methods were MRC (Multiple Regression & Correlation) and ANCOVA (Analysis of Covariance). MRC was used to investigate the contribution of average of students' lycee 1 and 2 grades, attitudes of students towards biology, students' socioeconomical status and teaching method to the students' achievement on understanding of excretory system. ANCOVA was used to find school type's contribution to the student's achievement on learning human excretory system.

Results of this study revealed that there was a significant contribution of attitudes of students toward biology course, teaching method, school type, averages of students' lycee grades, and socioeconomical status of students on understanding human excretory system. MRC results have shown that, teaching method, as an independent variable was second best explanatory variable of students' achievement

on understanding of human excretory system, and also ANCOVA result has shown that, school types have significant contribution to the students' achievement on understanding human excretory system.

KEYWORDS: Concept Mapping, Human Excretory System, and Traditionally Designed Biology Instruction.

ÖZ

KAVRAM HARİTALAMA VE DİĞER DEĞİŞKENLERİN İNSAN BOŞALTIM SİSTEMİNİN ÖĞRENİLMESİNE ETKİLERİ

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Bu çalışmanın amacı, öğrencilerin insanda boşaltım sistemini anlamaktaki başarısına öğretim metodu, öğrencilerin biyolojiye karşı tutumu, öğrencilerin sosyoekonomik durumu, lise 1 ve lise 2 not ortalamaları, ve öğrencilerin devam ettikleri okul türünün katkısını incelemektir.

Bu çalışmanın uygulaması 1999-2000 eğitim ve öğretim yılının kış döneminde iki farklı dersanede (Dersane A ve Dersane B) yapılmıştır. Çalışmaya 146 öğrenci katılmıştır. Bu öğrencilerin 76'sı deney grubunda, 70'i ise kontrol grubunda yer almaktadır. Deney grubuna insan boşaltım sistemi geleneksel ders anlatım metodu içinde kavram haritası kullanılarak anlatılmış, kontrol grubuna ise

geleneksel ders anlatım metodu kullanılarak insanda boşaltım sistemi anlatılmıştır. Her iki grupta da konu anlatımı iki ders saati yani 100 dakika sürmüştür.

Öğrencilerin lise 1 ve lise 2 not ortalamaları, devam ettikleri okulun türü, yaşları, cinsiyetleri, ailelerinin sosyoekonomik durumlarına ait bilgiler hazırlanan 6 soruluk bir anket ile, biyolojiye karşı tutumlarına ait bilgiler ise 15 soruluk biyoloji tutum ölçeği ile toplanmıştır. Boşaltım sistemi başarı testi ise 16 sorudan oluşmaktadır, ve öğrencilerin insan boşaltım sistemini anlamasındaki başarıyı değerlendirmek için kullanılmıştır.

Bu çalışmada MRC ve ANCOVA istatistik metodu olarak kullanılmıştır. MRC' de bağımsız değişken olarak öğrencilerin biyolojiye karşı tutumları, not ortalamaları, ailelerinin sosyoekonomik durumu, ve anlatım metodu alınmıştır. Bunların öğrencilerin başarısı üzerindeki paylarına bakılmıştır. ANCOVA metodu ise öğrencinin devam ettiği okul türünün öğrencinin başarısına katkısını incelemek için yapılmıştır.

Çalışmanın sonucunda, öğrencilerin biyolojiye karşı tutumları, not ortalamaları, ailelerinin sosyoekonomik durumu, devam ettikleri okulun türü ve anlatım metodu değişkenlerinin öğrenci başarısına katkılarının bulunduğu görülmüştür. MRC sonuçlarına göre anlatım metodu öğrenci başarısını açıklayan en iyi ikinci değişkendir. ANCOVA sonucu ise okul türünün öğrencilerin insan boşaltım sistemini anlama başarısı üzerine katkısı olduğunu göstermiştir.

ANAHTAR KELİMELER: Kavram Haritalama, İnsanda Boşaltım Sistemi, Geleneksel Anlatım Yöntemi

To My Family

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LIST OF SYMBOLS

CG	:Control Group
EG	: Experimental Group
ICM	: Instruction with Concept Mapping
TDBI	: Traditionally Designed Biology Instruction
SESQ	: Socioeconomical Status Questionnaire
ASTB	: Attitudes Towards Biology
ESAT	: Excretory System Achievement Test.
T	: T Statistic.
F	: F Statistic
p, α	: Significance Level.
df	: Degrees of Freedom
ANCOVA	: Analysis of Covariance
MRC	: Multiple Regression and Correlation
R	: Multiple Correlation Coefficient.
R^2	:Coefficient of Multiple Determination

CHAPTER 1

INTRODUCTION

Schools are primarily interested in students being able to incorporate meaningful materials into their cognitive structure (Ausubel & Robinson, 1969). This is fortunate, because humans are significantly better able to absorb and retain meaningful learning than rote learning. Ausubel (1963) posits that meaningful learning occurs when new information is linked to existing relevant concepts in the learner's cognitive structure. Novak, Gowin and Johansen (1983) have shown how this theoretical structure can be applied to developing a concept map, which can be used as a practical teaching and learning technique. Concept mapping is an excellent device that visually represents the hierarchical relationships between concepts within the structure or segment of discipline (Stewart, VanKirk, & Rowell, 1979).

Concept mapping is a tool for visualizing the interrelationships between concepts in an integrated hierarchical manner. This is not an outline or a flowchart, which often illustrates causal relationships. On the other hand, a concept map illustrates hierarchical relationships and also illustrates interrelationships from one side of the map to other.

Based on Ausubel's theory, Novak and colleagues (e.g., Novak and Gowin, 1984) coined the term concept map. Concept maps were intended to "tap

into learner's cognitive structure and to externalize, for both the learner and the teacher to see, what the learner already knows"

Ausubel's theory thus provided guidance as to what constitutes a legitimate concept map. Novak and Gowin (1984) argued that concept maps should be: (a) hierarchical with superordinate concepts at the apex; (b) labeled with appropriate linking words; and (c) crosslinked such that relations between sub-branches of the hierarchy are identified. The hierarchical structure arises because "new information often is related to and subsumable under more general, more inclusive concepts". Moreover, the hierarchy expands according to the principle of progressive differentiation: new concepts and new links are added to the hierarchy, either by creases for students as they recognize new links between sets of concepts or propositions at the hierarchy and another segment-represent the integrative connection among different sub-domains of the structure.

Concept mapping is a learning strategy that was developed first as a research tool to represent learner's prior, relevant knowledge, and later as a tool to enhance meaningful learning. (Heinze-fry & Novak, 1990)

Concept map have been reported to be a potent instructional tool for promoting what Ausubel has described as meaningful learning which refers to anchoring new ideas or concepts with previously acquired knowledge in non-arbitrary way (Novak, 1977). Meaningful learning results when a person consciously and explicitly ties new knowledge to relevant concepts or

propositions they already possess. By contrast, rote learning results when new knowledge is arbitrarily incorporated into cognitive structure. From the basis of Ausubelian learning theory, a key factor for potential success in meaningful learning is the framework of relevant concepts or propositions the individual possesses. According to Horton, Mc Conney, Gallo, Woods, Senn, and Hamelin (1993), in contrast to students who learn by rote, students who employ meaningful learning are expected to retain knowledge over an extensive time span and find new, related learning progressively easier.

Some studies, which tested the contention of the facilitative effect of concept mapping on meaningful learning, have produced mixed findings. For example, by using a sample of eighth-grade students, experimental classes, which received instruction in mapping demonstrated superiority over control classes in problem solving skills (Novak, Gowin & Johansen, 1983). On the other hand, by using 250 students in the investigation of the effects of concept mapping on meaningful learning of basic chemistry, cell structure and function, photosynthesis and respiration, mitosis, and meiosis found no statistically significant difference between the experimental and control groups at the alpha .05 level (Lehman, Carter, & Kahle, 1985). Other studies (e.g., Okebukola & Jegede, 1988; Okebukola 1990) showed that concept mapping positively affecting the achievement of the predegree students in genetics and ecology. Also studies done by Jegede, Alaiyemola, and Okebukola (1990) and Soyibo (1991) showed that

concept mapping has positive effect on 10^{th} grade students' achievement in biology and genetics.

Concept mapping has been recommended for use in courses in physics and literature (Moreira, 1985) chemistry (Novak, 1984), ecology and computer assisted instruction (Heinze-fry, Crovello, & Novak, 1984) reading (Gold, 1984) and social studies (Wease, 1986). In this study, excretory system was introduced to learners via concept mapping, that is, it was used as an instructional aid. The aim of this study is to show the contribution of concept mapping tool on students' understanding of excretory system.

CHAPTER 2

LITERATURE REVIEW

Science teaching has to develop conceptual understanding in students' minds rather than rote memorization of the concepts. Traditional approach (as dominated by lecture, textbook readings, memorization) to science instruction has been consistently shown to be ineffective in engaging student interest or developing conceptual understanding of the subject matter (Anderson & Smith, 1987; Bell, 1981; Bishop & Anderson, 1990; Driver, 1981; Haider & Abraham, 1991; Hewson & Hewson, 1988; Tobias, 1990). Therefore, in this study concept mapping was used as an instructional aid, which was too different than traditional lecturing because students treated by concept mapping is being enrolled much in learning progress than treated by traditional lecturing.

2.1. Concept Mapping

The concept mapping technique was developed by prof. Joseph D. Novak at Cornell University in the 1960's. This work was based on the theories of David Ausubel, who stressed the importance of prior knowledge in being able to learn about new concepts. Novak concluded that; "meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures".

Concept mapping is a technique for representing knowledge in graphs. Knowledge graphs are networks of concepts. Networks consist of nodes (points/verticles) and links (arc/edges). Nodes represent concepts and links represent the relations between concepts.

Concepts and sometimes links are labeled. Links can be non-, uni-, or bi-directional. Concepts and links may be categorized, they can be simply associative, specified or divided in categories such as causal or temporal relations.

Concept maps are intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit. In its simplest form, a concept map would be just two concepts connected by a linking word to form a proposition. For example, "sky is blue" would represent a simple concept map forming a valid proposition about the concepts "sky" and "blue."

Except for a relatively small number of concepts acquired very early by children through a discovery learning process, most concept meanings are learned through the composite of propositions in which the concept to be acquired is embedded. Although concrete empirical props may facilitate concept learning, the regularity represented by the concept label is given additional meaning through propositional statements that include the concept. Thus, "grass is green," "grass is plant," "grass grows," "grass is monocot," and so on lead to increasing meaning and precision of meaning for the concept "grass." A concept map is schematic

device for representing a set of concept meanings embedded in a framework of propositions.

2.2. Purposes of Using Concept Mapping

Concept maps are useful from many different respects, for instance; concept mapping can help teacher about decision of what to include in a curriculum, unit, or lesson so teacher can recognize which concepts or topics should be included. As a result students can see the connections among them. This also leads to the planning of remedial activities. Concept maps can also be used as an instructional tool for reviewing topics, organizing flow of lessons. Furthermore, concept maps can be used as an evaluation tool because they give monitoring information about students' understanding. It is obvious that, performance of all students will not be the same. Different students create different concept maps. These will be the mirrors of students' minds about learned topics. Actually, concept maps can not be classified as right or wrong. However, the more meaningful links among concepts a student can demonstrate in the map that he/she has constructed, the better understanding he/she reflects. From the students' point of view, concept maps are useful for organizing knowledge, integrating and applying large pieces of information, reflecting existing knowledge structure. As a result, concept mapping helps students realize the links between the concepts they have learned in the course and the concepts they have

learned previously and externalize these links. Since concept mapping cause students to become aware of their thinking process and knowledge structure, use of concept mapping results in long term memory so meaningful learning is promoted. Concept maps work to make clear to both students and teachers the small number of key ideas they must focus on for any specific learning task. A map can also provide a kind of visual road map showing some of the pathways we may take to connect meanings of concepts in propositions. After a learning task has been completed, concept maps provide a schematic summary of what has been learned. Because concept maps are an explicit, overt representation of the concepts and propositions a person holds, they allow teachers and learners to exchange views on why a particular prepositional linkage is good or valid, or to recognize missing linkages between concepts that suggest a need for new learning. Because they contain externalized expressions of propositions, concept maps are remarkably effective tools for showing misconceptions. Misconceptions are usually signaled either by a linkage between two concepts that leads to clearly false proposition or by a linkage that misses the key idea relating two or more concepts. As a brief, concept mapping can be done for several purposes:

- To generate ideas (brainstorming, etc).
- To design a complex structure (long texts, hypermedia, large web sites, etc.)
- To communicate complex ideas.

- To aid learning by explicitly integrating new and old knowledge.
- To assess understanding or diagnose misunderstanding.

2.3. Studies with Concept Mapping

Novak, Gowin and Johansen (1983) was used concept mapping strategy in order to find the answer of whether student's acquisition of science knowledge and problem-solving performance change as a result of instruction in the strategy or not. Results of that study shown that, this strategy is helpful to acquisition of science knowledge and problem solving performance.

The effectiveness of concept mapping as an instructional tool to enhance meaningful learning was investigated by Okebukola (1990); Heinze-Fry and Novak (1990); Horton et al. (1993); Briscoe and Lamaster (1991), and Eastman (1998). The results of the study carried out by Okebukola with the aim of examining the potency of concept mapping in attaining meaningful learning of genetics and ecology concepts showed that students in experimental group who prepared concept maps performed significantly better on the test of meaningful learning in ecology. Another study done by Heinze-Fry and Novak (1990) was done to investigate the use of concept mapping as an instructional tool to promote meaningful learning. The results indicated that even though there were no statistically significant difference between treatment and control groups with respect to scores that they obtained from multiple choice instrument and interview

data obtained to analyze how concept mapping affected learning in-depth, the mean score for the experimental group was higher. Horton et al. (1993) synthesized the findings of 19 previous concept mapping studies, which indicated that concept mapping has generally positive effects on both achievement and attitude of students in life science, physical, and non-science courses. After the study of the effectiveness of concept mapping on the facilitation of meaningful learning in freshman biology course, Briscoe and Lamaster (1991) reported that use of concept mapping allowed students to construct knowledge in their own terms and remember what they had learned. Furthermore, the study carried by Eastman (1998) revealed that concept mapping has a positive effect on students' achievement.

Concept mapping was used as an evaluation tool in some studies. For example, Wallace and Mintzes (1990) investigated the use of concept map as a tool to explore conceptual change. The result of the study suggested that concept mapping appears to be a valid and useful tool for detecting changes in the cognitive structure of students as indicated by changes in complexity and propositional structure of knowledge in the maps. In the study carried out by Arnaudin et al (1984), students pre- and post-instruction maps about circulatory system were compared and it was reported that post instruction map were more complex. It was obtained that in post instruction maps, there were significantly greater number of concepts, more relationships among concepts, more branches,

and more cross-links. As a result, they concluded that concept maps appear to be sensitive to changes in students' knowledge structure and may be useful in measuring students' learning. Moreover, in order to reveal understanding of photosynthesis by students, Hazel and Prosser (1994) used concept mapping. They found evidence about students' understanding of the topic through inspection of concept maps and reported that meaningful learning was associated with good post-course mapping. Study of Okebukola (1990) revealed that concept mapping improves problem-solving abilities. He found that students who created concept maps were significantly more successful in solving biological problems than the students in control group. Some studies were done to determine to misconceptions of students. For example, Arnaudin and Mintzes (1985) used this technique to determine the misconceptions of students about cellular respiration and circulatory system. Another study done by Roth and Roychoudhury (1993) shown that students externalize their conceptual framework regarding the concepts of interest. Thus, the concept map is a valuable evaluation tool for classroom teachers. They can use both the process and the final products of concept mapping to examine the quality of student understanding. Furthermore, Nakleh and Krajcik (1994) asserted that the "concept map provides a clear presentation of student's understanding of the way in which concepts are correlated". The authors also employed concept maps as a method of determining the types of representational systems comprising a participant's cognitive

structure. On the other hand, Domin (1996) made comments and criticism about this study. According to these, concept map method of analysis is unsuited for discerning the types of representational system used by individuals, because it allows the incorporation of researchers own words (ideas) to the cognitive structure of participant. Nakhleh and Krajcik (1996) replied to Domin's Comment on Concept Mapping and Representational systems. They stated that "we also believe that it is important to represent accurately students' understanding of science concepts and representation systems that they employ in discussing those concepts. Therefore, we utilized several safeguards to ensure that the students' ideas were accurately conveyed by the concept maps used in this study (Nakhleh & Krajcik, 1993,1994). First, we conducted rigorous reliability studies, and we reported reliabilities for constructing the concept maps (.82) as well as for scoring them (.83). Second, we used the students' own words except in well-defined instances, third we triangulated the findings from the concept maps with the interview data and with the data from the protocol analysis of the titration's to spot discrepancies and check the validity of our conclusions from the concept maps."

The study done by Stensvold and Wilson (1990) used concept map as a learning tool. There were two groups (Treatment group and Control group) in their study, Treatment groups differed from control groups in that the former received instruction in concept mapping and were asked to construct concept

maps before and after the completion of a series of laboratory activities. The control group completed the same laboratory activities but did not construct concept maps. In the course of week, students in both groups completed a sequence of six chemistry laboratories related to reactions of chemical compounds. As part of these activities, students carried out six chemical reactions and wrote formulas for each reaction. Reactions were selected to demonstrate various ways compounds form. Laboratory related concepts included compounds, products, reactants, ions, and ionic and covalent bonds. After completing the laboratory activities, all students were administered a comprehension test, which was constructed by the authors to measure knowledge and comprehension of the laboratory related chemical concepts. Concept maps were scored by counting the number of concept words and the number of appropriate links between words on each student map. Results of the study showed that high ability students performing concept mapping achieved lower scores on the comprehension test than similarly able students who did not construct concept map. High ability students may prefer to use a rote style of learning very different from that required to construct an articulate concept map.

Willerman and Mac Harg (1991) was used concept mapping in their study. There were two groups in their study one is experimental, the other one is control group. The classes were given a two-week unit dealing with physical and chemical properties of elements and compounds. The control group on the first

day was given an introductory lesson that included the objectives of the unit and some interesting questions designed to instill motivation. On the same day the experimental group received a blank concept map with spaces assigned for the concepts in hierarchical fashion. Arrows showing the linkage between the concepts were included. The students completed their concept maps by copying the teacher's example, which was on the overhead projector. The concept map was explained in the context of an advance organizer. Each student's concept map was checked for accuracy and completeness at the end of the activity. The result of this study indicated that the use of concept mapping as an advance organizer produces a significant increment in academic gain for the students in eight-grade physical science classes. The teacher-effect size of this gain is .40.

In this study, concept mapping used as a tool to teach excretory system to students. As mentioned earlier, there are some uses of concept mapping as an instructional tool. However, there is no study related to excretory system.

CHAPTER 3

PROBLEMS, HYPOTHESES AND DESIGN OF THE STUDY

In this chapter, the main problem, related sub-problems and hypotheses have been presented.

3.1 The Main Problem and The Sub-Problems

3.1.1. The Main Problem

The purpose of this study was to examine contributions of teaching method, students' attitudes towards biology, student's families' socioeconomical status, and their Lycee 1 and Lycee 2 average grades on achievement of students' understanding excretory system.

3.1.2. The Sub-Problems

1. What is the combined contribution of students' attitudes toward biology, students' socioeconomical status, lycee 1 and lycee 2 grade averages of students, and teaching method on students' understanding of human excretory system?

2. Is there a significant contribution of teaching method to students' understanding of human excretory system?

3. Is there a significant contribution of students' attitudes towards biology to students' understanding of human excretory system?

4. Is there a significant contribution of students' lycee 1 and lycee 2 grade averages to students' understanding of human excretory system?

5. Is there a significant contribution of students' socioeconomical status to students' understanding of human excretory system?

6. Is there a significant contribution of school type to students' understanding of human excretory system?

3.2. Hypotheses

1. There is no combined contribution of students' attitudes toward biology, students' socioeconomical status, students' lycee 1 and lycee 2 grades averages, and teaching method on students' understanding of human excretory system.

2. There is no significant contribution of teaching method on students' understanding of human excretory system.

3. There is no significant contribution of students' attitudes towards biology to students' understanding of human excretory system.

4. There is no significant contribution of students' academical grade averages to students' understanding of human excretory system.

5. There is no significant contribution of students' socioeconomical status on students' understanding of human excretory system.

6. There is no significant contribution of school type on students' understanding of human excretory system when gender and age were statistically controlled.

3.3. Research Design

This study is a correlational study that describes the degree to which two or more quantitative variables are related, and it does so by use of a correlation coefficient.

Table 3.3.1 Research Design of the Study

Groups	Treatment	After treatment
EG	ICM	SESQ, ASTB, ESAT
CG	TDBI	SESQ, ASTB, ESAT

In this table, EG represents the Experimental Group instructed with concept mapping. CG represents the Control Group instructed by traditionally designed biology instruction. ICM represents Instruction with Concept Mapping. TDBI represents Traditionally Designed Biology Instruction. SESQ refers

Socioeconomical Status Questionnaire; ASTB stands for Attitudes Towards Biology and finally, ESAT represents Excretory System Achievement Test.

In order to examine the effect of the treatment on dependent variable and to control students' attitudes towards biology, their backgrounds and socioeconomical status, two tests (SESQ and ASTB) were applied to students of both groups. At the end of the treatment, ESAT were administered to both experimental and control groups.

3.4. Population and Sample

Population of the study was the 11^{th} grade students who take the biology course at lycee in Ankara during the 1999-2000 school year. Sample of the study was 146 students from 5 types of schools. These were traditional, Super, Anatolian, Anatolian Vocational, and Vocational lycee. Sample of this study was obtained by convenience sampling.

3.5. Subjects of the Study

In this study 146 eleventh grade students from two Dersanes (Dersane A and Dersane B) were employed. Excretory System were instructed by two teachers, that is, students at Dersane B were instructed by researcher and the students at Dersane B were instructed by another teacher. This study was conducted during the 1999-2000 spring semester.

While traditional lecturing method was used by the teacher of Dersane B instruction via concept mapping was used by the teacher of Dersane A. Since the teacher of Dersane B doesn't know how to construct a concept map and to use it as an instruction tool, the two different instruction methods were not assigned randomly to each group. The experimental group consisted of 76 students from five classes while the control group consisted of 70 students from 4 classes.

3.6. Variables

In this study, there are two types of variables, which are independent and dependent variables. Independent variables are the variables the researcher chooses to study and often manipulate in order to assess their possible effects on one or more variables. Independent variable is presumed to have an affect on or to influence another variable called dependent variable.

Independent variables in this study were students' gender, their ages, their school type, their lycee 1 and lycee 2 grades average, their family's socioeconomical status (SES), their attitudes toward biology as a school subject measured by ASTB,

The dependent variable in this study was the students' scores on the excretory system achievement test. Types of variables are given in Table 3.6.

Table 3.6. Types of Variables

Variables	Type
ESAT scores	Dependent
Gender	Independent
Age	Independent
School type	Independent
Lycee 1 & 2 grades average	Independent
SES	Independent
ASTB scores	Independent

3.7. Instruments

3.7.1. Excretory System Achievement Test (ESAT)

This test was prepared for this study and it was the first use of it. ESAT (see Appendix D) consisted of 16 multiple-choice questions. The content of the test covers the human excretory system's structure, it's parts and it's mechanism of how it works. Test questions were prepared in Turkish because they were conducted on students whose training language was Turkish. Answers of this test were given at Appendix F.

Each question in this test is one point. Students giving the true answer to a question win 1point. Therefore, the maximum point in the achievement test could be 16. The minimum point in the achievement test could be 0.

The instructional objectives were stated before the development of this test (see Appendix A). Items were developed regarding to relevant instructional objectives.

This test was administered to students after the instruction of human excretory system to both experimental and control groups in order to determine the contribution of concept mapping on students achievement on understanding human excretory system. In this study, reliability of the Human Excretory System Achievement Test was obtained as .80.

3.7.2. Attitude Scale Toward Biology (ASTB)

This scale was developed to measure students' attitudes toward biology as a school subject. For this study, reliability of this scale was found as .93. This instrument consisted of 15 items in a point likert type scale (fully agree, agree, undecided, partially disagree, and fully disagree) in Turkish. Both negative and positive statements included in it and it was given after treatment to both experimental and control groups (see Appendix C).

For every fully agree alternative in positive statements maximum score (5) was given, for every agree alternative, (4) was given, for every undecided alternative, (3) was given, for every partially disagree alternative (2) was given, for fully disagree alternative, minimum score (1) was given. For negative statements, scoring was the opposite of positive statements scoring.

3.7.3. Socioeconomical Status Questionnaire (SESQ)

This questionnaire consists of 6 questions about student and his/her family (see Appendix B). This questionnaire was scored according to the students responds to each question. From question 1 to 6, the highest score for each question were given to alternative A. The lowest score were given to the last alternative, which is D or E. It depends on the number of question alternatives. Example for alternatives' scoring in this questionnaire is given below:

For question 1 (it has 5 alternatives); the highest score (5) was given to alternative A, (4) was given to alternative B, (3) was given to alternative C, (2) was given to alternative D, and (1) was given to alternative E.

For question 6 (it has 4 alternatives); the highest score (4) was given to alternative A, (3) was given to alternative B, (2) was given to alternative C, and (1) was given to alternative D.

Reliability of Socioeconomical status questionnaire was found as .30. The reason for obtaining such a low reliability might be the insufficient number of alternatives in this questionnaire.

3.7.4. Human Excretory System Concept Map

This map was prepared in the light of the text approved by Ministry of National Education. Concepts related with human excretory system was extracted from the excretory system unit. These concepts are Human excretory system,

kidney, urine, urethra, ureter, filtrate, urinary bladder, nephron, glomerulus, Bowman's capsule, proximal tubule, loop of Henle, distal tubule, filtration and reabsorption. Related concepts were linked to each other with the linking word(s). Such as, forms, consists, composed of, and so on. By creating links in hierarchical manner, urine formation process and the path of flow of excretory products through human excretory were explained (see Appendix E).

Concept map was prepared in Turkish. Since, instruction of Human Excretory System at both experimental and control group in Turkish. This map was used in experimental group as an instructional tool.

3.8. Treatment (ICM vs. TDBI)

This study was carried out over two weeks during 1999-2000 spring semester at Dersane A and Dersane B. A total of 146 students from two Dersane were involved in this study. Students of Dersane B were taught by traditional instruction. On the other hand, students from Dersane A were taught by Instruction via Concept Mapping. Second one was the experimental group. At the control groups, the topics related to human excretory system were covered as part of regular classroom curriculum in the biology course. Excretory system was instructed to students of both groups during two lecture hours. One hour is 50 minutes. Then last week the questionnaire and achievement tests were given to all students in both groups.

In experimental group, concept mapping was used as an instructional tool, which was prepared by researcher. Concept map was prepared in the light of the information obtained from literature review. Software called as inspiration 6 was used to draw the concept map related with human excretory system (see Appendix E).

Teacher of experimental group followed previously prepared concept map, and he was made list of words (concepts) on the blackboard before the instruction. When he was instructing human excretory system. Initially, the title of the topic, which was Human Excretory System, was written to the blackboard at the beginning of the lecture after that it was put into a circle. Then, teacher asked the students what the units of this system are. Students responded according to concepts previously written on the board and teacher wanted them to make a sentence consisting of these concepts. According to given responses teacher wrote suitable prepositions between concepts. This process lasted to form a concept map from more general concepts to more specific concepts. Students' participation was generally full because teacher asked them to say related concepts about human excretory system.

3.9. Analysis of Data

MRC and ANCOVA were used to find the contributions of school type, socioeconomical status, school grades' averages, attitudes toward biology, and

treatment on biological achievement test scores. MRC was used to find contribution of four independent variables, which are teaching method, attitude towards biology, socioeconomical status, and school grades' averages; ANCOVA was used to find whether school types have contribution on students' achievement.

3.10. Threats to Internal Validity in This Study

Internal validity means that observed differences on the dependent variable are directly related to the independent variable, and not due to some other unintended variable.

3.10.1. Subject Characteristics

The selection of pupils for a study may result in individuals (or groups) differing from one another in unintended ways that are related to the variables to be studied. This is sometimes referred to as "selection bias," or a subject characteristic threat. In this study convenience sampling was done. Therefore, age, gender, socioeconomic status, human excretory system knowledge of students might be different. Age and gender can not be confounding variables because ANCOVA was used to investigate the impacts of these variables on students achievement, Results showed that there were no impacts of these variables on achievement. Socioeconomical status of students' family also was used as an

independent variable for this study, but students' previous knowledge about human excretory system couldn't be controlled.

3.10.2. Mortality (Loss of Subject)

No matter how carefully the subjects of a study are selected, it is common to "lose" some as the study progresses. This is known as a mortality threat. But mortality is not a problem of internality in correlational studies since anyone "lost" must be excluded from the study.

Sometimes, loss of subjects may make more relationship in the remaining data, this creates a threat to external validity. Because the sample actually studied is often not the sample initially selected. Teachers participating to this study tried to avoid loosing of subjects by talking to students about the importance of this study.

3.10.3. Location

The particular locations in which data are collected, or in which an intervention is carried out, may create alternative explanations for results. This is called a location threat.

In this study, all testing and treatment took place in regular classrooms during scheduled course periods for both control and experimental groups. The classrooms didn't have any difference in terms of physical arrangements.

3.10.4. Maturation

Often change during an intervention may be due to factors associated with passing of time rather than to the intervention itself. This is known as a maturation threat.

Maturation can not be a threat in this study since control and experimental group students were at the same grade level.

3.10.5. Instrument Decay

Instrumentation can create problems if the nature of the instrument is changed in some way or another. This is usually referred to as instrument "decay."

The instruments used in this study (ESAT, SESQ, ASTB) do not permit different interpretations of results and not too long and difficult to score. Researcher and his colleague scored each test independently.

3.10.6. Data Collector Characteristics and Data Collector Bias

The characteristics of the data gatherers can also affect results. Gender, age, ethnicity, language patterns, or other characteristics of the individuals who collect the data in a study may have an effect on the nature of the data in a study may have an effect on the data they obtain.

In this study, control and experimental groups data gatherers gender, age, ethnicity, language patterns were the same.

To experimental group, researcher taught human excretory system. Therefore, there might be data collector bias in this study.

3.10.7. Testing

Practice on the pretest by itself is responsible for the improvement. This is known as testing threat.

In this study, researcher did not administer a pretest to subjects so all students had equal chance in ESAT.

3.10.8. History

One or more unanticipated, and unplanned for, events may occur during the course of a study, which can affect the responses of subjects. Such events are referred as a history threat.

All instruments administered both control and experimental groups at the same time. Any extraneous event didn't take place during the application of study.

3.11. Assumptions and Limitations

3.11.1. Assumptions

1. The teacher was not biased during the treatments.

2. Test was administered under standard conditions.

3. Students answered the questions of measuring instruments seriously and sincerely.

4. Students in control and experimental groups did not interact with each other.

3.11.2. Limitations

1. The subject of this study was limited to 146 eleventh grade students at Dersane A and Dersane B during 1999-2000 spring semester.

2. This study was limited to "human excretory system" unit.

CHAPTER 4

RESULTS AND CONCLUSIONS

4.1. Results

Results obtained through testing each of hypotheses stated earlier were presented in this chapter. The hypotheses were tested by MRC and ANCOVA at a significance level of .05.

4.2. Statistical Analysis

In order to test the hypotheses of this study mentioned in Chapter 3, Multiple Regression and Correlation (MRC) with stepwise method and Analysis of Covariance (ANCOVA) was used with the significance level of .05. All the statistical analyses were done with the Statistical Package for Social Sciences (SPSS). Raw data for this study were given at Appendix G.

Table 4.2.1. Descriptive statistics for control group

	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.
Attitude	70	51.00	21.00	72.00	51.40	1.38	11.61
Average grades	70	4.95	5.05	10.00	8.01	.13	1.16
SES score	70	13.00	11.00	24.00	18.32	.45	3.83
Achievement	70	14.00	2.00	16.00	8.98	.46	3.86
Valid N (listwise)	70						

Table 4.2.2. Descriptive statistics for experimental group

	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.
Attitude	76	55.00	20.00	75.00	54.25	1.47	12.82
Average grades	76	6.00	4.00	10.00	7.71	.16	1.40
SES score	76	14.00	12.00	26.00	19.61	.36	3.17
Achievement	76	13.00	3.00	16.00	11.44	.38	3.36
Valid N (listwise)	76						

Descriptive statistics for both groups were given in Table 4.2.1 and 4.2.2. According to these tables; the maximum score of students' attitudes towards biology and SES is greater in the experimental group than the control group. Means of these variables are also greater in the experimental group. The range of summation of students' lycee 1 and lycee 2 grades is equal to 4.95. On the other hand, it is 4 for experimental group. When control and experimental group's achievement scores in human excretory system achievement test are compared, it is seen that; experimental group's mean of achievement in human excretory system achievement test is greater than control group's mean of achievement.

Table 4.2.3.a. Gender frequency in control group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	31	44.3	44.3	44.3
	1.00	39	55.7	55.7	100.0
	Total	70	100.0	100.0	

Table 4.2.3.b. Gender frequency in experimental group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	31	40.8	40.8	40.8
	1.00	45	59.2	59.2	100.0
	Total	76	100.0	100.0	

Table 4.2.3.a and 4.2.3.b. gives the frequency of students' gender. In this study female students were coded as 0, male students were coded as 1. At both of the experimental and the control group, number of male student is higher than number of female student.

Students' age distribution is shown in table 4.2.4.a and 4.2.4.b. According to these data, frequency of 16 and 17 years old student is higher in control group than experimental group. It was expected result, because majority of participants in the experimental group were Anatolian school and Super lycee students who were enrolled in foreign language training for one year at the beginning of lycee.

Table 4.2.4.a. Frequency distribution of students' age in control group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16.00	4	5.7	5.7	5.7
	17.00	37	52.9	52.9	58.6
	18.00	18	25.7	25.7	84.3
	19.00	8	11.4	11.4	95.7
	20.00	3	4.3	4.3	100.0
	Total	70	100.0	100.0	

Table 4.2.4.b. Frequency distribution of students' age in experimental group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16.00	1	1.3	1.3	1.3
	17.00	25	32.9	32.9	34.2
	18.00	37	48.7	48.7	82.9
	19.00	12	15.8	15.8	98.7
	20.00	1	1.3	1.3	100.0
	Total	76	100.0	100.0	

In this study, there were five types of lycee to which students went. These types were coded by the use of some numbers. Such as, Traditional lycee was coded with number 1, Super lycee was coded with number 2, Anatolian lycee was coded with number 3, Anatolian vocational lycee was coded with number 4, and finally vocational lycee was coded with number 5. Experimental group consists of more students from Anatolian and Super lycee than control group. In control group, 63% of participants are students at traditional lycee. The frequency distribution is given at table 4.2.5.a and 4.2.5.b.

Table 4.2.5.a. Frequency distribution of school type in control group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	44	62.9	62.9	62.9
	2.00	7	10.0	10.0	72.9
	3.00	8	11.4	11.4	84.3
	4.00	9	12.9	12.9	97.1
	5.00	2	2.9	2.9	100.0
	Total	70	100.0	100.0	

Table 4.2.5.b. Frequency distribution of school type in experimental group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	39	51.3	51.3	51.3
	2.00	13	17.1	17.1	68.4
	3.00	15	19.7	19.7	88.2
	4.00	5	6.6	6.6	94.7
	5.00	4	5.3	5.3	100.0
	Total	76	100.0	100.0	

The multiple regression correlation coefficients, R^2, are a measure of the proportion of variability explained by, or due to the regression (linear relationship) in a sample of paired data. It is a number between zero and one and a value close to zero suggests a poor model. A very high value of R^2 can arise even though the relationship between the two variables is non-linear. The fit of a model should never simply be judged from the R^2 value. R^2 values for this study were given at table 4.2.6.

A "best" regression model is sometimes developed in stages. A list of several potential explanatory variables is available and this list is repeatedly searched for variables, which should be included in the model. The best explanatory variable is used first, then the second best, and so on. This procedure is known as stepwise. This method combines both Forward and Backward procedures. Due to the complexity of intercorrelations, the variance explained by certain variables will change when new variables enter the equation. Sometimes a variable that qualified to enter loses of some of its predictive validity when other variables enter. If this takes place, the stepwise method will remove the weakened

variable (George & Mallery 1995).

MRC analysis with Stepwise Method was performed to test the hypothesis of this study. The resulting outputs related to the contributions of each independent variable were shown in table 4.2.6 and table 4.2.7

Hypothesis 1: Combined contribution of students' attitudes toward biology, students' socioeconomical status, students' academical grade averages and teaching method on student's understanding of human excretory system is significant, df=4, F=40.239, $p \leq .05$, two tails (see table 4.2.6). R^2 value of all four independent variables is .533, that is, 53% of the achievement can be explained by these four independent variables.

Table 4.2.6. MRC results for combined contribution of four independent variables

R	R Square	Adjusted R Square	Std. Error of the Estimate
.730	.533	.520	2.6400

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1121.835	4	280.459	40.239	.000
Residual	982.747	141	6.970		
Total	2104.582	145			

The power, the probability of rejecting the false null hypothesis, of this study is quite high. It is related with α level, sample size, the magnitude of the treatment effect in the population (the degree of departure from null hypothesis). In this study, α level is .05, and sample size is 146, control group consists 70 individual on the other hand, experimental group consists 76 individual. For

correlational studies, a sample of at least 50 is deemed necessary to establish the existence of a relationship (Fraenkel & Wallen 1996). Both small and medium effect size (f^2) was used to find the power of the test. Small effect size is equal to .08; medium effect size is equal to .15.

By using the formula;

$$L=f^2*(n-k-1)$$

L values of both small and medium effect size were obtained and these were used to find the power of the study. In that formula, n indicates sample size; k indicates the number of independent variables. For small effect size, L value is 11.2. For medium effect size, L value is 21, and the power of the study at small and medium effect size was obtained as .75 and .95. (Cohen & Cohen 1983).

Hypothesis 2: The second hypothesis was that there is no significant contribution of teaching method on students' understanding of human excretory system. MRC results have shown that contribution is significant and students' achievement can be explained by teaching method, $t=5.314$, $p\leq.05$, two tails (see table 4.2.7).

Hypothesis 3: The third hypothesis was that there is no significant contribution of students' attitudes towards biology to students' understanding of human excretory system. Null hypothesis was rejected because attitudes of students towards biology explain well the achievement of them on understanding human excretory system, $t=3.799$, $p\leq.05$, two tails (see table 4.2.7).

Hypothesis 4: The fourth hypothesis was there is no significant contribution of students' lycee1 and 2 grade averages on students' understanding of human excretory system. MRC results showed that there is a significant correlation between students' grades and their achievement on understanding of human excretory system, $t=6.323$, $p\leq.05$, two tails (see table 4.2.7).

Hypothesis 5: The fifth hypothesis was there is no significant contribution of students' socioeconomical status on students' achievement on understanding of human excretory system. Null hypothesis was rejected because there is a significant correlation between these variables, $t=2.068$, $p\leq.05$, two tails (see table 4.2.7).

Table 4.2.7. MRC results showing the significance of independent variables.

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-7.883	1.634		-4.824	.000
Average of grades	1.282	.203	.437	6.323	.000
Teaching method	2.436	.458	.320	5.314	.000
Attitude scores	8.034^{E}-02	.021	.259	3.799	.000
SES scores	.135	.065	.126	2.068	.041

Hypothesis 6: The Analysis of Covariance (ANCOVA) tested this hypothesis, since school type and gender were nominal variables in order to use them in MRC, dummy coding should have been done. When ANCOVA was being done, gender and age of students was used as covariates. ANCOVA results showed that gender and age of students have not significant impact on students'

achievement on understanding of human excretory system (Table 4.2.8). By controlling gender and age of students' with ANCOVA, impact of school type on students' achievement of understanding human excretory system was investigated, significance of school type is .000 (Table 4.2.8.), that is, there is a significant contribution of school type on students' understanding of human excretory system.

Table 4.2.8. Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	459.781	6	76.630	6.476	.000
Intercept	12.883	1	12.883	1.089	.299
Gender	16.115	1	16.115	1.362	.245
Age	5.684	1	5.684	.480	.489
School type	419.300	4	104.825	8.859	.000
Error	1644.801	139	11.833		
Total	17495.000	146			
Corrected Total	2104.582	145			

In order to understand which types of school have impact on students' achievement on understanding of human excretory system, Post-Hoc analysis was done (Table 4.2.9). According to Post Hoc Analysis results, School type 2 (Super lycee) and school type 3 (Anatolian lycee) have different impact on students' achievement on learning human excretory system. Students of these schools were more successful than the others. When school type 1 (traditional lycee) students were compared with the students of School type 2 (Super lycee), School type 3 (Anatolian lycee), School type 4 (Anatolian Vocational lycee), and School type 5 (Vocational lycee). Super lycee and Anatolian lycee students' achievement were found as different than traditional lycee students' achievement. Mean difference

value between traditional lycee and Super lycee (I-J) was –3.783. The minus sign could be explained by greater mean value of Super lycee than Traditional lycee, that is, students of Super lycee was more successful than students of Traditional lycee (Table 4.2.9). Results of Post-Hoc analyze showed that Super and Anatolian lycee students' achievement score on understanding of human excretory system was greater than Traditional lycee, Anatolian Vocational lycee, Vocational lycee students' achievement score.

Table 4.2.9. Post-Hoc results

		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
(I) School type	(J)School type				Lower Bound	Upper Bound
1.00	2.00	-3.783*	.856	.000	-6.118	-1.447
	3.00	-3.609*	.810	.000	-5.818	-1.400
	4.00	.788	.993	.932	-1.920	3.497
	5.00	-.949	1.453	.966	-4.913	3.013
2.00	1.00	3.783*	.856	.000	1.447	6.118
	3.00	.173	1.051	1.000	-2.692	3.040
	4.00	4.571*	1.198	.001	1.304	7.838
	5.00	2.833	1.600	.391	-1.530	7.197
3.00	1.00	3.609*	.810	.000	1.400	5.818
	2.00	-.173	1.051	1.000	-3.040	2.692
	4.00	4.397*	1.165	.002	1.219	7.575
	5.00	2.659	1.576	.441	-1.638	6.957
4.00	1.00	-.788	.993	.932	-3.497	1.920
	2.00	-4.571*	1.198	.001	-7.838	-1.304
	3.00	-4.397*	1.165	.002	-7.575	-1.219
	5.00	-1.738	1.677	.839	-6.312	2.836
5.00	1.00	.949	1.453	.966	-3.013	4.913
	2.00	-2.833	1.600	.391	-7.197	1.530
	3.00	-2.659	1.576	.441	-6.957	1.638
	4.00	1.738	1.677	.839	-2.836	6.312

* The mean difference is significant at the .05 level.

4.3. Conclusions

The following conclusions can be drawn from the results of the current study:

1. Concept mapping contributed significantly to the better understanding of human excretory system.

2. Student attitudes towards biology contributed significantly to the better understanding of human excretory system.

3. Student lycee 1 and 2 grade averages contributed significantly to the better understanding of human excretory system.

4. Student's socioeconomical status contributed significantly to the better understanding of human excretory system.

5. Student attitudes towards biology, teaching method, students' academical grade averages, students' socioeconomical status, contributed significantly to the better understanding of human excretory system.

6. There is a correlation between students' school type and their achievement on understanding human excretory system.

7. Anatolian and Super lycee students differ in achievement than Traditional, Anatolian vocational, and Vocational lycee students.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

5.1. Discussion

The main purpose of this study was to investigate the contribution of teaching method, students' lycee 1 and 2 grade averages, their families' socioeconomical status, and their attitudes towards biology on 11^{th} grade students' understanding of human excretory system.

When students were at lycee 2, their teachers in their schools instructed excretory system. Therefore, it was assumed that all students participating to this study have learned something about human excretory system. However, learning has not been at the same level for all students. There might be several factors affecting it. These factors could be their school types, socioeconomical status, and attitudes towards biology, gender, age and teachers' instructional methods.

When age and gender controlled by ANCOVA, it was found that there was a significant contribution of students' school type on students' achievement on understanding human excretory system. ANCOVA results showed that gender and age did not contribute to the students' achievement on understanding human excretory system. In order to see the impacts of each school types, Post-Hoc analysis was done. At the end of the analysis, Super lycee's and Anatolian lycee's

students was found to be different in achievement scores than the other school types students. Students of these schools were selected by an entrance examination, that is, these students should have successful academical background. Experimental group contains more Super and Anatolian lycee's students. This might explain the achievement differences between control and experimental groups.

Students' academical grade averages, attitudes towards biology, socioeconomical status, and teaching method's contribution on the achievement of understanding human excretory system were investigated by MRC with stepwise method. According to this analysis, the best explanatory variable of students achievement on understanding of human excretory system is students' attitudes towards biology and then the second best explanatory variable was teaching method, the third one is the academical grade averages of students and the final one is the students socioeconomical status. The results showed that there are so many factors affecting students' achievement. If students like biology, their participation to instruction will be higher, so the students will take an active role in the learning process. Teaching method (instruction with concept mapping in traditional teaching method) was the second best explanatory variable of students' achievement. Concept mapping helps students realize the links between the concepts they have learned in the course and the concepts they have learned previously and externalize these links. This method cause students to become

aware of their thinking process and knowledge structure, use of concept mapping results in long term memory so meaningful learning promoted. This will increase the achievement of students. Study done by Heinze-Fry and Novak (1990) to investigate the use of concept mapping as an instructional tool is supporting our results. They stated that the use of concept mapping as an instructional tool promotes meaningful learning. Another study carried out by Arnaudin et al (1984) showed that post-instruction maps of students were more complex than pre-instruction maps. Post instructional maps consisted more relationships among concepts, more branches, and more cross-links. They concluded that concept maps appear to be sensitive to changes in students' knowledge structure and may be useful in measuring students' learning. Study results of Willerman and Mac Harg (1991) indicated that, concept mapping used as an advance organizer can significantly improve eight-grade science achievement. According to them, the students were probably helped by the organization and visual relationships of advance organizer in a way, which differs from the assistance provided by only a prose passage or an oral explanation. Another reason for its effectiveness may be attributed to its being constructed by a teacher rather than a student. Since the concept map was more complete and accurate than a student constructed map. It became a better anchor for new information. There is another reason why the use of concept map as an advance organizer may have contributed to its effectiveness in this study. It is more likely that a concept map developed by the teacher

provided the students with greater direction for learning the concepts and facts that overlapped with the teacher's test than did the technique of using only discussion of the objectives in the unit.

Another variable's (students' grade averages) contribution is significant also at .05 p value, and this was the third best explanatory variable on this test. Their academical grade averages might give clue to us about their achievement on understanding of human excretory system. Because these students are more familiar to excretory system unit from lycee 2. The fourth variable was the students' socioeconomical status, which was also significant at the significance level of .05. Student's achievement on understanding human excretory system is related with his/her parent's educational level, family income, and reading habits.

The MRC results showed that all four variables have contribution on the students' achievement of understanding human excretory system. R^2 value of all four independent variable is .533 (see table 4.2.6).

In summary, this study showed contributions of four independent variables on achievement of understanding human excretory system, and correlations between school type and achievement. Furthermore, which schools students differ in achievement was also investigated by this study.

5.2.Implications

1. This study provided the evidence to support the notion that there are some variables contributing to students' achievement. Accordingly, this study has the following implications regarding students' understanding of human excretory system.

2. Teachers should to be trained about the use of these instructional methods for better acquisition of scientific conceptions.

3. Students should be introduced with new concepts. Relationships among them should be emphasized to make students establish connections between them meaningfully.

5.3. Recommendations for Further Research

On the basis of the findings of this study, the researcher recommends the following topics for future studies:

1. Future study could investigate the concept mapping effectiveness on different science topics.

2. Future study could investigate the effect of different independent variables on achievement.

3. Future study could use concept map as an evaluation tool.

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APPENDIX A

INSTRUCTIONAL OBJECTIVES

General Objective

Understands the basic characteristics of excretion.

Behavioral Objectives

1. To explain the parts of human excretory system.
2. To describe the urine formation.
3. To explain the properties of glomerulus.
4. To explain material exchange between glomerulus and bowman capsule.
5. To describe urine formation.
6. To describe filtration process.
7. To describe absorption process.
8. To describe secretion process.
9. To distinguish between filtrate and urine.
10. To describe the kinds of excretory system's end product.
11. To predict the constituents of urine.

APPENDIX B

SOCIOECONOMICAL STATUS SCALE

Sevgili öğrenciler,

Yapılmakta olan bir tez çalışması için sizlerle ilgili birtakım kişisel, biyoloji alanına yönelik tutumlarınıza, ve çalışmada uygulanacak başarı testi ile ilgili bilgilere ihtiyaç duyulmaktadır. Bu amaçla düzenlemiş olduğumuz anket üç bölümden oluşmaktadır. Ankette yer alan her soruyu dikkatle okumanız ve cevaplandırmanız araştırmanın güvenirliliğini arttıracaktır. Bu ankette vermiş olduğunuz her cevap yalnız araştırma için kullanılıp, kesinlikle gizli tutulacaktır. Araştırmanın geçerliliği açısından cevaplarınızın doğru ve eksiksiz olması zorunludur. Anketi doldururken lütfen atlanmış soru bırakmamaya ve tüm soruları eksiksiz cevaplandırmaya özen gösteriniz. Katkılarınız için şimdiden teşekkür ederiz.

KİŞİSEL BİLGİLER:

Cinsiyetiniz: ----------Kız ---------Erkek
Doğum Tarihiniz: --------(gün) ---------(ay) ---------(yıl)

Okuduğunuz Lisenin :
Adı:----------
Yeri (il/ilçe):----------
Hangi branşta öğrenim görmektesiniz?----------
Lise 1 yıl sonu ortalamanız nedir?----------
Lise 2 yıl sonu ortalamanız nedir?----------

AİLEYE İLİŞKİN BİLGİLER:

1. Babanızın eğitim düzeyi nedir?
A) okur yazar değil B) ilkokul C) ortaokul D) lise
E) üniversite F) yüksek lisans- doktora

2. Annenizin eğitim düzeyi nedir?
A) okur yazar değil B) ilkokul C) ortaokul D) lise
E) üniversite F) yüksek lisans-doktora

3. Siz hariç kaç kardeşsiniz? (sizden büyük ve sizden küçük olanlar dahil)
A) kardeşim yok B) 1 C) 2-3 D) 4-5 E) 6 ve üstü

4. Evinizde ya da kaldığınız yerde çalışmak için ayrı odanız var mı?
A) evet B) hayır

5. Aşağıdaki gelir dilimlerinden hangisi, ailenizin ortalama aylık gelirine karşılıktır?

A) 100 milyon ve altı B) 105-300 milyon
C) 305-500 milyon D) 500 milyon üstü

6. Kendinize ait, ders kitaplarınız da dahil, ortalama kaç kitabınız var?
A) 0-10 B) 11-24 C) 25-100 D) 100 den fazla

APPENDIX C

BİYOLOJİ DERSİ TUTUM ÖLÇEĞİ

Açıklama:

Bu ölçekte Biyoloji dersine olan tutumu yansıtan cümleler verilmiştir. Her cümlenin karşısına **tamamen katılıyorum, katılıyorum, kararsızım, katılmıyorum** ve **hiç katılmıyorum** olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

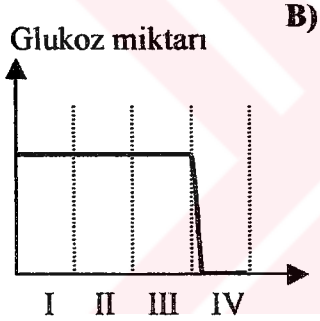
	Tamamen Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1.Biyoloji çok sevdiğim bir alandır.	O	O	O	O	O
2.Biyoloji ile ilgili kitapları okumaktan hoşlanırım.	O	O	O	O	O
3.Biyolojinin günlük hayatta çok önemli yeri yoktur.	O	O	O	O	O
4.Biyoloji ile ilgili ders problemlerini çözmekten hoşlanırım.	O	O	O	O	O
5.Biyoloji konularıyla ilgili daha çok şey öğrenmek isterim.	O	O	O	O	O
6.Biyoloji dersine girerken sıkıntı duyarım.	O	O	O	O	O
7.Biyoloji derslerine zevkle girerim.	O	O	O	O	O
8.Biyoloji dersine ayrılan ders saatinin daha çok olmasını isterim.	O	O	O	O	O
9.Biyoloji dersine çalışırken canım sıkılır.	O	O	O	O	O
10. Biyoloji konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.	O	O	O	O	O
11.Düşünce sistemimizi geliştirmede biyoloji öğrenimi önemlidir.	O	O	O	O	O
12. Biyoloji çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir.	O	O	O	O	O
13. Dersler içinde biyoloji dersi sevimsiz gelir.	O	O	O	O	O
14. Biyoloji konuları ile ilgili tartışmaya girmek bana cazip gelmez.	O	O	O	O	O
15.Çalışma zamanımın önemli bir kısmını biyoloji dersine ayırmak isterim.	O	O	O	O	O

APPENDIX D

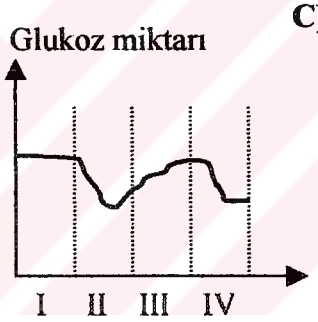
BOŞALTIM SİSTEMİ BAŞARI TESTİ

1. **Beslenmesi dengeli olan sağlıklı bir bireyin;**
   I. Glomerulus kılcalları,
   II. Bowman kapsülü,
   III. Henle kanalı,
   IV. İdrar toplama kanalcığı,
   kısımlarındaki glukoz miktarları aşağıdaki grafiklerin hangisiyle gösterilebilir?

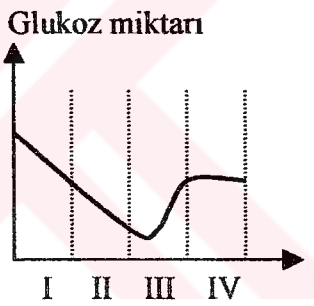
A)



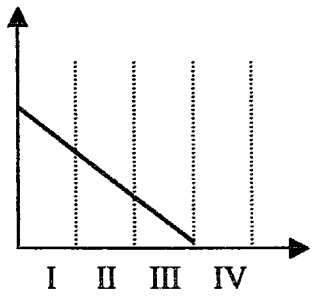
B)



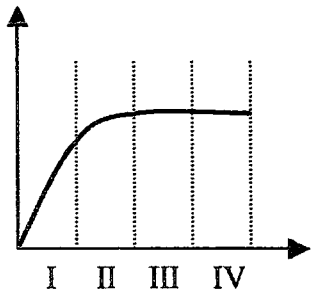
C)



D)



E)



2. Sağlıklı ve dengeli beslenen bir insandan alınan;

I. Bowman kapsülü
II. Glomerulus kılcalları
III. Üreterdeki sıvıların

birim hacimlerindeki glikoz yoğunluğu çoktan aza doğru, aşağıdakilerden hangisi gibi olur?

A) I-II-III **B)** II-III-I **C)** III-I-II **D)** III-II-I **E)** II-I-III

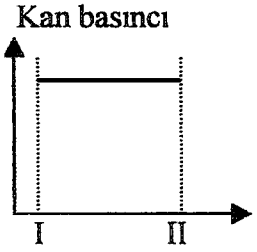
3. Bowman kapsülündeki süzüntüde;

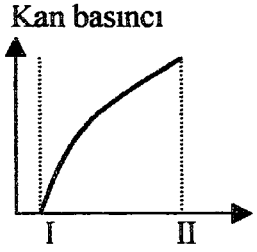
I. İnorganik tuzlar
II. Glikoz
III. Üre
IV. Su
V. Albümin

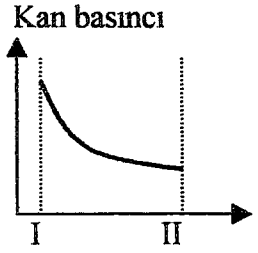
gibi maddelerden hangileri bulunur?

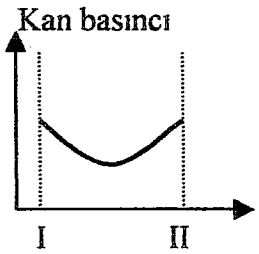
A) I-III-IV **B)** I-II-III-IV **C)** III-IV-V **D)** I-III-IV-V **E)** I-II-IV

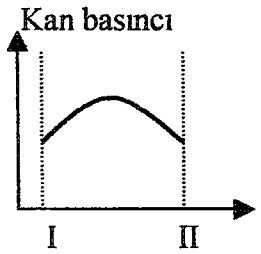
4. Bir glomerulus kılcal damarının başlangıcı (I) ile sonu (II) arasındaki mesafede, kan basıncı aşağıdaki grafiklerden hangisi ile gösterilebilir?

A)


B)


C)


D)


E)


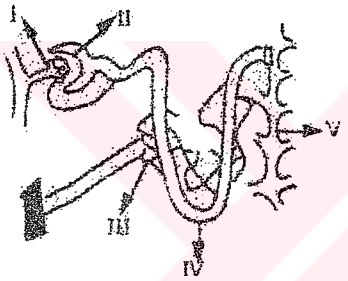
5. Nefronların esas görevi; temizlenmesi gereken maddeleri kandan alıp, idrar şeklinde vücut dışına atmaktır.

I. Üre, ürik asit
II. Na^+, K^+, Cl^-, H^+ iyonlarının fazlası
III. Suyun fazlası
IV. Şekerin fazlası

gibi maddelerden hangilerinin vücuttan atılması o kişinin sağlıklı olmadığını gösterir?

A) Yalnız I **B)** I-II-IV **C)** II-III-IV **D)** I-II **E)** Yalnız IV

6.



Yukarıda sağlıklı bir insanın böbreğinde yer alan nefron kısımları görülüyor.
Burada hangi kısımda geri emilme gerçekleşir?

A) I **B)** II **C)** III **D)** IV **E)** V

7. Glomerulustan süzülüp böbrek boşaltım kanalında ilerleyen sıvı içinde bulunan aşağıdaki maddelerden hangisinde geri emilme diğerlerine göre daha az olur?

A) Su **B)** Aminoasit **C)** Üre **D)** Mineraller **E)** Glikoz

8. Bir memelinin nefronlarındaki glomerulus sıvısında %3 derişime sahip X maddesine rastlanmıştır.
Aynı nefronun bowman kapsülündeki süzüntü tahlil edildiğinde, X maddesine rastlanmamış ise, X maddesi aşağıdakilerden hangisi olabilir?

A) Glikoz **B)** Kan proteinleri **C)**Vitamin **D)** Üre **E)** Aminoasit

9. Aşağıdakilerden hangisi ergin insan böbreğinde <u>bulunmaz</u>?

A) Glomerulus **B)** Protonefridyum **C)** Nefron
D) Henle kulpu **E)** Bowman kapsülü

10. I. Glomerulus
II. Bowman kapsülü
III. Henle kanalı
IV. Üreter
V. Havuzcuk
Bir böbrekte, yukarıdaki yapıların hangisindeki sıvı, bileşim olarak kan plazması sıvısı niteliğini kaybetmiştir?

A) Yalnız V **B)** Yalnız I **C)** Yalnız IV **D)** III-IV-V **E)** I-II-III

11. I. Difüzyon
II. Osmoz
III. Aktif taşıma
Yukarıdakilerden hangisi ya da hangileri nefronlarda geri emilme işinde etkilidir?

A) I-II-III **B)** Yalnız I **C)** Yalnız II **D)** Yalnız III **E)** II-III

12. Glomerulus (kılcal damar yumağı) yapısı ve işlevleriyle ilgili olarak verilen aşağıdaki açıklamalardan hangisi <u>yanlıştır?</u>

A) Glomerulusta süzülme meydana gelir.
B) Glomerulus boyunca kan basıncı osmotik basınçtan yüksektir.
C) Glomerulus kılcalları çift sıralı epitel dokudan oluşmuştur.
D) Glomerüler sızıntıda proteinler bulunmaz.
E) Glomerulustan bowman kapsülüne süzülen sıvı olduğu gibi dışarı atılır.

13. I. Glomerulustaki kanın süzülmesi
II. Kıvrımlar bölgesindeki süzüntünün idrar toplama kanalına akması
III. Bowman kapsülündeki maddelerin kıvrımlar bölgesine geçmesi
IV. Geri emilme ile bazı maddelerin kana iade edilmesi
Kanda idrar oluşumu ile ilgili bazı olaylar yukarıda belirtilmiştir. Bu olaylar nefronlarda hangi sıraya göre gerçekleşir?

A) I-II-III-IV B) I-III-IV-II C) III-I-II-IV D) III-II-IV-I E) II-III-IV-I

14. Sağlıklı bir insanda Bowman kapsülüne geçen süzüntü sıvı nefron kanallarından toplama kanalına geldiğinde bileşimi değişerek su derişimi azalır. Bu farklılığın nedeni aşağıdakilerden hangisidir?

A) Nefron kanallarında bazı maddelerin parçalanması
B) Nefron kanallarında geri emilmenin olması
C) Nefron kılcallarından toplama kanalına yeni maddelerin geçmesi
D) Henle borularındaki hücrelerin süzüntüdeki bazı maddeleri kullanması
E) Nefron kanallarındaki süzüntünün yalnız nefronla toplardamarlara geçmesi

15. Sağlıklı bir insan böbreğinde idrar oluşurken aşağıdaki olaylardan hangisi gerçekleşmez?

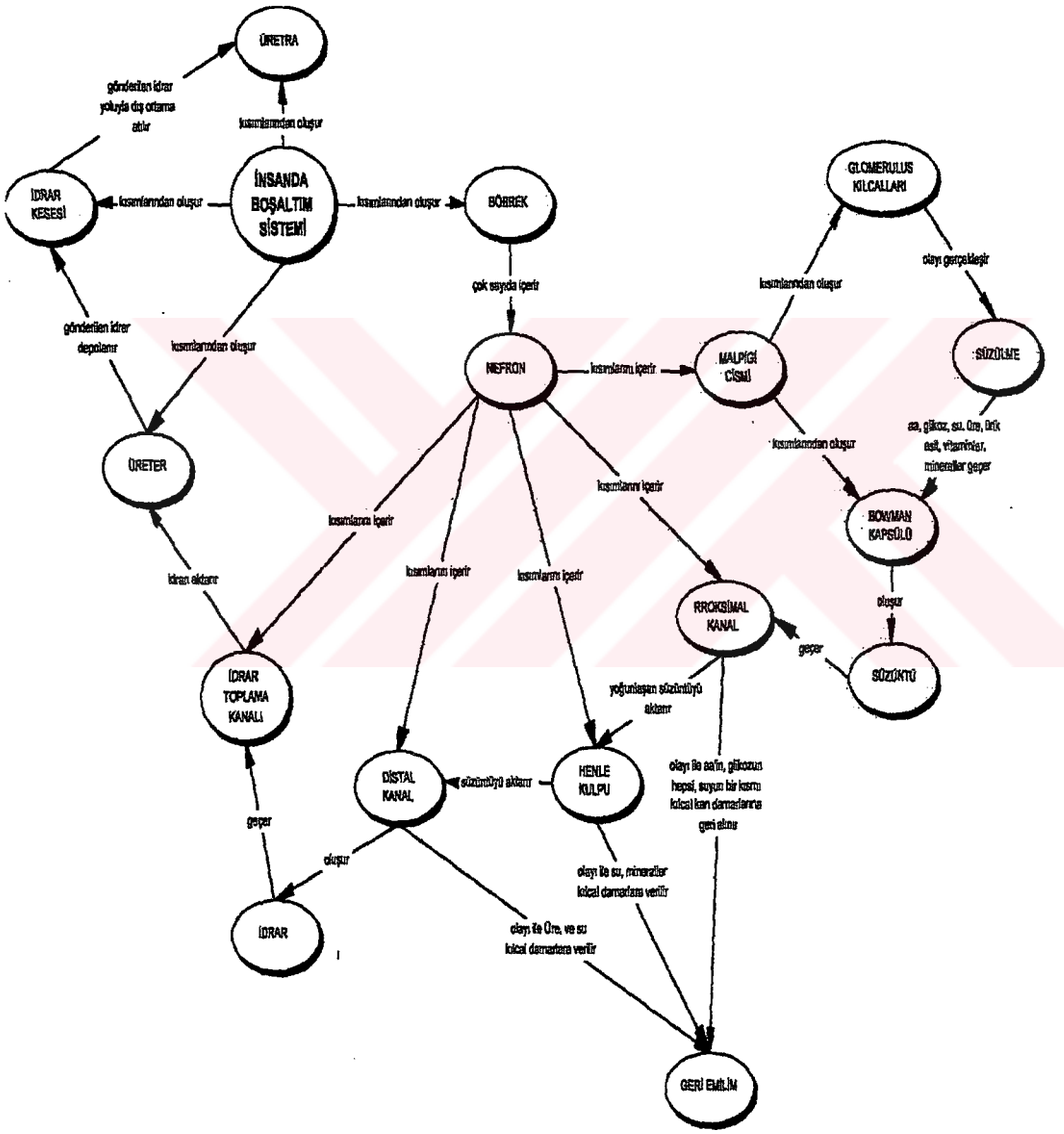
A) Aktif taşıma yapılır.
B) Süzülme gerçekleşir.
C) Vücut için gerekli olan suyun %99'u geri emilir.
D) Kan proteinleri idrara karışır.
E) ATP harcanır.

16. Nefron kanalcıklarının çok uzun olması ve geri emilmenin evrimleşmesinin canlılara sağladığı en önemli yarar aşağıdakilerden hangisidir?

A) Su ve madde kaybını önlemek
B) Metabolizmayı hızlandırmak
C) Metabolizmayı yavaşlatmak
D) Sindirim artıklarını azaltmak
E) Kanın süzülmesini hızlandırmak

APPENDIX E

HUMAN EXCRETORY SYSTEM CONCEPT MAP



APPENDIX F

ANSWER KEY FOR EXCRETORY SYSTEM ACHIEVEMENT TEST (ESAT)

Question number	Correct item
1	D
2	E
3	B
4	A
5	E
6	D
7	C
8	B
9	B
10	D
11	A
12	E
13	B
14	B
15	D
16	A

APPENDIX G

RAW DATA

Teaching method	Attitude scores	Lycee 1 and 2 grades average	SES score	Achievement	Gender	Age	School type
1	35	7,26	15	3	0	17	1
1	54	5,9	20	4	1	17	1
1	22	5,54	15	4	1	19	1
1	50	5,8	14	5	1	17	1
1	64	8,15	19	6	1	18	1
1	27	5,7	19	6	1	18	1
1	56	6,63	20	6	1	17	1
1	33	7,43	16	6	0	17	1
1	44	6	21	7	1	17	1
1	36	4	20	8	1	16	3
1	62	6,99	21	8	0	17	1
1	20	5	20	8	0	18	1
1	35	6,9	18	8	1	19	1
1	38	6,8	21	8	1	17	1
1	40	5,3	20	8	1	18	1
1	49	5,98	15	9	1	19	4
1	48	9,1	12	9	1	18	5
1	53	9,62	19	9	1	18	5
1	63	8	19	9	0	17	1
1	62	6,98	18	9	0	17	1
1	69	8,15	24	9	0	17	1
1	73	6	19	9	1	18	1
1	56	6,84	21	9	1	19	1
1	59	7,98	14	10	0	17	1
1	50	6	22	10	1	18	5
1	54	7,86	21	10	1	18	1
1	29	6,12	21	10	1	19	1
1	75	6,7	22	10	1	17	1
1	46	7	13	10	1	19	4
1	53	8,6	17	10	1	18	4
1	43	6,5	21	10	1	20	4
1	57	7,7	23	11	1	17	1

Teaching method	Attitude scores	Lycee 1 and 2 grades average	SES score	Achievement	Gender	Age	School type
1	33	9,57	17	11	0	19	2
1	54	7,45	19	12	0	18	3
1	63	6	15	12	0	17	1
1	62	7,9	20	12	1	17	1
1	63	9,85	20	12	1	19	2
1	51	7,97	12	12	0	17	2
1	59	9,2	21	13	1	19	2
1	68	8,5	15	13	1	17	1
1	66	8,43	23	13	0	17	2
1	50	6	19	13	1	18	4
1	56	7,48	18	13	0	17	1
1	74	9,5	19	13	1	18	1
1	54	6	16	13	0	18	2
1	63	8,08	25	13	0	18	2
1	59	9,2	22	13	0	18	2
1	69	9,31	24	13	0	18	2
1	67	9,7	22	13	0	18	2
1	54	7,2	21	14	1	17	1
1	59	8,74	23	14	0	19	3
1	59	6,9	20	14	0	18	2
1	60	7,5	18	14	0	18	1
1	60	6,91	21	14	1	19	3
1	57	6,98	17	14	1	18	1
1	54	8	18	14	0	18	1
1	55	7,05	22	14	0	18	1
1	73	7,68	19	14	1	18	3
1	37	8,68	22	14	0	17	1
1	67	10	24	15	1	18	2
1	70	9,03	21	15	0	18	1
1	32	8	19	15	0	19	1

Teaching method	Attitude scores	Lycee 1 and 2 grades average	SES score	Achievement	Gender	Age	School type
1	52	8,6	23	15	1	18	3
1	66	8,57	17	15	1	17	3
1	54	9,84	20	15	1	18	1
1	61	9,79	26	15	1	17	3
1	59	9,3	23	16	0	18	3
1	71	8,8	23	16	0	18	2
1	65	7,5	21	16	0	18	3
1	61	9	25	16	1	18	3
1	75	9,1	21	16	1	18	3
1	59	10	22	16	0	18	3
1	58	9,5	21	16	1	18	3
0	21	5,58	11	2	1	17	1
0	37	5,05	19	2	1	18	1
0	45	7,2	14	3	1	17	1
0	36	7,23	11	3	0	17	1
0	32	6,41	23	4	1	19	3
0	46	7,69	16	4	1	18	1
0	55	8	17	4	1	17	1
0	44	6,13	19	5	1	18	1
0	23	6,73	13	5	1	19	5
0	40	7,44	18	5	0	18	4
0	37	7,5	22	5	0	18	1
0	48	7,15	22	5	1	17	1
0	52	8,87	15	5	0	20	4
0	26	6,23	12	5	0	17	1
0	39	6,98	22	5	1	18	1
0	52	7,59	19	5	1	18	1
0	59	6,84	14	6	1	16	1
0	59	6,9	15	6	1	17	4

Teaching method	Attitude scores	Lycee 1 and 2 grades average	SES score	Achievement	Gender	Age	School type
0	59	9,31	24	6	1	18	3
0	48	6,41	22	6	1	16	4
0	55	7,81	22	6	0	18	1
0	52	7	18	6	0	17	1
0	58	6,5	15	7	1	18	3
0	57	7,98	16	7	0	17	1
0	49	6,65	12	7	1	19	1
0	34	7,2	14	8	1	18	1
0	53	8,25	21	8	0	17	1
0	57	8	11	8	0	16	1
0	63	9,14	19	8	0	19	4
0	65	9,37	13	8	0	20	4
0	39	7	24	8	1	17	4
0	40	6,5	16	8	0	17	1
0	51	6,68	23	8	1	17	1
0	45	7	23	9	1	17	1
0	38	7,3	21	9	1	17	4
0	64	7,45	16	9	0	19	1
0	41	7,45	17	9	1	17	1
0	54	8,16	21	9	1	18	3
0	48	7,4	20	10	1	17	1
0	46	8,03	14	11	0	19	1
0	60	8,61	24	11	0	17	1
0	52	9	15	11	1	17	1
0	56	9,58	22	11	1	17	1
0	55	7,72	16	11	0	19	4
0	61	8,57	19	12	0	17	1
0	62	9	23	12	1	17	2
0	59	8,94	22	12	0	17	3
0	55	9,2	18	12	1	18	2
0	31	9,64	24	12	1	17	3

Teaching method	Attitude scores	Lycee 1 and 2 grades average	SES score	Achievement	Gender	Age	School type
0	55	8,28	17	13	1	19	5
0	65	8,78	15	13	0	17	1
0	62	9,4	13	13	1	17	1
0	71	9,26	21	13	0	16	1
0	65	9,55	23	13	0	17	3
0	52	8,71	18	13	1	20	1
0	52	8,11	17	14	1	18	3
0	53	8,36	22	14	0	17	2
0	68	8,74	16	14	1	18	1
0	63	9,15	24	14	0	17	1
0	72	9,26	16	14	0	17	1
0	61	8,92	16	14	0	17	2
0	67	10	14	14	0	17	1
0	56	7,25	20	15	1	17	1
0	55	9,6	21	15	1	18	1
0	60	9,59	22	15	0	17	2
0	69	9,61	23	16	1	17	2
0	63	9,96	20	16	1	18	1