A GROUP OF STUDENTS' AND TEACHERS' PERCEPTIONS WITH RESPECT TO BIOLOGY EDUCATION AT HIGH SCHOOL LEVEL

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ABSTRACT

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This study aimed to explore students' and teachers' perceptions with respect to biology education at high school level in order to reveal the reasons of students' low achievement in biology as indicated by the university entrance examinations between the years 1996-2002.

The study was conducted with a qualitative approach. Therefore two separate interview schedules were developed to be conducted with 45 high school biology teachers and 45 eleventh grade science students in 10 schools including private, Anatolian, and public high schools. All the interviews were audiotaped and transcribed verbatim by the researcher.

Results revealed that there are serious problems in biology education such as biology curriculum covering high amounts of topics, unavailable time allocated to biology, insufficient economical conditions... The reasons of students' low achievement in biology can be summarized under the headings of students' perception of biology, the nature of biology lesson, questions asked in university

entrance examinations, students' perception of other science lessons, and biology education in Turkey.

Keywords: Qualitative Approach, Achievement in Biology, Biology Education

ÖZ

BİR GRUP ÖĞRENCİ VE ÖĞRETMENİN LİSE DÜZEYİNDEKİ BİYOLOJİ EĞİTİMİ HAKKINDAKİ GÖRÜŞLERİ

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Bu çalışma, öğrenci ve öğretmenlerin lise düzeyindeki biyoloji eğitimi hakkında görüşlerini ve böylece 1996-2002 yıllarında üniversite sınav sonuçlarının da gösterdiği üzere, öğrencilerin biyoloji dersindeki başarılarının düşük oluşunun sebeplerini araştırmayı amaçlamıştır.

Çalışma nitel bir yaklaşımla yapılmıştır. Çalışmanın amacı doğrultusunda iki ayrı görüşme formu geliştirilmiştir. Görüşmeler özel, Anadolu ve genel liseden oluşan 10 okuldaki 45 lise biyoloji öğretmeni ve 45 on birinci sınıf fen öğrencileriyle gerçekleştirilmiştir. Görüşmeler kayda alınmış ve araştırmacı tarafından çözümlenmiştir.

Sonuçlar biyoloji müfredatının çok fazla konu kapsaması, biyoloji dersine ayrılan zamanın ve ekonomik şartların yetersiz olması gibi biyoloji öğretiminde ciddi problemlerin olduğunu göstermiştir. Biyoloji dersindeki başarının düşük oluşunun sebepleri; öğrencilerin biyolojiyi algılayışları, biyoloji dersinin özellikleri, üniversite giriş sınavlarında sorulan biyoloji sorularının özellikleri, öğrencilerin diğer fen

derslerini algılayışları, ve Türkiye'de verilen biyoloji öğretimi başlıkları altında toplanabilir.

Anahtar Kelimeler: Nitel Yaklaşım, Biyolojide Başarı, Biyoloji Öğretimi

To My Parents

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CHAPTER 1

INTRODUCTION

> Because of the importance of biology in the lives of every educated citizen and its increasing eminence in the scientific explosion, it behooves professional biologists to provide a challenging scholarly and yet attractive undergraduate education both for non-biologists and biologists.

With this statement, many years before, Johnson (1986) pointed out the importance of biology which will have a profound impact on our lives through advances for the next few decades. Biology is the science of living things among which human has the strongest place. Biological sciences stimulate human interest to find the truth with an intellectual rigor therefore have an important cultural and educational function. Accordingly, the purpose of science is "to discover the laws that govern the natural world and so increase our understanding of it" (Liras, 1994).

Everyone accepts that "biology is the science of twenty-first century". There have been many developments which form an important base for both medicine and health issues. In the past few years many issues have been biology-based such as biodiversity, genetically modified organisms, reproductive technologies, the prolongation of life (Reiss, 1998). All of these improvements meet human needs and so these times have been considered as 'the Age of Biology' (Jarman, Ruth, McClune and Billy; 2001).

Educators have been trying to provide a better education to the youth for a better future. A better education lies in motivating students and involving them in the process of learning. Developing individual creativity at the heart of continuous innovation, and encouraging students to use this skill in shaping their lives should be

defined as the foremost goals of today's education (Marchaim, 2001). Science educators have made studies for meaningful understanding of science disciplines. It has been exposed that science education should enable pupils to understand the nature of science and to think like scientists (Roberts, 2001).

It is evident that for a meaningful understanding and learning of science there should be meaningful science teaching. Learning is defined by Haladyna (1997) as "any change in mental behavior that is lasting and the product of experience". On the other hand, he defined teaching as "the coordinated set of activities that require measuring student behavior reflecting instructional intent". In recent decades, it has been aimed for not only biological sciences but for all science disciplines that students should apply the acquired knowledge to everyday issues. Furthermore science education should make students gain a criticizing mind about the scientific developments. This aim has been stressed by Millar and Osborne (1998) that science education should "help young people acquire a broad general understanding of the important ideas of science .... so they can understand, respond critically to, media reports of issues with a science component". What is more, American Association for the Advancement of Science (1993) defined achieving scientific literacy as the central goal of science education, that is, student's understanding of the nature of science.

It is therefore likely that, based on the above information, the primary goal of science education is to educate scientifically thinking and literate students who can apply their knowledge to everyday life. Thus, instead of teaching and learning isolated bits of "inert knowledge", recent science education underlines the need for "quality over quantity, meaning over memorizing, and understanding over awareness" (Mintzes, Wandersee, James and Novak, 2001). For that reason science education should include practical activities as well as theory for a real understanding of nature of science. Liras (1994) stated that the student must connect the theoretical concepts with the practical aspects of real word via the motivation of teacher and subject discipline. Thus, aims of science education should be defined:

- To stimulate and excite pupils' curiosity about events in the world.

- To satisfy this curiosity with knowledge.
- To engage learners at many levels.
- To provide critical and creative thinking.
- To make pupils understand how major scientific ideas contribute to technological change-impacting on industry, business and medicine and improving quality of life.
- To make pupils learn to question and discuss science-based issues that may affect their own lives, the direction of society and the future of the world (Osborne, 2000).

Kept these objectives in mind, therefore, science/biology teachers have responsibilities. They should provide real teaching- learning process by meeting the following aims (Liras, 1994):

To provide sessions that:

- are active, interesting, and participatory;
- allow full discussion and stimulate the students;
- establish the essential basic concepts;
- use the instrumentation adequately to illustrate important and basic aspects of modem biology;
- develop a greater interaction between teacher and student;
- increase the student's capacity to respond to the question "How.....?", and not "What....?"

In the light of these objectives, as has been aforementioned, to be able to judge about scientific issues someone has to posses an understanding of ideas and procedural understanding. Accordingly, biology education should aim this. For that reason aims of biology education should be clarified. Development of biological literacy in all pupils is among the aims of biology education (Roberts, 2001). Biologically literate people can have ideas and judge about important issues such as healthcare, environmental protection, pollution and controversial issues for example cloning. In addition, they can also make, at least, some critics on issues of other science disciplines. Development of biological literacy should be the prevalent most

important aim of biology education, because it follows the occurrence of sub-aims. Biology knowledge, applying this knowledge to everyday life, critical thinking, looking for scientific resolutions to problems, scientific self concept, the skills of using equipment properly, the skills of experimental techniques are among the aims of biology education that should be gained by students through biology education. On the other hand, it should be noted that biology education should prepare some pupils for becoming working biologists (Roberts and Gott, 1999).

In the developing world with the appreciable increase of importance of biology through huge developments, it has been given greater considerable value to biology in Turkey. In the recent years Turkish science educators have made many studies for a better biology education including instructional methods, fundamentals, problems and curriculum of biology education. For example Tekkaya, Çapa and Yılmaz (2000) demonstrated that Turkish science education had many problems which were categorized into five groups as problems depending on administrative factors, problems depending on teachers, problems depending on students, problems depending on social factors, and problems depending on institutions that educate teachers. They stated that the disconnection between modern science disciplines and science disciplines taught in schools accounted for the problems met in science education. In addition, they emphasized the importance of making relations with daily life, getting rid of memorization, using computers and applying acquired knowledge for a meaningful science education. What is more, they suggested that to increase the interest in science, especially biology, the number of science questions in university entrance exams should be increased.

Besides the goals and the curriculum of Turkish biology education have been identified as a consequence of appreciable efforts. The curriculum has been reconstructed after many studies starting in 1993. At that time, the Educational Research and Development Directorate (ERDD) prepared a curriculum model with the help of the Ministry of National Education. Needs-assessment and analyses had been made. As a result necessary changes had been done (Model for Curriculum Development, 1993, ERDD).

In 1995, ERDD made a needs-assessment study in 41 schools of Turkey, because in order to make high school biology lessons more meaningful and interesting, the biology curriculum had to be made meaningful, meeting the needs of biology education. Problems about biology curriculum, biology teaching methods, biology textbooks, economical resources, time allocated for biology teaching were demonstrated by the information obtained from the participants; teachers, university and high school students, parents and scholars in the field. Findings revealed that students had difficulties in understanding of Latin words and relating biology topics to daily life. Besides students lacked interest. The insufficiency of laboratory conditions and textbook and lack of equipment and materials were other problems. Furthermore time allocated for biology had been found very inadequate and their suggestions for appropriate class hours to be 4 for Biology I and 6 for both Biology II and III. There was complaint about crowd of the classes and therefore 20-25 was the suggestion for appropriate number of students in a typical classroom. The results of the study showed that biology education was dependent on memorization, and an important teaching strategy, field trips, couldn't be done. In addition, participants made suggestions about the topics to be added to the curriculum. They thought that it was necessary to add topics related to health, daily life, developments in biology (Need Assessment Report of High School Biology Lessons, 1995, ERDD).

In the light of findings of needs-assessment study, a new biology curriculum was developed. A pilot study had to be done in order to gain insights and evaluations about this new curriculum. The participants were academicians, scholars in the field, teachers and students in 34 high schools in Turkey. After the pilot study had been done; the crowd of classes, insufficient laboratory conditions, lack or incompleteness of instructional materials and insufficient class hour for biology were depicted as the problems which were in accordance with the findings of needs-assessment study (ERDD, 1995). On the other hand, teachers agreed that the new curriculum was effective in making education more contemporary. Besides it was able to meet the goal of "improving and developing problem-solving ability and creativity of students". Consequently this pilot study revealed that the new biology curriculum was sufficient and suitable in many respects, but for efficient application of the curriculum, the materials and equipment to be used and the number of students per

class were found important factors. Another point to be mentioned is that, although new biology curriculum intended a student-centered teaching, observations showed that it was rather teacher-centered (Pilot Study Report of High School Biology Curriculum, 1996, ERDD).

The new biology education with the new curriculum was started to be implemented from 1998-1999 educational year. The goals and objectives of the new biology curriculum were identified in the way that would give rise to learning far from memorization and students would not only grasp the subjects in the best pattern but also use the knowledge in daily life. New curriculum aimed at getting students to gain consciousness of health care, thus topics are made linked to human health. Teaching learning strategies of each topic were explained in detail and supported with different kinds of examples and questions. Furthermore films, transparencies, experiments, field trips, and observations were suggested as supportive aids. All the information about the new curriculum was announced in the curriculum guide (Journal of Announcements of Ministry of National Education- T.C. Milli Eğitim Bakanlığı Tebliğler Dergisi, 1998, No: 2485). In this guide it was stated that biology education aimed to make students active learners through the provision of learning not only by just hearing but also by seeing, doing and searching. Since only by this way is the retention of knowledge possible. Furthermore the curriculum aimed to educate pupils trying to find resolutions to the problems with a "scientific approach". In the guide, the following goals were stated as the fundamentals for the development of the biology curriculum:

The student, through biology education, should be able to;

- Comprehend basic structure of living organisms
- Recognize and protect the environment, comprehend the importance of environment for human life,
- Gain conscious o health care
- Think critically and approach the resolutions to the problems that he/she met through the life with scientific method
- Suggest resolutions to the biological problems that Turkey meets
- Relate the gained knowledge to everyday life

In addition the great contribution of teaching materials and equipment to learning was emphasized. The materials ant equipment provide learning by living and stimulate student interest. Several scientific studies have shown that usage of teaching aids that address to the five senses increases the retention of knowledge. Consequently, teacher should use different kinds of teaching materials and equipment as far as possible (Journal of Announcements of Ministry of National Education – T.C. Milli Eğitim Bakanlığı Tebligler Dergisi , 1998, No: 2485).

Up to this point, there has been given information, in essence, about what the biology education aimed for a better learning. It is reasonable that the more the aims are tried to be met, the higher will be the performance. Here another important issue, achievement, comes in mind. Haladyna (1997) defined achievement as easily changeable cognitive behavior that is short-term learning. Many studies have been made about achievement including factors affecting achievement. Also demonstrative studies that depict achievements in some fields or of some countries have been made.

Among these, the Third International Mathematics and Science Study (TIMSS) was the largest and the most comprehensive comparative international study of education ever undertaken. TIMSS 1999 was designed to provide a base for better understanding of educational systems of 41 countries including Turkey. TIMSS 1999 compared the mathematics and science achievement of students in these countries. It was designed to provide trends in eighth-grade mathematics and science achievement in an international context. The aim was to improve the teaching and learning of mathematics and science for students everywhere by providing data about what types of curricula, instructional practices, and school environments result in higher students achievement (TIMSS, 1999).

There were six content areas in the study:

Earth science:

Earth features, earth processes, and earth in the universe

Life science:

Diversity, organization and structure of living things; life processes and systems enabling life functions; life spirals, genetic continuity and diversity; interactions of living things; and human biology and health

Physics:

Physical properties and transformations; energy and physical processes; and forces and motion

Chemistry:

Classification and structure of matter; chemical properties; and chemical transformations

Environmental and resource issues:

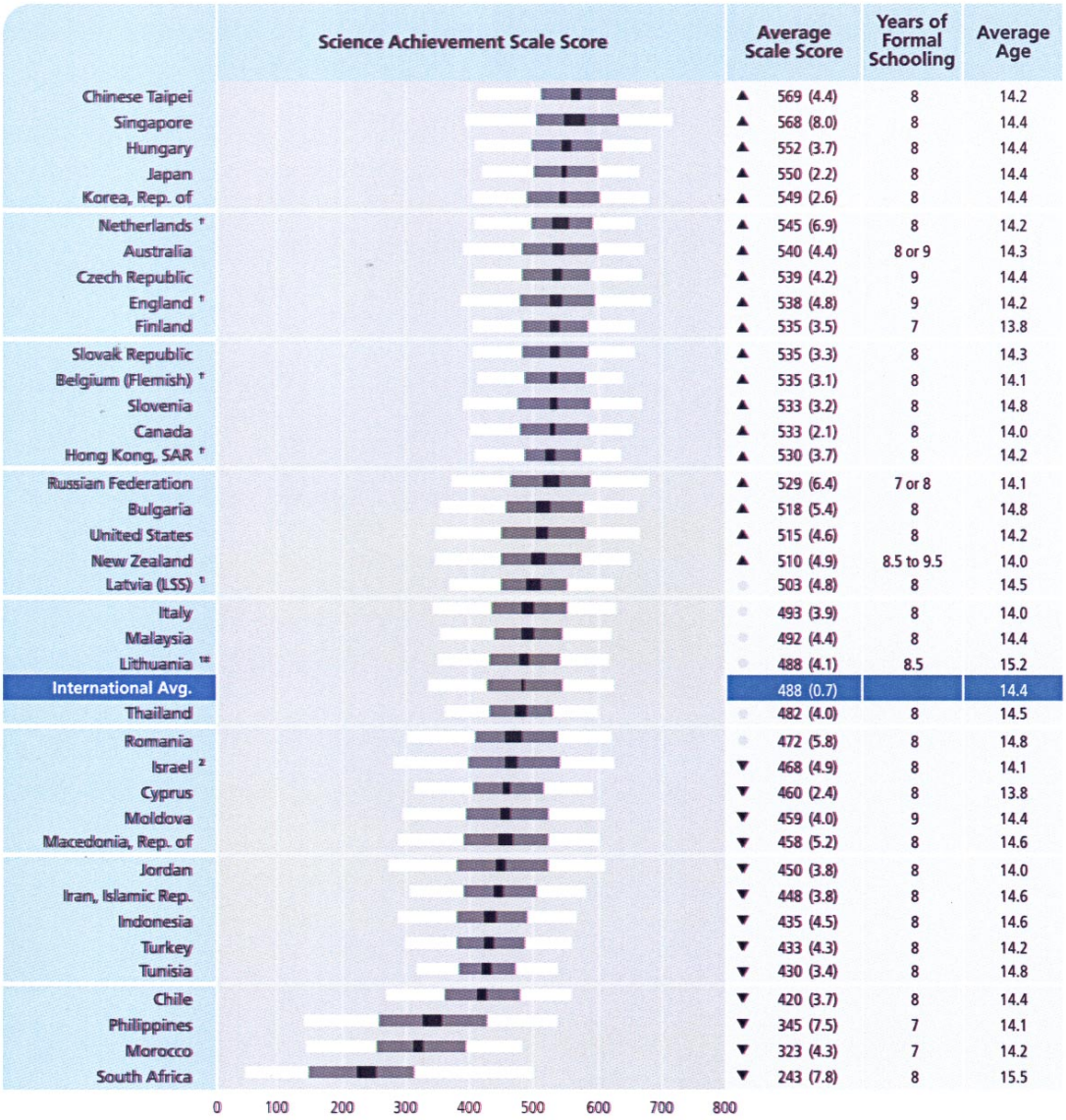
Pollution; conservation of land, water; and sea resources; conservation of material and energy resources; world population; food supply and production; and effects of natural disasters

Scientific inquiry and the nature of science:

The nature of scientific knowledge; the scientific enterprise; interactions of science, technology, mathematics, and society; and the tools, procedures, and processes used in conducting scientific investigations.

In order to compare relative performance of each country in each content area, the international average for each content area was scaled to by 488, the same as the overall international average. In Table 1.1, the average science achievements of all countries are presented. As can be seen, the science achievement of Turkey is 433 which is below the international average achievement, 488.

Table 1.1 The Distribution of Science Achievements



The average achievements of Turkey in all content areas are; 435 for earth science, 444 for life science, 441 for physics, 437 for chemistry, 461 for environmental and resource issues and 445 for scientific inquiry and the nature of science. The results showed that the achievement scores of Turkey are below the international average for not only biology but also for other science fields. TIMSS 1999 also investigated gender effect on achievement. In many countries gender difference for science achievement was negligible, so for Turkey.

TIMSS 1999 collected detailed information about students' home backgrounds, how they spend their time out of school, and their attitudes towards science. TIMSS stated that students from homes with expensive educational resources have higher achievement from less advantaged backgrounds. In the study home educational resources included number of books in the home, educational study aids in the home (computer, study desk for own use, and a dictionary) and their parents' education. The results showed that low average student achievement reflected low level of educational resources in students' homes. According to the results, Turkey was the third from the bottom of 38 participated countries with 1 % of students at high level of home educational resources, that is, these students had more than 100 books in the home, all three educational aids and their either parent's highest level of education is finished university. So the low science achievement of Turkish students may be attributed to this low percentage of students at high level of home educational resources.

Out-of-school study time (OST) was another factor that TIMSS 1999 investigated. It was stated in TIMSS' report that well-chosen homework assignments can reinforce classroom learning. Besides the homework also allows students having trouble to keep up with their classmates to review material taught in class. TIMSS categorized students as being at high level, medium level and low level. Students at high level reported spending more than three hours each day out of school studying all subjects combined, students at medium level reported spending one to three hours while students at low level reported one hour or less per day out-of-school study. Results revealed that Turkey was among the countries with heavy emphasis on homework. Findings indicated, internationally, low level OST corresponded to lower average science achievement. However spending a lot of time studying was not usually associated with higher achievement. Students at the medium level OST had average achievement as high as or higher than that of students at high level. Turkey was the 7th among the countries to have high level for OST. Turkish students were at high level with 50%, at medium level with 39 %, and low level with 6 %. Accordingly, it is possible to say that assigning a lot of homework is not a way to reach a higher achievement of students in biology in Turkey.

Attitude towards science was the other parameter that TIMSS 1999 investigated. TIMSS reported that to generate a positive attitude towards science is an important goal of science education. TIMSS categorized students into high level with positive or strongly positive attitude towards science; into low level with negative or strongly negative attitude towards science and into medium level with attitudes between these extremes. It was stated that there was a clear positive association between attitudes towards science and science achievement on average overall. Forty-five percent of Turkish students were placed at high level with average science achievement of 443. Forty nine percent of them at medium level with average achievement of 431, while 5 % were at low level with an average of 428. Therefore, it is likely that trying to generate more positive attitudes toward biology will result in Turkish students' higher biology achievement.

As a result, TIMSS provides insights about Turkish students' achievements in science content areas which are all below international average. Another reference that give information about the achievements of Turkish students is university entrance examinations (Table 1.2).

Table 1.2 The mean (M) and standard deviation (SD) values of mathematics, physics, chemistry and biology lessons in university entrance examinations between the years 1996-2002 (Student Selection and Placement Center, ÖSYM)

Year	Mathematics		Physics		Chemistry		Biology	
	M	SD	M	SD	M	SD	M	SD
1996	6,69	10,71	2,72	4,71	2,14	3,92	**1,73**	3,19
1997	13,80	14,30	5,27	6,01	6,07	5,14	**3,36**	4,04
1998	14,98	15,24	7,12	6,47	4,10	4,71	**3,93**	3,92
1999	7,73	11,68	1,65	3,93	1,25	2,90	**0,65**	2,09
2000	7,14	11,63	1,58	3,74	1,70	3,29	**1,17**	2,47
2001	7,82	12,06	2,15	4,58	1,39	3,37	**0,61**	1,78
2002	8,73	12,38	3,16	4,41	1,39	3,42	**0,99**	2,40

The values in the table depicts that in each year biology point averages were the lowest, especially in year 2001 which is 0.61 if even the number of questions asked in the exams are taken into account, anyway the mean values of biology will be the lowest. For example in year 2002 the number of questions asked in students selection exam (ÖSS) was; 12 from biology, 45 from mathematics, 19 from physics and 14 from chemistry. If number of question for each is thought as 12, then the mean values for each will be 2,32 for mathematics, 1,99 for physics, 1,19 for chemistry and 0,99 for biology**.** Furthermore this situation is valid for all the years. Therefore the reasons that underlie this pattern are worthwhile to be investigated. This is the starting point for this study which sought to identify these reasons in a qualitative approach. Besides while exploring these reasons, it will be possible to demonstrate the current situation and the problems of Turkish biology education.

Accordingly, the purpose of this study is to investigate the reasons of students' low achievement in biology by conducting interviews with both high school biology teachers and 11th grade science students.

Significance of the Study

Although this study is limited with 45 biology teachers and 45 science students, the results of this study provide insights about not only the reasons of low achievement in biology but also the problems that both students and teachers face during biology teaching-learning process. In the light of the results of this study educators, curriculum developers, and teachers can try to improve Turkish biology education to make it more meaningful by trying to get rid of the problems which interfere with higher achievement in biology. Accordingly both students and teachers will have more positive feelings toward biology which will contribute to a better biology education.

CHAPTER 2

REVIEW OF LITERATURE

This study describes a qualitative approach to analyzing reasons of low biology achievement of students. Therefore it is reasonable to reveal what affects achievement in biology. Many researchers have long investigated factors that affect achievement which will be presented in the following paragraphs respectively.

Researchers defined achievement as a function of many interrelated variables: students' ability, attitude and perceptions, socioeconomic variables, school-related variables, parent and peer influences. Many of these variables are home- and family-related and thus are difficult to change since they are outside the control of educators. Whereas school related variables can be influenced and changed by educational interventions (Singh, Granville, and Dika, 2002). Walberg (1981) advanced educational productivity theory which determines achievement by nine factors in three sets:

1) Student variables such as ability or prior achievement, motivation, and age or developmental level;

2) Instructional variables such as time and quality;

3) Variables of psychological environments of the classroom, home, peer group, and mass media.

Fraser, Walberg, Welch and Hattie (1987) reported that previous achievement, family and home environment, motivational variables, instructional time and also academic time affect achievement.

Young, Reynolds, and Walberg (1996) investigated the influence of school and individual factors on determination of science learning of 10th grade students. The dependent variable was the science achievement while the independent variables were in two levels. Student-level independent variables were sex, attitude toward science, prior achievement, motivation, instructional time, home environment, peer characteristics, and mass media; school-level independent variables were instructional quality and classroom environment. Results of their study showed that most of the variance was dependent on the individual level rather than on the school level. Previous achievement had most influence on achievement however initial science attitude, instructional time, home environment, and exposure to mass media also had significant student-level influences on science achievement. On the other hand, at the school level, classroom environment was found to be significant.

Singh et al. (2002) examined the effects of school-related constructs, motivation, attitude, and academic engagement on 8th grade students' mathematics and science achievement. Motivation construct was twofold; attendance of school and classes, and participation and preparedness for classes. Academic time was found to have the strongest effect on science learning so students who spent more time on science homework had higher achievement. The attitude toward science had the next largest effect and the other factors also had positive effects on science learning. Attitude has been considered as an important factor affecting biology achievement. Oliver and Simpson (1988) found a significant relationship between affective behaviors in the science classroom and achievement. Researchers have investigated the relationship between attitude and achievement. For example Eisenhardt (1977) found that achievement influenced attitude more often than attitude influenced achievement. On the other hand, according to various studies there isn't strong positive correlation between attitude and achievement (Schibeci and Riley, 1986; Keeves and Morganstern, 1992).

Wood investigated the effect of high school biology students' science related attitudes on the amount of effort put forth while using an educational computer science program to solve real life problems. She found that the amount of effort put forth by high school students can be predicted by science related attitudes and

concluded that improving a student's attitude toward a subject can help that student achieve higher success and achievement in school. Another study by Weinburgh and Englehard (1994) investigated the relationships between gender, prior academic performance, beliefs and student attitudes toward biology laboratory experiences with high school students. They found gender to have a significant effect on attitudes; females had more positive attitudes toward biology laboratory than males. Prior academic performance was also significant; students with lower GPAs had more positive attitudes toward biology laboratory.

Gender is another variable considered to have effect on biology achievement. According to many studies males have more positive attitudes toward science than females (Johnson, 1981; Simpson and Oliver, 1985). On the other hand, Schibeci (1984) found that females have more positive attitudes toward biology whereas males have more positive attitudes toward physics and chemistry. Friedler and Tamir (1990) through analysis of 40 studies found no differences in biology and chemistry among students who specialize in science in senior high school. In addition they found that females' orientation to science is enhanced by inquiry and laboratory-based instruction. Another study conducted by Steinkamp and Maehr (1984) revealed that motivational orientation of female students in biology and chemistry is higher than male students who have more positive orientation in physical and general science. This pattern was attributed to female students' anticipation of maternal role, verbal inclination, and early preference not affected by stereotyping. On the other hand, male students' more positive orientation in physical and general science was attributed to their learning outside of the class by extracurricular activities and contacts with knowledgeable males. Weinburgh and Englehard (1994) had also found female students to have more positive attitudes toward biology laboratory than males. However, it was found in the study of Tekkaya, Özkan, and Sungur (2001) that boys perceive biology topics easier than girls. They attributed the reasons of this situation to socialization factors and classroom experiences leading to low self esteem and passive dependent behavior among girls (Çakıroğlu, 1999; Shamai, 1996).

Interest and motivation have been considered important predictors of achievement in science. Reynolds and Walberg (1992) regarded motivation as one of the major factors that determine achievement. Motivation encourages academic engagement which further enhances interest and motivation. Consequently much learning occurs. Students' interest in a subject matter may cause students to continue or withdraw learning (Hidi, 1990). Singh et al. (2002) investigated the effect of motivation and interest on science achievement of 8th grade students. In their study motivation included attendance to school and classes, participation and preparedness for classes (coming to classes with pencil, books and homework). They found that motivated students who have positive science attitudes are more likely to spend more time on science homework, thus, concluded that motivation and interest affect science achievement positively. They stated that students' motivation to learn science can be increased and improved when teachers create a curriculum that focuses on conceptualizing and creating a meaning and relevance. Consistently, Vaidya (1993) stated that by keeping interest, pride, and joy of learning in mind neither a teacher nor a student will fail.

Misconceptions are among the factors that have been reported to influence the achievement of students in biology. Yip (1998) defined misconception as those held by students that are at variance with scientific knowledge even after formal instruction. Therefore for providing meaningful learning researchers have tried to identify the misconceptions that students posses in biology: photosynthesis (Waheed and Lucas, 1992), amino acid and translation (Fisher, 1985), genetics (Pashley, 1994), reproduction (Yip, 1998), ecology (Adeniyi, 1985), vertebrate and invertebrates (Braund, 1998), the digestive system (Teixeira, 2000). In recent years, there has been an increasing interest in students' misconceptions in Turkey: cellular division (Yılmaz, 1998), photosynthesis (Çapa, 2000; Tekkaya and Balcı, 2003), circulatory system (Sungur, Tekkaya and Geban, 2001), ecology (Özkan, 2001), respiration (Aşcı, Özkan and Tekkaya, 2001; Alparslan, Tekkaya and Geban, 2003).

Sources of misconceptions can be both in- and out-of-school experiences. Misinformation transmitted by teachers, misapplication of content taught in school, misapplication of scientific terminology, wrong descriptions of the observations of

the demonstrated phenomenon in school, inadequacy of curriculum, textbook errors, presentation of science topics in isolation are among the causes of misconceptions (Çapa, 2000). These findings of misconceptions and their sources are crucial to improve meaningful learning consequently to increase achievement in biology.

Reasoning ability is another factor that is also taken into account by many researchers who have found significant relationship with biology achievement. For example, Johnson and Lawson (1998) investigated the effect of reasoning ability on biology achievement in expository and inquiry classes. They found significant positive correlation between reasoning ability and biology achievement in both of the classes. Consistently Cavallo (1996) also found that students' reasoning ability affected students' achievement in genetics problems. Furthermore Lawson and Thompson (1988) concluded that formal reasoning ability is essential for 7^{th} grade students to cope with their existing misconceptions and develop acceptable biological conceptions about genetics and natural selection. In addition Lawson, Alkhoury, Benford, Clark and Falconer (2000) found that there is significant correlation between developmental level and conceptual knowledge of college biology students. More recently, Sungur and Tekkaya (2003) investigated the effect of reasoning ability on achievement of 10^{th} grade students in human circulatory system concepts. The results of their study revealed that formal students achieved significantly higher than concrete students. Lawson and Thompson (1988) indicated that while formal students can overcome their misconceptions by evaluating and comparing situations, concrete students continue to use their misconceptions which interfere with meaningful learning.

Another variable that has been investigated for its effects on biology achievement is classroom environment. According to Talton and Simpson (1987) classroom environment is composed of six areas; the emotional climate of science classroom, science curriculum, physical environment of science classroom, science teacher, other students in the science classroom, friends' attitudes toward science. They found significant correlation between attitude toward science and all the classroom environment variables. Manoussou (1989) investigated the relationship between attitude toward biology classroom environment and biology achievement of

9th and 11th grade Greek students. Manoussou found significant correlation between attitude toward biology classroom environment and achievement in biology. In addition emotional climate of biology classroom showed the strongest relationship with biology achievement at 9th grade while at 11th grade, biology curriculum showed the strongest relationship with biology achievement. Apart from, Manoussou concluded that classroom environment is an important factor for developing positive attitudes toward biology. Simpson and Troost (1982), also, emphasized that if students experience an unpleasant and punishing science classroom then the limited science knowledge that they learn will soon be lost.

Instructional methods and materials are absolute to influence biology achievement. Technology is very important for many areas and education as well. Computers are becoming a very important tool for education since computer usage provides saving time and taking interests of learners. Therefore computers can be used in biology for collecting, storing data, and also the presentation of this data. It is evident that Computer assisted learning (CAL) provides reinforcement, and increases student motivation. In the study of Hounshell and Hill (1989), in a high school computer-loaded biology course, higher achievement and more positive attitudes were observed. Although strong misconceptions were present at the beginning, it was found that specialized computer programs help develop inquiry skills and increase scientific knowledge (Shute and Bonar, 1986). In addition by viewing animations class discussions and exposition of the misconceptions can be possible. CAL packages provide virtual field trips, simulations and laboratories when real ones are not available in the school system, this encourages discovery learning (Peat and Fernandez, 2000). Another study by Soyibo and Hudson (2000) conducted with 11th grade females revealed that experimental subjects who had a combination of lecture, discussion and computer-assisted instruction (CAI) outscored the control group subjects who was taught by lecture and discussion methods in biology achievement test. Besides experimental subjects' attitudes to biology and CAI were significantly better than control subjects'. They attributed experimental group's higher achievement to their better attitudes to biology than control group. Some studies, however, found computers to have limited value in science. For example a study conducted by Wainwright (1989) showed that experimental group having CAL

scored significantly lower than the control group using worksheets. Wainwright attributed this result to paper and pencil sheets which allowed students to more easily experiment with trial and error in balancing chemical equations.

Besides inquiry, as a teaching approach, is a powerful teaching technique which involve students in gathering information, collecting and interpreting data, formulating hypotheses and drawing logical conclusions and cooperative learning strategy which encourages students to work together in small groups and to use a variety of activities to improve their understanding of subject matter (Chang and Mao, 1999). It is, therefore, not surprising that to increase achievement in biology is possible by this method. The National Research Council (1996) developed National Science Education Standards and stated that "working collaboratively with others not only enhances the understanding of science , it also fosters the practice of many of the skills, attitudes, and values that characterize science" (p.50). Inquiry instruction encourages students to extend their thinking and express their ideas in a variety of ways (Scheneider, Krajcik, Marx and Soloway, 2001). It is indicated by many researchers that inquiry teaching results in greater student achievement and positive science attitudes more than the traditional teaching (Ertepinar and Geban, 1996; Berenfeld, 1996; Basaga, Geban, and Tekkaya, 1994; Geban, Askar and Ozkan, 1992; Hall and McCurdy, 1990; Henkel, 1968). For example Chang and Mao (1999) made a study in which treatment group received an inquiry-group instruction; control group students received traditional approach. In inquiry group, students made hands-on and minds-on activities, gathered and recorded data and interpreted them and their relationships. Textbooks, cooperative learning, group discussions and presentations were involved, students were active. In the control group the traditional instruction stressed lectures given by teachers, use of textbooks, clear explanations of important concepts to students, occasional demonstrations with models. Briefly, instruction was teacher centered, teacher transferred the science knowledge to the students. As a result students in the experimental group had significantly higher achievement scores than the control group students and student attitudes toward the subject matter were statistically more positive for inquiry group than the control group. On the other hand, some other researchers (Germann,1989; Oliver, 1965; Orr, 1968) found that

inquiry teaching strategies have no significant effects on the achievement or learning of science process skills.

Practical studies in science lessons have an important place among instructional methods for a meaningful learning. It is generally believed that science is better learnt in an applied manner by way of doing laboratory studies. For example Akçay (1990) compared the effect of different teaching methods on achievement of Turkish university students on cell concept. He found significant superiority of experimental teaching over lecturing and questioning. The student by doing experiments constructs the base for learning, because by using more senses they provide retention in their learning. Many studies confirm these expressions. In addition Asıcı (1991), and Erten (1991) in their studies expressed the importance and necessity of laboratories in biology education. Scientific concepts may be clarified and reinforced via the manipulation of materials during laboratory experiences for the low achieving students and this may contribute to the development of more positive attitudes toward biology laboratory. So students with poor prior academic achievement in science should be encouraged to use laboratory experience (Weinburgh and Englehard, 1994). Fuller (1992) compared three approaches about laboratory activities by assigning three groups; in the first group pupils carried out experiments themselves, in the second group the teacher demonstrated the experiment to the class, and in the third group a presentation on the same topic was given by the teacher using talk and blackboard (control group). According to the results of a written test applied to these groups in the 7^{th} grade the second group in which the teacher demonstrated the experiments scored higher than the other two groups. On the other hand, the use of experiments done by the students themselves led to significantly better attitude scores towards biology lessons, whereas the group in which the teacher demonstrated the experiments showed a slight negative change in attitude. Sabri and Emuas (1999) in their study examined the relationship between science laboratory experiments observed in secondary school and the academic achievement of Palestinian students in university physics, chemistry and biology courses. They concluded that there is a strong relationship between the total number of secondary science laboratory experiments in secondary school and the academic achievement of Palestinian students in science theory and laboratory courses. On the

other hand, they mentioned that laboratory work is both time consuming and expensive compared to the other models of instruction (Sabri and Emuas, 1999).

Use of demonstrative materials also strengthens the instruction in biology lessons. According to the study of Killermann (1998) about biology teaching methods; slides, pictures and preserved animals have supplementary roles and living animals should be used as often as possible. The use of living organisms should aim to help students develop consciousness for conservation of nature and protection of living creatures. Wisnievwski (1994) completed a study about the effect of use of films on learning and attitude. The pupils were assigned to two groups and one received lesson without the use of films, the other group received the similar lesson with additional use of film. When the groups tested a week later the group that had been shown a film scored significantly better than the other group. The film should have helped students activate their long-term memory of the content of the lessons. So educational TV programs about the topic, can have a positive effect both at the emotional and at the cognitive level.

Active involvement of students for a higher achievement is what science educators and researchers have paid attention. Cross (1987) concluded that "When students are actively involved in the learning task, they learn more than when they are more passive recipients of instruction." Completing short in class writing activities, engaging in class discussions, field trips, completing laboratory exercises, participating in simulation activities, computer assisted instruction activities, making individual or small group presentations are among the strategies in active learning (Frederick, 1981, 1986). Besides Penick (1995) mentioned that in the classrooms where the students are encouraged to ask questions are there successful students. In these classes teachers also ask questions. The more questions they ask the more likely they are to be involved to learn and know what is happening. Penick also stated not only that the best teachers' classes are laboratory-centered and student-active but also that the most effective teachers in the US do some kind of hands-on activity. In the active learning process students do things and think about the things they are doing (Eison and Bonwell, 1988). By actively participating, the students with learning disadvantages in the learning process it is possible to create real

meaning (Frankenstein, 1981). Glasson (1989) also made a study to expose the influence of hands on or teacher demonstration laboratory methods. He found that the two instructional methods resulted in equal declarative knowledge achievement that is factual or conceptual knowledge of students. However, he found significantly better performance on procedural knowledge that is application of knowledge, finding solutions to the problems in favor of students in the hands-on laboratory class. Glasson mentions that "hands-on activities promote peer interaction where students are free to argue, make mistakes and challenge each other".

Teacher has always been considered a crucial factor affecting achievement. Teacher effectiveness contributes to higher achievement in science and biology. Haladyna (1997) defined teaching as a formal process for helping students learn which includes coordinated set of activities that require measuring student behavior reflecting the instructional intent. Since classroom is an ever-changing environment, effective teaching involves not only interchange between teacher and his or her students but also among the students themselves (Eison, 1990). Teacher's enthusiasm comes at first. Eison (1990) stated that in the classroom, the instructor's enthusiasm or the lack of it is contagious. McKeachie (1974) underlined that "probably no one thing is more important in education than the teacher's enthusiasm and energy." Wong (1993, as cited in Aldridge, Fraser and Huang 1999) reported that many students identified the teacher as the most crucial element in a positive classroom learning environment in Hong Kong. Those teachers created an atmosphere that was not boring and at the same time kept the discipline. They interacted with students friendly. Subject matter knowledge is another variable to be considered for teacher effectiveness. On the other hand, it may seem surprising that many studies show small or statistically insignificant relationships between teacher performance and subject matter knowledge (Ayers and Qualls, 1979; Haney, Madaus, and Kreitzer, 1986). Ashton and Crocker (1987) reviewed 14 studies and only in 5 of them they reported positive relationship between subject matter knowledge and teacher performance. Yet, Druva and Anderson (1983) found that students' science achievement is positively related to the teachers' course taking background in both education and science. On the other hand, Tobin, Tippins, and Gallrd (1994), as cited from Halim and Meerah (2002), based on their observations of primary and

secondary school Australian teachers; found that teachers' explanations and analogies reinforced misconceptions in pupils when teaching outside their specializations. In addition there are studies including teachers' knowledge of teaching and learning. Ashton and Crocker (1987) found in their review studies significant positive relationships between education coursework and teacher performance. In Monk's (1994) study about students' mathematics and science achievement that education coursework had a positive effect on student learning was found. Perkes (1967-68) also found that there was a significant relationship between science education coursework and students' achievement on tasks requiring problem solving and applications of science. Those teachers who had greater training in science teaching used laboratory techniques, discussions and conceptual applications of ideas. Teachers with less training in education placed more emphasis on memorization. The pedagogical skills may interact with subject matter knowledge to influence teacher performance positively or negatively (Byrne, 1983). Halim and Meerah (2002) investigated science trainee teachers' pedagogical content knowledge and its influence on physics teaching. They concluded that trainee teachers' pedagogical content knowledge for promoting conceptual understanding is limited, therefore they lacked the ability to transform their understanding of basic concepts in physics required to teach lower secondary school science pupils. Murnane and Philips (1981) have found a relationship between teachers' effectiveness and their years of experience. However, being an experienced teacher does not ensure that one will know how to develop effective science teaching strategies (Halim and Meerah, 2002). Successful teachers were found to use many kinds of teaching strategies and interaction styles rather than a single approach. Effective teachers try to meet the needs of different students and demands of curricular goals, topics, and methods (Doyle, 1985). Different strategies are included in active teaching and this active teaching responds to both students' needs and curriculum goals (Good, 1983). Another study (Öztürk, 1999) investigated teacher roles in high school biology curriculum implementation and concluded that teacher's beliefs, attitudes and teaching performances affect the implementation of the curriculum in different ways.

Another factor that affects students' achievement in biology is learning difficulties that students have in a variety of concepts. In Johnstone's (1991) study

the nature of science itself and the methods by which science is taught are mentioned to be the reasons of the difficulties of learning science. He stressed the fact that many pupils claim that science is hard to learn; therefore he concluded that science is not successfully transmitted. The reasons may lie under three variables: the transmission system itself, the methods used, the facilities available, and the nature of pupils' learning. Johnstone's one reasoning was the nature of science concepts, that is, science concepts exist only in mind, they are difficult to be exemplified compared to the other concepts. Another point to be mentioned is that science is full of many terms. The technical and non-technical terms are another source of difficulty, but non-technical terms are much more problematic compared to technical terms since pupils think they understand non-technical terms (Cassells and Johnstone, 1983). High school biology curricula is divided into seven levels of biological organization in 1970s and 1980s; molecular level, cell, tissue and organ, organism, population community, and biome (Lazarowitz and Penso, 1992). Lazarowitz and Penso attributed difficulties in learning of the topics that are considered difficult to two reasons: The biological level of organization and the abstract level of the concepts. According to Klinckman (1970) also, the appropriateness of biological level of organization might be a reason; young students or poor achieving students may get higher scores if instructed in topics of the levels of organisms, population, and community while they have difficulties in learning concepts of molecular, cell, tissue, and organ levels. Lazarowitz and Penso (1992) identified photosynthesis, respiration, enzyme activity, dominance and co-dominance, and sex-linkages the concepts as being on an abstract level in biology curricula. They after analyzing answers of 12^{th} grade in Israel concluded that students had difficulties to relate their answers to relevant factors in the experiments and to separate variables investigated in the experiments and to distinguish relevant ones from irrelevant ones. In addition students' answers were not relevant to the problems posed in the questions. They encountered difficulty to determine the relationship between ideas and facts.

In another study, by Tekkaya, Özkan, and Sungur (2001), high school students participated and interviews with biology teachers were conducted to determine the biology topics perceived as difficult by Turkish students. They found hormones, genes and chromosomes, mitosis and meiosis, nervous system, and

Mendelian genetics to be difficult concepts for students to learn. They concluded that curriculum covering quantity of subject matter, abstract and interdisciplinary nature of concepts, textbooks cause learning difficulties in these topics.

Accordingly, biology curriculum and textbooks, by covering large content area, are considered among the factors that affect achievement in biology. Chiepetta and Fillman (1998) mentioned that high school biology course content being high in quantity does not provide inquiry learning in which students construct knowledge in a meaningful manner. They also confirm this statement by the saying of biology teachers, science supervisors, and science educators that high school biology courses contain too many subject matters and this makes students memorize too many terms which blocks meaningful learning. Chiapetta and Fillman stated that most high school biology texts are encyclopedic containing large amounts of information and many technical terms (Lumpe and Beck, 1996). Many biology teachers try to cover all the text. Yet, biology teachers should provide conceptual development of major biological ideas and avoid rote learning of so many facts but on the other hand, it is necessary to provide students with facts to improve understanding of ideas (Anderson, 1989). In addition, Penick (1995) indicated that the biology textbooks contain so many terms that learning biology from the book is like learning a foreign language. He also mentioned that science curricula avoid application of knowledge and therefore pupils think that what they learn in school is not useful for them in life so they see science as nonsense.

Learning takes place not only at school but out of school as well. As Partridge (2003) mentioned, scientific experiences outside the classroom captivate students' interest in, and enthusiasm for science inside the classroom. Field trips have effective instructional role to provide students meaningful understanding and consequently higher achievement of biology. Through field trips, the events and the objects that cannot be brought into class are possible to be observed. In biology education the aim is to see and watch the events happening in the nature or animals and plants and the processes related to these. In this teaching method students by using all the senses and skills of cognitive level try to obtain data about the biological material (Çilenti, 1991). In the study of Scherf (1986), for topic of plant types, 4th grade students were

assigned into 3 groups two of which were experimental and the other was the control group. Students in experimental group engaged in lessons and field trip in which preparation in the classroom followed by work outside. Students in the second group had lessons only in which both preparation and work in the classroom, whereas students in the control group had no formal lessons on plant forms. When they were tested for their ability to recognize plant types , the first group students who participated in the lessons outside and could see the plants growing in their natural environment showed a greater ability to recognize plants than the other students worked only in the class. In an another study by Kern and Carpenter (1986), two classes of a college laboratory course in earth science were compared to pose the effect of field activities. One class had activities using laboratory manual, while the other had field activities. At the end the performance of two classes was compared; the results were similar on lower-order learning, but the class which had field activities showed greater ability to apply the acquired information. On the other hand, lack of time, lack of people for assistance, the field trip risk assumed by the school, lack of funding, limited availability of transportation, excessive class size are among the factors that Mason (1980) reasoned for the limited use of field activity as an instructional model in biology lessons.

In recent years informal science education has been considered important to improve meaningful learning and achievement. Science educators are becoming more interested in informal or alternative forms of education like museums or other non-school settings to meet students' needs which may not be met in traditional settings (Randle and Anderson). Blosser (1984) reported data of some documents and indicated that children gain science information from television and other informal science education experiences. Blosser mentioned from report of 21st CENTURY document that informal science education through the use of science museums provide students and parents with science hobbies and they become involved in weekend and evening programs. Libraries, voluntary youth organizations, Boy and Girl Scouts, and other science and technology related groups by working museums and schools provide an enriched environment for informal learning. Furthermore Pollock (1991) defined televisions and zoos in addition to the museums as the important features of informal biological education. He stated that

education is the strongest reason for the existence of zoos. Besides Randle and Anderson made a study with 7th and 8th grade students who completed a unit on evolution. They found that the use of alternate sites such as museums, provide an environment including a variety of learning styles that meet the needs of students who will feel comfortable exploring science.

Hicks and Cochran (1986) compared learning in school and in museums and indicated that learning in school includes verbal communication with facts and concepts presented in a structured way whereas in museums objects which are less structured and directed by learner's interest, ideas, and experience, form the basis of learning process. Museums offer reality and so visits should be relevant to the curricular purposes. On the other hand, Randle and Anderson emphasized museum educators' saying that museums are regarded as field trips where students see interesting objects and have fun not as activities that complement classroom learning.

Reading research articles can be a way of teaching-learning strategy in science. Yarden, Brill and Falk (2001) discussed if high-school biology students can learn by reading primary literature and if efficient teaching of subject matter in high school is possible by reading the relevant research articles. It is stressed that reading research articles is an important skill which can be used to develop scientific literacy. Research articles, in contrast to textbooks, focus on a single research question and provide a limited amount of academic knowledge compared to the textbooks. Through the articles students are exposed to research plan, research methods, research question, scientific communication, the problems and the solutions scientists bring, and also they can develop the ability to critically assert the goals and conclusions of the scientific research. Research articles may be a novelty and a challenge for students. Considered this rationale in mind Yarden and Brill (2000) developed a curriculum based on primary literature in developmental biology for high school biology majors (11th and 12th grade) in Israel. A model for learning through research articles in the classroom was constructed and introduced to 11th grade biology majors during the implementation of the curriculum. According to this model students read article together section by section and after each section they raise questions which are written on the board or on a transparency by the teacher.

Students propose hypotheses or make predictions about the experiments in order to answer the questions. As a discussion progresses the teacher's role evolves into moderator rather than instructor. The most important role of teacher is to encourage students to ask questions. After the conduction of this model, Yarden et al. (2001) concluded that learning through research articles is a challenging task for high school students. The open atmosphere in the class in which students interact each other and are encouraged to ask questions by the teachers, facilitates high school students' understanding of the content of the articles. Students who learned using the research articles reported that learning from research articles was more interesting and challenging intellectually, and enabled them to express their own views and develop a real discussion in class. Yarden et al. also underline that "Learning through research articles should not be sole way of learning, but rather an additional way among others, which enables student exposure to the professional scientific world." (p. 193)

Family involvement is also an important educational issue. Schwartz (2001) indicated that schools communities and families must be committed to the achievement of children and so must provide long term educational improvement. Schwartz identified the role of family as the involvement in their children's schooling, development of a home atmosphere conducive to learning, participation in homework completion, and meeting performance standards or anything, related to family role, contributing to educational success. High parent involvement is a characteristic of many successful schools some of which involve parents in all aspects of curriculum, decision making and classroom management (Davis, 1995). Teachers can involve parents by holding meetings for parents in which the importance of curriculum is explained. Teachers can share with families books, videotapes, child-made materials etc (Swick, Boutte, and Scoy; 1994) .

Keeping the above literature in mind Eison's (1990) saying is of great value: "The greater the diversity and variety found in one's instructional objectives, the easier it will be for the instructor to maintain students' interest." (p.23)

In order for provision of higher achievement in biology, a clear identification of goals and objectives of science education is important. To meet the goals of science education constructivist and conceptual change approach should be taken into account. According to constructivist approach humans are knowledgeable, active, purposive, adaptive, and self aware. They construct their own knowledge using their previous knowledge. For a meaningful learning to occur learner should interpret and integrate his/her prior knowledge (Magoon, 1977). In this perspective learners who base their understanding on their previous knowledge are active (Bodner, 1986). Accordingly, what can be encouraged is conceptual change through which science teachers have to determine students' existing conceptions and enhance broadening and restructuring their knowledge as well as correcting their incorrect conceptions.

In the light of constructivism how to provide a meaningful science education need to be taken attention. Driel, Beijaard and Verloop (2000) stated that science is usually presented as a rigid body of facts, theories, and rules to be memorized and practiced. This situation has been criticized by policy makers, teachers, educators and researchers. So some reforms in science education have been discussed and these reforms share some implications for teaching science: The emphasis should be, instead of transmitting knowledge, on designing situations and kinds of activities which provide active learning. The teachers should investigate students' knowledge and identify misconceptions, then accordingly design the appropriate method. Teachers should respond to any situation not anticipated in the class (Kennedy, 1998). The number of topics should be decreased, so the teachers will accept the idea that "less is better" (Millar and Osborne, 1998). Teachers should deal not only with students having high abilities or high motivation for science, but with all students both from a cognitive and an affective perspective. There will also occur a shift toward the teaching of inquiry skills (Driel, Beijaard, and Verloop, 2000).

Delpech (2002), investigated why students are bored with science and exposed the findings of Science and Technology Committee Report of Science Education (2002): In the curriculum topics are revisited in more depth at later stages. This deep coverage of topics later may be considered as repetition by the students

and so they find this boring. Another reason stated may be the practical activities having little educational value and turning into tedious and dull activity for both students and teachers. Due to these reasons students are losing their enthusiasm for science and find it boring. Students should have the opportunity to do exciting and varied experimental and investigative work and deal with hands-on activities. Some suggestions are made in the article:

- Developing an understanding of science , rather than recalling a large body of facts
- Agreement between teachers and others as to what scientific core material is needed
- Assessment of scientific literacy skills
- Better resources, time and training for teachers before implementation of changes
- Correcting imbalance in difficulty between science/nonscience courses
- Improving laboratory and preparation rooms
- Reducing class sizes to a maximum of 20 for practical lessons

Additionally, Bybee (2002) finds a basis for advancing teaching and learning biology in the National Research Council report How People Learn: Brain, Mind, Experience, and School (Bransford, Brown and Crocking, 1999). Three findings from How People Learn have implications for biology education.

> Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of test but revert to their preconceptions outside the classroom. (pp.14-15)

Bybee relates this first finding to biology teaching, specifically how experiences to draw out students' current understandings are structured or some sense of inadequacy of ideas is exposed and opportunities and time to reconstruct ideas are provided.

> To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application. (p. 16)

Bybee at this point mentions that the biology curriculum should incorporate fundamental knowledge and contribute to students' development of a strong conceptual framework. Only factual information is not sufficient. Mastery of concepts should allow deep understanding which provide learner to reformulate the facts into usable knowledge. The mastery of concepts facilitates learning to be transferred into new problems.

> A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. (p. 18)

Bybee here mentions that this "third finding has implications for the theme of scientific inquiry as students address experiences where the biology teacher helps them monitor their understanding, incorporate additional information, review the consistency of new information with what is already known, and explain new ways of thinking that will advance their understanding."

One of the major goals of science education is the development of scientific literacy which includes the development of positive attitudes toward science (Linn, 1992). To educate the students who feel the excitement of understanding the natural world is the other goal of school science underlined by the National Science Education Standards (1996). Furthermore developing individual creativity is an important issue and among the foremost goals of education should be encouraging students to use this skill. Students should be prepared to think creatively, to put information into practical use, to work collaboratively, to use technology as an aid. Project based learning is an effective educational approach that focuses on creative thinking, problem solving and interaction of students to use new knowledge (Marchaim, 2001).

As a conclusion The Nuffield Foundation (1998) makes recommendations: Science curriculum should provide the students with key ideas that the reliable knowledge of natural world can be deduced. The curriculum should make it possible for teachers not only to focus on students' ability to understand and interpret scientific information and to discuss controversial issues but also to measure their knowledge and understanding of scientific ideas.

CHAPTER 3

METHOD

In the previous chapter several studies related to the objectives of this study have been examined involving achievement and achievement-related issues. This chapter explains the procedure for the whole study:

3.1 Research questions

This study aims at exploring the reasons underlying low achievement of Turkish students in biology as indicated by the results of university entrance examinations for many years (see Table 1.2). The research questions were asked in this respect. Questions are in two fold: questions depending on information to be obtained from teachers and to be obtained from students. Questions are listed as follows:

1. What are the teachers' opinions about the reasons of low achievement of students in biology?
2. What are the students' opinions about the reasons of low achievement of students in biology?
3. Are there any similarities between students' and teachers' views about the reasons of low achievement in biology?
4. What are teachers' views about biology?
5. What are students' views about biology?
6. What are the ideas of teachers about biology education (biology course time, curriculum, textbooks, examination systems etc.)?

7. What are the ideas of students about biology education (biology teachers, biology course time, curriculum, textbooks, etc.)?
8. What are the differences about the problems that biology teachers face between different school types; private high schools, Anatolian high schools and public high schools?

3.2 Overall Research Design

In this study the qualitative research method have been used to gather data. So two one-to-one interview schedules have been prepared to be conducted to students and teachers. To give some information about qualitative research and interviewing will be worthwhile.

Qualitative researches investigate the quality of relationships, activities, situations, or materials. In this type of research the emphasis is on describing an activity or a situation and the samples of the studies are usually selected via purposive sampling since the researcher wants to ensure the sample is suited to the intent of the study (Fraenkel and Wallen, 1996). It is possible to obtain detailed information about cases or people by way of qualitative research and the purposive sampling process increases understanding of the cases while reducing generalizability (Patton, 1990).

Validity has been defined as "appropriateness, meaningfulness, and usefulness of the specific inferences researchers make based on the data they collect" while reliability refers to the consistency of these inferences over time (Fraenkel and Wallen, 1996). In qualitative study it depends on perspective of the researcher and the degree of confidence researchers can place in what they heave seen or heard. Fraenkel and Wallen emphasized that how researchers can be sure that they are not being misled. Furthermore whether a researcher sees what he or she sees or what he or she thinks is a concern of validity in qualitative studies (Kirk and Miller, 1986).

Triangulation is among the methods that qualitative researchers use to ensure that they are not being misinformed. In triangulation a variety of instruments is used

to collect data. The validity is enhanced if a conclusion is supported by data collected from a number of different instruments (Fraenkel and Wallen, 1996).

By way of generalizing it is possible to have expectations and predictions for the future of a situation. Generalization can be thought as "a statement or claim of some sort that applies to more than one individual, group, object or situation". Generalization is possible in qualitative studies but generalization is to be done by interested practitioners who are in situations similar to the one(s) investigated by the researcher. Practitioner assesses the applicability of the researcher's findings and conclusions and determines if the researcher's findings fit his or her situations (Fraenkel and Wallen, 1996).

Interviewing of the selected individuals is an important method in qualitative research. Bogdan and Biklen (1992) have defined interview as "a purposeful conversation, usually between two people but sometimes involving more, that is directed by one in order to get information from the other" (p.96) . Fetterman (1989) identified interviewing as the most important data collection technique in qualitative studies. Interviewing, careful asking of relevant questions, aims to find out what is on people's mind, what they think or how they feel about something (Fraenkel and Wallen, 1996). Patton (1990) has stated:

We interview people to find out from them those things we cannot directly observe. The issue is not whether observational data is more desirable, valid, or meaningful than self-report data. The fact of the matter is that we cannot observe feelings, thoughts, and intentions. We cannot observe behaviors that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. We cannot observe how people have organized the world and the meanings they attach to what goes on in the world. We have to ask questions about those things.

Interview method has both advantages and disadvantages. By way of interviewing it is possible to obtain full and detailed answers from the interviewees (Tutty, Rothery and Grinnell, 1996). In addition interviewer has the opportunity not

only to observe non-verbal behavior and evaluate the validity of respondents' answers but also to control question order. Furthermore interviewer can standardize the environment where the interview will be made in the efficient manner (Bailey, 1982). The other advantage of interview is that the interviewer can clarify obscure questions and ask the respondent to expand the answers particularly important or revealing. On the other hand, interviews may take much longer time compared to questionnaires; in addition, the presence of researcher may effect respondents in the way that they do not say what they really think (Fraenkel and Wallen, 1996).

In this study separate interviews were conducted with high school students and high school biology teachers. Accordingly, two interview schedules of the semi-structured type were developed. Semi-structured type interviews can be assumed as verbal questionnaires which consist of series of questions designed to elicit specific answers on the part of respondents. It is possible to use them to obtain information that can later be compared and contrasted. These are most useful to obtain information to test a hypothesis in researcher's mind (Fraenkel and Wallen, 1996). A recording device was used to record the interviews and after that they were all transcribed verbatim and analyzed by the researcher.

3.3 The Sample

The sample of the study consisted of a total of 45 high school biology teachers and 45 eleventh grade high school science students. Samples were selected from different school types in order to provide variation and increase both the reliability and the generalizability of the study. Ten schools including 3 private high schools, 4 Anatolian high schools and 3 public high schools in Ankara took part in the study. These schools were selected by purposeful sampling on the basis of their general success, that is, the schools are known successful ones among high schools in Ankara to place students into universities. The schools were selected on the criteria of their high success in general in Ankara. Patton (1990) stated "The power of purposeful sampling lies in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of evaluation". (p.52)

The 45 biology teachers who participated in the study were all the teachers working in these 10 schools, this number of teacher was considered to be sufficient to obtain the necessary information for the study. Teachers participated in the interview voluntarily. They were asked their experiences in teaching and the universities from which they were graduated. Their characteristics are presented in Table 3.1. Out of 45 teachers 34 (76%) were females and 11 (24%) were males. Of the teachers, 16 (36%) had attended pedagogical courses, the others were either graduated from education faculties or started to work without a need of pedagogical courses.

Table 3.1 Teachers' Characteristics

		N	%
Gender	Female	34	76
	Male	11	24
Experience (in years)	2-10	21	47
	11-20	18	40
	21-29	6	13
Graduation	Faculty of Education	22	49
	Faculty of Arts and Sciences	23	51
	Master Degree	5	11
	Ph D Degree	1	2
School Types	Private high school	17	38
	Anatolian high school	16	36
	Public high school	12	26
Total		45	100

After interviews were conducted with teachers, a size of 45 students was considered as sufficient to be interviewed. Again to increase variation and generalizability it was appropriate to make interviews from 3 types of schools. The students were selected by purposive sampling. Science students were chosen because they should study biology as well as other science lessons. In addition eleventh graders were more appropriate since they would be more informative because they have been studying biology, mathematics, physics and chemistry for about 3 years to win university entrance exams. Besides to obtain more meaningful information these 45 students were selected on the basis that they were good at other science lessons and mathematics but not at biology. Furthermore the students who would really be able to inform the researcher about the questions of interest were chosen. Accordingly the biology teachers were asked these kinds of students and as a result 45 students were selected. Voluntary involvement was taken into consideration for students as well in order to ensure consistency.

The students to be interviewed were selected to vary by gender. The sample consisted of approximately equal number of boys (n=22) and girls (n=23). Their ages ranged between 16-18. The characteristics of students are presented in Table 3.2.

Table 3.2 Students' Characteristics

		N	%
Gender	Female	22	49
	Male	23	51
Age	16	7	16
	17	27	60
	18	11	24
School Type	Private high school	15	33
	Anatolian high school	15	33
	Public high school	15	33
Total		45	100

3.4 Data Collection Instruments

As indicated before this study comprised two separate semi-structured interview schedules used to gather data; structuring helped to ensure consistency across interviewees. Questions were asked to all of the participants. One interview was developed for teachers and the other was developed for students. Both of the interviews consisted of open-ended questions to permit interviewees maximum latitude in their answers.

3.4.1 Teacher Interview Schedule

Teacher interview schedule (see Appendix A) consisted of a part to obtain information about the interviewee characteristics and the 27 questions to be asked for

the purpose of the study. In the first part of the interview schedule teachers were asked about their demographic data, but not their names in order to keep confidentiality. Instead of their names each individual was assigned a number. The open-ended interview questions were prepared after related literature about the achievement was searched. The literature about the factors affecting biology achievement helped researcher for preparation of appropriate questions that will provide better information for the purpose of the study. Therefore the answers to the questions were the ones that were thought to best explain the reasons of low achievement and the related issues. Teachers were asked if it was possible for them to involve in the interview after they were given some information about the study by the researcher.

Probes were used to provide a better understanding and obtain a deeper information. In this study probe questions weren't written in the interview schedule but asked when needed. They were used to make the responses clear or to make sure that interviewee understood the question in the correct way. An example of a probe is as follows:

Question: Do you enjoy teaching biology?
If answer: Yes, ASK: Why?
If answer: No, ASK: Why not?

3.4.2 Student Interview Schedule

Student interview schedule was designed after the interviews with the teachers were completed. The information obtained from teachers served as a source for developing the student interview schedule including open-ended questions. The students were asked questions parallel to the teachers' questions and their opinions were obtained related to the reasons of low achievement of students in biology.

Student interview schedule (see Appendix C) included a part about information about their characteristics; their ages, their genders, and their school types but not their names in order to keep confidentiality. Each student was given a number. After that 19 questions in the interview sought to investigate the reasons of low achievement of students in biology and related issues. Voluntary involvement was valid for students as well. Students were informed by the researcher about the study.

Probes were used in the interview of students also in order to provide students a better understanding of the interview questions. An example of probe is as follows:

Question: Does biology engage your interest?
If answer: Yes, ASK: Why?
If answer: No, ASK: Why not?

3.5 Data Collection Procedures

After the teacher interview schedules were prepared, necessary permissions were taken from related authorities. When the permissions of principals of the schools were taken, the interviews were to be made.

Data were collected through face-to-face interviews with a total number of 45 eleventh grade science students and 45 biology teachers. The interviews were recorded by a tape-recorder in order not to miss anything and gain time. Gay (1987) about recording stated:

> several people were able to listen to the recordings independently, and classifications could be compared. A recorder could initially make subjects nervous, but usually they tended to forget about its presence as the interview progressed, whereas they were constantly aware when someone was writing their responses. In general, however, mechanical recording proved to be more objective and efficient than writing. (pp. 204-205)

In addition audio-tapes may be replayed many times for continuous study and analysis. Furthermore experts can also hear what the researcher observed and offer their insights accordingly (Fraenkel and Wallen, 1996).

3.5.1 Interview with Teachers

Teacher interviews were carried out for about 3 weeks. Teachers were requested for interview and required interview time was told. Individual interviews were conducted with each teacher in their free times. Before the interviewing started a silent environment where the interviewees were able to speak and think comfortably was provided. The teachers were informed about the researcher and the study. Furthermore they were informed that what they told would be known only by the researchers and they were definitely convinced that confidentiality would be kept through the research study. If teachers had any points in question, they were made clear by the researcher.

Tape recorders were used with the allowance of the interviewees. The interviews which teachers were irritated of the presence of tape recorder were carried out by handwriting. Each teacher was interviewed in one session lasting in the range from 30 to 60 minutes. To prevent confusion, date and number of interview were recorded carefully at the beginning of each interview.

All of the cassettes were labeled with the number and the date of the interviews to give an order to the procedure.

3.5.2 Interview with Students

The student interviews were carried out in about 2 weeks. After the necessary permissions were taken from both the school principals and their teachers, face-to-face interviews were made with each of the 11^{th} grade science students who involved voluntarily. An empty place was provided for the students so that any interruption was avoided. Students were informed before beginning to the interviews about the researcher and the study. The procedure was in the similar way with the teacher

interviews: The students were convinced that their responses would be known only by the researcher. With the allowances of students a tape recorder was used to record the interviews. Besides their names weren't of interest for the reasons of confidentiality. Students were informed that tape recorder was used to make interviews rapidly and not to miss anything. The students were approached friendly and told to remain comfortable during the interview. They were encouraged to reflect their own views.

If existed, their questions were answered. After that firstly their personal information were recorded then their opinions were asked concerning the reasons of low achievement in biology in 19 questions. Each individual interview lasted about 15-20 minutes. All of the students were interviewed in one session. The date and the interview number were recorded. The cassettes also were labeled with the same information.

3.6 Data Analysis Procedure

The audio-taped interviews were transcribed and analyzed. In order to produce verbatim transcriptions of the interviewees' responses, the cassettes were replayed to check whether any missing point was present in the text. Any gaps in the text were filled after several listening of the recordings. In the cassettes if there were lacking parts, only the answers including those parts were excluded. If the missing data were high for an interviewee's responses then all of the responses of that interviewee were excluded.

After the transcriptions were completed, the responses were categorized for each question in order to analyze them as part of the coding system. For each question the responses of all interviewees were listed with the previously assigned number. The similarity of the responses was checked. Accordingly categories, into which interviewees' similar or same responses would be grouped, were identified and named. So these categories formed the codes. Each code was carefully examined and it was investigated if there emerged categories under each code which will become subcodes. The number of individuals who gave responses in each code and subcode was recorded. After several revisions, the percentages were calculated. They

were all tabulated (see chapter 4). Tables were designed in the way that would best explain the reasons of low achievement in biology. The process was the same for both teachers and students.

3.7 Limitations of the Study

Limitations of this study can be listed as follows:

- Since this study was conducted in 10 schools of Ankara chosen purposefully, findings cannot be generalized to all of the Turkish students.

- This study is limited to 11^{th} grade science students in 10 schools including private, Anatolian, and public high schools.

- Due to reason of time limitations, 45 students took part in the study about the reasons of low achievement of students in biology.

- Due to reason of time limitations, 45 teachers were interviewed about the reasons of low achievement of students in biology.

- There may be some points that haven't been explored in this study. Due to time limitation not all the questions were asked with details.

- This study lacks triangulation which is an important limitation for a study.

- Although interviewees were requested to tell what they really thought or what the real situation was, there might have been interviewees who didn't expose reality.

- Absence of classroom observations might be regarded as another limitation of this study.

Anyway, it should be mentioned that this study offers important insights into the way to increase students' biology achievement.

3.8 Time Schedule for the Whole Study

The study completed in approximately one year time period:

TIME	PROCESS
November 2002-February 2003	Reviewing the literature
November-December 2002	Getting necessary permissions from related foundations
January 2003	Interviewing with teachers
February 2003	Transcribing the interviews of the teachers
February-March 2003	Interviewing with students
March 2003	Transcribing the interviews of the students
April 2003	Analysis of data
April-August 2003	Writing the overall study

CHAPTER 4

RESULTS

This chapter is divided into two parts. The first part deals with the information obtained from the interviews with the biology teachers concerning the reasons of low biology achievement. The second part presents the results of the interviews conducted with the 11th grade science students. To maintain confidence, students' and teachers' views utilized here are referenced according to their assigned number given in the research within the parenthesis. In the parentheses each interviewee's characteristics are also given.

4.1 Teacher Interview Results

A total number of 45 biology teachers (34 females, 11 males) were asked 27 questions in the face-to-face interviews of semi-structured type.

Teachers were shown the table of comparative point averages of science and mathematics lessons in university entrance exams between the years 1996-2002 (see Table 1.2). Then they were asked the question of "What do you think what are the reasons of low achievements in biology as indicated by the results of university entrance examinations between the years 1996-2002?" Selected examples of excerpts from the interviews with teachers are provided below:

Some teachers reasoned characteristics of ÖSS questions:

> ÖSYM asks questions out of the curriculum prepared by National Ministry of Education. This irritates us. Both university preparatory courses and ÖSS ask questions from details that we don't teach to the students which makes us feel

bad. (Teacher 30, female[F], Anatolian High school[A], 8 years of experience[y.o.e])

Usually ÖSS questions are at synthesis level, especially after the year 1996. Questions aren't measuring knowledge now. The questions are above students' level, however they should be at high school level. Questions are not from high school biology curriculum. I can give you examples of ÖSS questions taken from university biology textbooks. Another point is less number of questions, students think that biology questions are not valuable; I can win university without solving biology questions. (Teacher 16 [M, P, 12 y.o.e])

Teachers emphasized the low number of biology questions and high number of topics included in university exams.

Students have this logic: "Instead of studying so many topics for university entrance exam and solving 2-3 biology questions in ÖSS, it is better for me to study mathematics and physics and so that get higher points." So students easily give less importance to biology. In addition the coefficient of biology question is lower than other science lessons and mathematics. So students solve one mathematics question instead of 3 biology question to get the same point. Actually if I were them I would think with this logic too. Low achievement in biology is completely due to university examination system. I don't think that achievement of biology is low in the high schools. (Teacher 7, F, Private High School [P], 8 y.o.e)

...Let me list you the factors: The contents of biology curriculum of all the three grades are included in ÖSS. Whereas for other science lessons and mathematics this is not the case, students are responsible for the contents of 9^{th} and 10^{th} grade not for 11^{th} grade of these lessons. In ÖSS 12 questions from biology are asked. Whereas 18 from physics and 44 from maths... So this is a kind of logic: Instead of studying all of the contents of biology 12 questions it is more reasonable to study less topics for 18 questions from physics and 44 questions from maths, isn't it? (Teacher 31, Male [M], A, 9 y.o.e)

Student considers the amount of biology topics and number of questions asked in ÖSS. There are more than 20 topics in biology and from these topics 12 questions are asked in ÖSS while 45 questions are asked in ÖSS from 12 topics of mathematics. Students have an opportunist mind which says "why to study

> 20 topics for 12 questions", so instead of putting great effort for 12 questions they put effort for 45 questions. (Teacher 33 [M, A, 11 y.o.e])

Some teachers stressed the role of biology in education:

> Neither M.E.B nor ÖSYM gives sufficient importance to biology. Class hours for mathematics are always high from primary schools to high schools. To enter a university the coefficient of mathematics, physics and chemistry questions is higher than that of biology. So students concentrate more on these lessons and give less importance to biology; they support these lessons with preparatory courses and private courses. (Teacher 36, M, Public High school [Pb], 9 y.o.e)

Some of the teachers stressed the problems related to economical source. A teacher working in private college said:

> We, teachers, have economical problems in general. Furthermore we are lazy and we don't improve ourselves... in this school we don't have any economical problems, we have all the opportunities to enrich the courses with different activities and facilities or visual materials. On the other hand, in public schools the teachers lecture and go. (Teacher 9 [F, P, 12 y.o.e])

A few teachers complained about the Turkish education system:

> For about a decade biology teachers have been made unhappy. Biology courses are given by science teachers not biology teachers in Turkey. These people who are not competent on subject matter have been appointed as biology teachers. I think this situation is the greatest reason of this low achievement. Moreover our education system is dependent on memorization. So the student says "biology is dependent on memorization; I can do well in anyway". Whereas in order to succeed at biology it is necessary to know biology completely even to know about other science lessons. (Teacher 45 [F, S, 20 y.o.e])

One of the teachers talked about biology education depending on memorization:

> Since primary school students are given biology education depending on memorization, students are said "if you memorize you can do well". This is not the case for physics or chemistry which includes numerical problem solving. This makes physics and chemistry much more understandable. Whereas if students learn biology at conceptual level from primary school years, it will be easier for us to teach biology. In high schools we are trying to break their point of view that biology depends on memorization, but students can't achieve this. On the other hand, ÖSS questions are at the conceptual level. If students are taught biology from the beginning at conceptual level by different activities and far from memorization then students will understand biology, not memorize... (Teacher 3 [F, P, 15 y.o.e])

Teachers expressed their reasoning beckoning many important issues after many followed-up questions which are going to be presented in the following sections.

4.1.1 Teachers' Perception of Biology

The first four questions in the interviews sought to reveal the teachers' opinions, as biology teachers, about biology in general, its aims, a field of profession, and its role. Teacher is an important factor that affects achievement. Therefore it was reasonable to get teachers' views which might be a source for students to have positive or negative feelings.

The fist question "What do you think about biology in general?" investigated teachers' approach to biology. Selected examples of excerpts are below:

> the science of living things (Teacher 4 [M, P, 2 y.o.e])

> I think this lesson contributes many things to students. Biology means everything to me. (Teacher 23 [F, A, 20 y.o.e])

> Biology... science of life (Teacher 41 [F, S, 9 y.o.e])

A teacher who came from Azerbaijan stated:

> I think that biology is the science of the century, but in Turkey it doesn't receive the attention that it deserves. (Teacher 14 [M, P, 13 y.o.e])

One of the teachers from private high school who worked for about 26 years as a biology teacher expressed her feelings:

> If I had had this mind before I wouldn't have been a biology teacher. Actually I like biology, but it is very difficult to teach. (Teacher 15 [F, P, 27 y.o.e])

Teachers' responses are presented in Table 4.1.

Table 4.1 Teachers' perception of biology

Teachers' responses	N	%
Science of living things	23	51
A necessary science discipline	12	27
Field that I enjoy	11	24
Field related to real life	10	22
A developing science of the century	8	18
Difficult to teach	1	2

As indicated in Table 4.1, approximately half of the teachers reflected their perception of biology as a traditional textbook definition. some of them emphasized its importance for her/himself or they mentioned their feelings that they liked biology.

Teachers' responses to next question "What is the aim of biology education?" were as in the following:

To arm students with biology knowledge necessary for daily life (Teacher 3 [F, P, 15 y.o.e])

Students should learn the events happening both in their bodies and nature, so that they can comment on these events. So the aim is to develop awareness about what is happening in the world. (Teacher 6 [F, P, 17 y.o.e])

To inform student about their bodies, to teach to protect their health., to teach about the environment in which they live and also to give insights into the reduction of hazards given to the nature. (Teacher 23 [F, A, 20 y.o.e])

To teach biology using the scientific issues like cloning. (Teacher 21 [F, A, 8 y.o.e])

The responses of teachers are tabulated in Table 4.2.

Table 4.2 Teachers' thoughts about the aims of biology teaching

Teachers' responses	N	%
To teach students about their bodies and the environment	32	71
To teach characteristics of living things	32	71
To teach students to relate biology knowledge to real life	26	58
To teach to think in scientific approach	6	13

Teachers' responses about the aims of biology education emphasized the importance of gaining insights about scientific developments, application of knowledge to real life situations in a scientific approach, consciousness about environmental issues.

The next question investigated teachers' feelings about their profession. Therefore teachers were asked "Do you enjoy teaching biology?". Their responses were as follows:

> Certainly.. Biology is not abstract; it is exactly related to our lives. Biology informs us about ourselves about the issues that a person must absolutely know. I am happy to give this necessary knowledge. (Teacher 5 [M, P, 4 y.o.e])
> Yes, we are learning together with the students. I like the things that I learn and I think students, even not all, also like. They like learning things related to life itself and this makes me happy. (Teacher 7 [F, P, 8 y.o.e])

> Yes, because it is enjoyable to give students the fundamental knowledge that they will use through their live (Teacher 19 [F, A, 13 y.o.e])

> It is sometimes tiring to teach biology... because biology may sometimes be boring and at that time students are against learning. Accordingly these uninterested students affect us negatively... in general I like teaching....Perhaps I must like , because this is my profession...but I know that I enjoy teaching.... (Teacher 33 [M, A, 11 y.o.e])

The only teacher who didn't enjoy teaching biology mentioned that teaching biology was difficult because students were less interested in biology:

> No; the least number of questions among science courses belongs to biology in ÖSS exams and other general exams made in overall Turkey, and students' interest in biology is directly proportional to the number of questions asked in ÖSS. Besides university preparatory courses broadened the range of biology topics by asking questions from even medicine books. These all cause difficulty in teaching biology. (Teacher 15 [F, P, 27 y.o.e])

Responses revealed that 42 (93%) of the teachers enjoyed teaching biology while 1 (2%) of the teachers didn't. Two (5%) of the teachers mentioned that they sometimes enjoyed teaching biology. Teachers stated that they enjoyed because it was enjoyable to teach something, they liked teaching. In addition since students learnt themselves and the life and biology was life itself they liked biology. On the other hand, lack of curiosity of students about biology, boring and abstract nature of some biology topics were the reasons that teachers who enjoyed teaching sometimes mentioned.

In the 4th question they were asked "Do you think that it is necessary for students to learn biology?" Examples of the responses are as follows:

> The topics not used in everyday life are not necessary to learn. There are unnecessary topics but we teach them since they are present in the curriculum. For example where will the children use the digestive system of a worm in their life? (Teacher 11 [F, P, 8 y.o.e])

> Of course, because biology is the determinant lesson to win the university exam. (Teacher 41 [F, S, 9 y.o.e])

Of the teachers 44 (98%) responded positively and stated the reasons in accordance with the aims of biology education (answers of 2nd question). Some teachers expressed ÖSS as the reason to learn biology. One teacher (2%) responded that not all of the topics are necessary to be learnt.

4.1.2 Teachers' Instruction

Interviewer in the next five questions dealt with the teachers' instructional methods, techniques, and materials which, If used in the correct way, contribute to better understanding and higher achievement in biology.

Teachers' instruction should meet students' need. Therefore teachers were asked in the next question that "What are the expectations of students from you as a biology teacher for a better understanding of biology?". Selected examples of excerpts are provided below:

> Actually, I don't know exactly. If you write on the board only, then lack of communication with the students occurs. If you go on by ask and answer, then not every student understands the answers of the questions. The levels of the students are not same. ..but when they watch video cassettes, they are happy. (Teacher 4 [M, P, 2 y.o.e])

> Students request me to teach biology in a much simpler way. For example they don't want synonymous word this much.. Let me give you an example: "sürgen doku, meristem doku, bölünür doku". These all have the same meaning, but

student should absolutely know all these three, because in university exam any one of these may be used in the question. So they want me to reduce the use of many words having the same meaning. (Teacher 30 [F,A, 8 y. o.e])

While I'm teaching I consider the classroom as if it is a theatre stage. I make dramatizations. For example in the topic of sense of taste I told my memory that while I was drinking very hot soup I burnt my tongue and cried 'ah, my papilla!'. Students liked this very much and didn't forget the term 'papilla'. So I make lesson enjoyable. (Teacher 31 [M, A, 9 y.o.e])

The responses are presented in Table 4.3.

Table 4.3 Teachers' responses about the expectations of students

Teachers' responses	N	%
Active involvement of students	12	27
Lessons related to real life	9	20
Lessons including practical studies	8	18
Lessons with less concepts	8	18
Lessons with visual aids	7	16
Lessons being enjoyable	6	13
Lessons excluding unnecessary details	5	11

As indicated in Table 4.3 teachers were aware that in order to better learn biology, their students wanted to be actively involved in the lessons including practical studies and visual aids. They also stated that the students want to have fun in the class, to learn by playing games. Besides teachers notice the negative effect of covering many terms and details.

In the next question the teachers were asked: "Do you believe that you do everything that you can do to teach biology? Can you describe strengths and weaknesses of your instruction?". Teachers' responses were as follows:

> I believe I can't do. There are problems with the curriculum and lack of equipment. Educational system of Turkey hasn't been well established yet. There are continuous changes, but the adaptation of these changes never occurs. There are education-related improvements; but there aren't laboratory equipment, textbooks and sources that will support these improvements. In service training is not sufficient. It is difficult for teachers to adapt themselves to the changes.... The strength of my instruction is that I can't teach the lesson in the way that I want. I want to teach biology completely depending on application. Biology lesson depends both on theory and application. Students can forget what they heard, may not remember what they saw but do not forget what they did. Students will feel, think and understand what something is, then will create objects related to that topic in their minds. (Teacher 16 [M, P, 12 y.o.e])

> Oh who can say 'I am excellent'?...but I put efforts to improve myself. Every year you find new examples that contribute to your instruction. Then when I turn to back and deal with my instruction, I say 'Ah, If only I had made this'. For example last year I taught students the topic of nervous system but I didn't talk about short- and long-term memory. I wish I had.(Teacher 7 [F, P, 8 y.o.e])

As can be understood from the responses some teachers think that education is an ever changing area and teachers should catch the improvements. Teachers explained their strengths as follows:

> Actually it is not possible to say 'I do everything', but I know that I do some extraordinary things: I improve myself, follow the innovations and recent developments. I make my instruction enjoyable by playing games, making discussions. I make students prepare quizzes. I call experts, such as doctors, to speak in the lessons. These are all my strengths but anyway I know it is not sufficient. (Teacher 9 [F, P, 12 y.o.e])

> While teaching the topic I give all the information in details and I must, so that students can understand deeply. You should teach atom, light while teaching

photosynthesis so that a real understanding can occur.(Teacher 16 [M, P, 12 y.o.e])

Teachers' explanations showed that they define improving themselves, making the lesson visual, giving examples from real life, being competent on subject matter as strengths of their instruction. Besides trying to make students get rid of the idea that biology depends on memorization, coming well-prepared to the classes were other strengths mentioned by some of the teachers.

Teachers also explained their weaknesses:

I'm trying to do everything. I wish I could do many applications, but time is not available so this affects achievement negatively. (Teacher 13 [F, P, 29 y.o.e])

...I wish I do much more laboratory studies but due to insufficient laboratory conditions and dense curriculum I can't.(Teacher 22 [F, A, 8 y.o.e])

..for example I don't design experiments. I have trouble if I make any mistake. Besides in the university we hadn't courses really depended on experiments. ...my another weakness is that I don't enrich the lesson with different activities or games. Prospective teachers come to my class and teach the topic with different games. We, I think, after some time concentrate on theory by lecturing rather than using some other instructional methods now..(Teacher 20 [F, A, 8 y.o.e])

The responses revealed that about half of the teachers (49%) didn't visualize the lesson with different kinds of materials. In addition some of them explained their weakness that they didn't improve themselves didn't conduct experiments or arrange field trips.

Teachers reasoned the weakness of their instruction as in the following examples of excerpts:

During the first years when I was graduated, I thought that experiments are more important, but now they are meaningless to me, I think they don't contribute to learning. My opinion may be related to the conditions. We have 4

> microscopes and our classes are of at least 30 students. This makes me unhappy. During the experiments to control the students is difficult. So I gave up making experiments from time to time. I don't believe that this is a lack of strength in my instruction. Students also believe that laboratory studies are useless, and time consuming. They want to solve test questions instead. (Teacher 32 [M, A, 9 y.o.e])

> With these conditions I can't do what I want. We don't have necessary equipment, video-cassettes, CDs, we have laboratory but the classes are too crowded to do experiments. We have overhead projector, but I don't use it. (Teacher 35 [F, S, 8 y.o.e])

The responses are presented in Table 4.4.

Table 4.4 Teachers' reasoning of their instructional weakness

Teachers' responses	N	%
Insufficient economical resources	14	31
Difficulty in classroom management	10	22
Dense curriculum	9	20
Insufficient time	7	16
Difficulty in administrative procedure for field trips	2	4

Their responses are mostly focused on insufficiency of economical resources (31%) which cause teachers not to perform laboratory studies. Besides teachers adapted to the system: Crowded classes, lack of students' interest, difficulty in classroom management were stated as discouraging factors for some of the teachers (22%) to strengthen their instruction with different instructional methods. Therefore doing experiments appeared to be useless after some time for a few teachers. Lack of confidence was another reason that one of the teachers mentioned. Some of the

teachers mentioned the conflict between using different kinds of methods together and meeting curriculum guidelines in a limited time.

Accordingly, in the following question teachers were asked that "Which methods do you use mostly?". One of the responses was as follows:

> Lecturing is the method that I mostly use but I know it is the least effective method. Lecturing should be supported by other methods. I use experimental teaching, questioning additionally. Besides I give students research works. Experimental teaching provides retention of knowledge, questioning provides a dynamic lesson. When we discuss their research works in the class their interests arouse more. (Teacher 10 [F, P, 11 y.o.e])

> Lecturing, questioning, demonstration...I do experiments. (Teacher 26 [F, A, 13 y.o.e])

> Questioning, lecturing, discussion. (Teacher 45 [F, S, 20 y.o.e])

Table 4.5 The mostly used methods by teachers

Teachers' responses	N	%
Questioning	42	93
Lecturing	35	78
Demonstration	24	53
Discussion	19	42
Experiments	18	40
Presentations made by students	6	13

A great majority of teachers, 42 teachers (93%), stated that one of the methods that they mostly used was questioning, 35 (78%) of the teachers said that

they used lecturing method. Teachers (24%) used demonstration method by showing charts, models, or by drawing figures on the boards. Some teachers aided even from computers. Teachers used their methods since they thought those were effective ones. They also stated that they are accustomed to those methods. Teachers didn't limited their instruction only one method, but rather they used many methods together. In addition to the mostly used methods presented in Table 4.5, few teachers also used some other methods like teaching by playing, by making analogies, by taking students to the conferences, but these teachers are very low in number.

The next question investigated the instructional materials which contribute to meaningful learning. Teachers were asked "What are the materials that you most frequently use?". Some example excerpts are provided below:

> Textbook, internet, CD, video. Our library is rich with many resources that we benefit. We perform laboratory studies. We use everything when needed. (Teacher 3,[F, P, 15 y.o.e]).

> I use video, CD, overhead projector, textbook. I do laboratory studies only at 9^{th} grade. At 10^{th} grade laboratory studies are very low in number due to lack of time. At 11^{th} grade we try to cover topics of both 11^{th} grade and the topics left from grade 10. (Teacher 13 [F, P, 29 y.o.e])

> I use only textbook. There is one overhead projector, but we can't use it due to the crowd of the classes. (Teacher 36 [M, S, 9 y.o.e]).

> I use textbook, scientific journals and models. I can't do laboratory studies, because classes are too crowded. (Teacher 45 [F, S, 20 y.o.e])

Of the teachers, only 37% used video or CD as visual aids, the rest didn't utilize these aids. On the other hand, a few teachers complained about the lack of economical resources, but that although video and overhead projector are present in their schools they don't use these tools was understood from their sayings. They complained about the crowd of the classes and insufficiency of time. On the other hand, some of them make use of many kinds of resources like textbook, CD, video, models, overhead projector, laboratory, and internet. Besides they do experiments.

In order to explore if teachers try other methods to improve their instruction, teachers were asked as the next question: “Do you use methods other than the ones that you usually use (field trips, museums, story telling, laboratory studies)?”. An example excerpt is provided below:

> I don’t use methods other than the ones that I use in general, because using other methods may be time consuming or I should spend additional effort. This seems difficult to me. (Teacher 5 [M, P, 4 y.o.e])

Of the teachers, 34 (76%) replied “yes”, and others (24%) replied “no”. Some of the teachers stated that due to the limited conditions they couldn’t get out of their traditional methods, some of them didn’t use other methods though they had opportunities. Some teachers said students were not accustomed to other methods. Teachers also stated that 11th grade students did not want to do even laboratory studies, they only wanted to solve test items for ÖSS. Teachers were additionally asked if they made field trips, they used story telling method, they took students to museums, exhibitions, conferences etc. Only 11% of the teachers made field trip activities, while the others didn’t. Sixteen percent of the teachers took students to museums, exhibitions, or conferences. They stated that administrative procedures for the field trips, museum visits or other out-school activities were very difficult. Of the teachers, 37% used story-telling method. Some teachers stated that story-telling method created a mood of sleep.

Teachers’ opinions about how a good biology learning occurs was investigated in the next question: “How should a good biology education be?”. Selected examples of excerpts from the interviews are provided below:

> The greatest problem is memorization. Biology education should be far from memorization. It should be taught by use of many methods together; experiments, observations, questioning. It should depend on demonstration. Teacher must provide students with the consciousness of exploring. (Teacher 45 [F, S, 20 y.o.e])

> Teachers should enrich the lesson by using many visual materials together. Both the students and the teachers should be well prepared for the lesson. The lesson should be made student-centered by experiments and research works. (Teacher 20 [F, A, 8 y.o.e])

> Giving only information isn't sufficient, because after some time information goes out of their minds. So the lesson should be visualized. Teachers can increase students' curiosity by making good use of technology, making students actively involve in the lesson, making laboratory studies. (Teacher 5 [M, P, 4 y.o.e])

> Only a single method shouldn't be used. When needed, questioning should be used. When needed demonstration or lecturing or experimental teaching should be used. (Teacher 31 [M, A, 9 y.o.e])

Of the teachers one who had MS degree in biology education in U.S. and now working in a public high school, stated that:

> Applications should be made. Actually the presence of laboratory lessons is for that students apply what they learnt in theory in the practice lessons, but in this school the teachers of biology theory and biology practice courses are different. So unfortunately the objectives of practice courses weren't met. Biology education should be in a biology class as in U.S.; everything is under your hand, the models, pictures, examples of living organisms, plants etc. (Teacher 44 [F, S, 12 y.o.e])

Teachers' responses are presented in Table 4.6.

Table 4.6 Teachers' responses about how a good biology education should be

Teachers' responses	N	%
Use of visual aids	28	62
Practical studies	22	49
Student participation in the lesson	15	33
Different kinds of methods together	13	29
Related to real life	8	18
Far from memorization	7	16
Field trips	6	13

As indicated in Table 4.6, visualization of the lesson took emphasis by more than half of the teachers (62%), then application of the knowledge comes (49%). Teachers mostly stated that for a good biology education, teachers must use many methods together; experimental teaching, demonstration, questioning, computer assisted instruction. In addition to the responses presented in the table, one of the teachers stressed that biology education should emphasize the health related issues such as protection of the body. In addition a few teachers mentioned that biology course should include field trips. Some teachers stated that students were so focused on ÖSS that only when something (or a topic) was related with ÖSS, were the students interested in that thing.

4.1.3 Learning Difficulties

The question "What are the topics that students perceive as difficult?" investigated teachers' opinions about the topics that students perceive as most difficult. Accordingly teachers' responses will reveal the learning difficulties which

are apparent to affect biology achievement. Some examples of excerpts are provided below:

> Students hate tissues, they don't like topics at knowledge level. (Teacher 9 [F, P, 12 y.o.e])

> They have difficulties in understanding concepts in general. This may be due to the presence of Latin words or naming a concept with more than one word. That is if an event has 4 names, student ought to know all of them, because any one of them may be used. (Teacher 32 [M, A, 9 y.o.e])

> Students confuse some concepts. They frequently complain about the Latin words. Besides we notice misconceptions usually at grade 9, but after some time they get rid of them. (Teacher 37 [F, S, 15 y.o.e])

> Students have difficulties with the topics related to other science courses. Photosynthesis and respiration are related to both physics and chemistry. Besides concepts are the greatest problem of biology, there are many Latin words which force students to memorize. I notice misconceptions of students. Actually even teachers have misconceptions. The misconceptions of students are coming from teachers and biology textbooks. (Teacher 16 [M, P, 12 y.o.e])

> Photosynthesis and respiration are among the topics that students have difficulties. I think there are gaps between disciplines so they can't relate these topics with other disciplines. In addition students find these topics abstract. also...organic molecules, because they haven't learnt organic chemistry yet, accordingly they memorize (Teacher 45 [F, S, 20 y.o.e])

The responses of the teachers about the most difficult topics are presented in Table 4.7.

Table 4.7 Teachers' thoughts about the topics which students perceive as the most difficult

Teachers' responses	N	%
Photosynthesis, respiration	15	33
Tissues	8	18
Endocrine System	7	16
Cellular division	2	4
Organic molecules	1	2

Of the teachers, (47%) stated that their students had difficulties in understanding of many concepts in biology. Responses revealed that students have most difficulties in topics of interdisciplinary nature, such as photosynthesis and respiration (33%). In addition, animal systems especially endocrine system, and tissues seem difficult because include much information and depend on memorization such as hormone names. Students perceive cellular division as complicated. On the other hand, as understood from the responses, misconceptions, presence of many Latin words, more than one words referring to the same concept are the reasons of learning difficulties. Besides students had difficulties to make conceptual connections between different topics of biology or between biology and other science disciplines.

4.1.4 Students' Interests and Achievements in biology

Questions 12 through 16 investigated students' interests and attitudes toward biology which contribute to higher achievement. In addition, commenting, asking questions, relating biology knowledge into real life situations are indications of students' interests and achievement.

Some examples of responses to the question “Do you think that students have positive attitudes toward biology?” are as follows:

> Yes, because they are good at biology. They watch documentaries, they follow scientific journals, they bring articles, they make researches. They even want to establish a biology club in the school. (Teacher 22 [F, A, 8 y.o.e])

Some teachers told that their students are honest to express their negative feelings:

> ... not always...because they come to high schools with an idea that biology depends on memorization. In primary school they learn biology by memorizing. So they come to lycees with negative feelings toward biology. In addition some students honestly say that they don’t like biology. Besides sometimes we get feedback from some parents that their children didn’t like biology. (Teacher 7 [F, P, 8 y.o.e])

> I don’t think that students have positive feelings. They sometimes say this honestly: ‘Is it worthwhile to learn biology for only 11-12 questions asked in the university exams?’ Their like of a lesson parallels with the number of question asked in university exams. Furthermore they find biology difficult and they complain about the Latin words in biology. (Teacher 15 [F, P, 27 y.o.e])

Twenty three (51%) of the teachers stated that their students had positive feelings toward biology and that they understood this from their interests toward the course, their researches made by their own, requests, involvement in the lesson, the examples that they gave about the topic. Ten (22%) of the teachers stated that they didn’t think that their students had positive feelings toward biology, 12 (27%) of the teachers mentioned that the students were partly positive toward biology. Teachers reasoned that students thought that biology was boring and depended on memorization. In addition they complained about the students who were so concentrated on ÖSS that they didn’t give importance to the lesson.

The similar results are revealed by the responses of teachers to the next question: “Do you think that your students are good at biology?”. Of the teachers 22

(49%) replied “yes”, 13 (29%) of them replied “no” and 10 (22%) of them replied “partly”. Teachers who said “yes” understood their students’ achievement from their involvement in the lessons, their questions, their grades got from the exams. Some of them understood from their number of correct answers in the university entrance exams. Selected responses are as in the following:

> I consider students successful to the extent that they can express themselves in the living world. (Teacher 45 [F, S, 20 y.o.e])

> My students can relate their knowledge to the daily life. (Teacher 32 [M, A, 9 y.o.e]).

> Actually they are successful in schools but not in university entrance exams, because university exam questions are different. (Teacher 2 [F, P, 2 y.o.e].)

Other question was “Do the students ask questions about the scientific developments?” Of the teachers 28 (62%) replied “yes” and gave examples of their students’ questions such as “cloning”, 3 (7%) of the teachers replied “no”, and the rest (31%) responded that their students asked, if any, insufficient or a few questions about scientific developments. Teachers complained about that “students’ life is equal to ÖSS” (Teacher 29 [F, A, 17 y.o.e])

Another question “Can your students make any comments about any topic?” investigated the extent to which their students could apply their biological knowledge which is an indication of meaningful learning. Twenty (44%) of the teachers replied “yes” gave “cloning” as an example of such questions. Twenty five (56%) of them responded that students made a few or insufficient comments or no comments. Again teachers complained about the interference of ÖSS with students’ interest in biology.

An example from the responses is:

> Of course we absolutely want this; we want them not only have simple information but also have curiosity, ask, and make comments. (Teacher 6, F, P, 17 y.o.e)

The next question “Can the students relate the biology knowledge to the daily life?” also sought the presence of meaningful learning. Followings are some examples of teachers’ responses:

Teachers claimed that teachers should provide this:

> If you have a style in which students have to make relations, then students try to make these relations. For example while teaching endocrine system I want students to search for acromegaly or diabetes. Then they look for people having these illnesses around them and share that information with students in the class. (Teacher 3 [F, P, 15 y.o.e])

> It is compulsory for my students to make those relations. (Teacher 44 [F, S, 12 y.o.e])

Twenty six (58%) of the teachers replied “yes”, and stated that their students gave examples from their daily life, such as diabetes. A few of teachers stated that their students didn’t make relations with daily life. The rest responded that their students rarely related their knowledge to the daily life.

The results of this section revealed that teachers mostly complaint about students’ concentration on ÖSS deeply which interferes with their meaningful learning.

4.1.5 Teachers’ Instructional Efforts

The following five items aimed at exploring teachers’ instructional efforts for a meaningful teaching-learning process.

Since talking about scientific developments by the use of research articles contribute to the engagement of students’ interest, in the next question teachers were asked “Do you talk about current scientific developments in your lessons? Do you bring articles and read them in the class?”. A typical response was:

> ... because articles increase students' interests. We bring articles and read them in the class, students bring articles too.(Teacher 10 [F, P, 11 y.o.e])

Most of the teachers (98%) replied that they talked about the recent developments, at least when it was related to the topic. Only one teacher didn't talk about the developments, she stated that "curriculum is too dense" (Teacher 27). On the other hand, of the teachers 16 (36%) stated that both themselves and their students brought articles which were sometimes read in the class and sometimes only reviewed orally. Besides 24 (53%) of all the teachers mentioned that their students brought articles

The question "Do you relate topics with other disciplines while teaching biology?" investigated if teachers took interdisciplinary nature of biology into account. Typical answers were:

> Yes, I relate the topics with other disciplines, but at the beginning I had difficulties due my insufficient knowledge about other disciplines. I compensated my missing knowledge by taking special courses from physics and chemistry teachers, so now I don't have difficulties any more. (Teacher 15 [F, P, 27 y.o.e])

> Students mostly have difficulties with biology topics including organic chemistry since students will take organic chemistry course at grade 11. (Teacher 17 [F, P, 25 y.o.e]).

Responses revealed that all of the teachers related topics with other science disciplines, especially with chemistry. Fifteen (33%) of the teachers mentioned that their students had difficulties in relating biology topics with other disciplines. They gave 'nervous system' (Teacher 2), 'photosynthesis' (Teacher 3) as examples for the topics that are related to other science disciplines. Nine (20%) teachers stated that they might have difficulties in relating and at that time they got help from teachers of other branches.

The next two questions "Do you relate new topics with the previous ones? Do you measure students' prior knowledge before teaching the new topic?" investigated

teachers' efforts to teach biology as the whole, not in isolation, because biology topics are connected to each other and therefore prior knowledge is important for understanding of the newcoming topic. Some typical answers are as follows:

> Biology topics are related to each other. (Teacher 18 [F, A, 13 y.o.e])

> Biology should be taught as the whole, not as isolated facts. (Teacher 3 [F, P, 15 y.o.e])

> I want students to come well-prepared for the topic to be taught. They prepare questions which will be answered by themselves in the class" (Teacher 40 [M, S, 24 y.o.e]).

All of the teachers (100%) indicated that it was absolute to relate the topics to each other. Most of the teachers (76%) measured their students' prior knowledge by question-answer in class, while the others (24%) stated that they didn't always measure their prior knowledge

Teachers were asked in the next question "What question types do you ask in your exams?" since question types affect students' perception of biology and therefore make students study by memorizing or by understanding. Selected examples of interview excerpts are below:

> I usually ask multiple choice questions dependent on comment in order to prepare students for ÖSS. (Teacher 11 [F, P, 8 y.o.e])

> I prepare exams with mixed type questions; true-false, fill in the blanks, multiple choice, and open-ended questions. So I can assess knowledge of each students, because each student transfers his/her knowledge in different ways. (Teacher 24 [F, A, 5 y.o.e])

> I usually ask open-ended questions; a case is given and students comment on that case. I think we can measure their knowledge better by this way...In addition students should express themselves by using biology language so I prefer essay type questions. (Teacher 7 [F, P, 8 y.o.e])

The question types teachers using are presented in Table 4.8.

Table 4.8 The question types that teachers use in their exams

Teachers' responses	N	%
Multiple choice	40	89
Essay type (including short answer)	32	71
Fill in the blanks	21	47
Matching	10	22
True – false	9	20
Case	2	4

As seen from the table, a great majority of teachers (98%) preferred multiple choice questions. Responses showed that the reasons lie under both the easiness of evaluation of multiple choice questions and university entrance exams in which multiple choice questions are asked. While some teachers made exams with one type of questions, the others made exams including many types of questions to measure different learning dimensions of different students. Only 2 (4 %) of the teachers asked case type questions in which students were given a case and wanted to comment on that case. Teachers didn't preferred questions with long answers since they thought that these questions made students memorize the concept.

4.1.6 Teachers' Problems When Teaching Biology

Four questions in this part investigated teachers' opinions about Turkish biology education, biology curriculum and time allocated to biology which are important elements that affect teachers' instruction. In addition teachers' problems during teaching which interfere with biology achievement of students.

Teachers were asked their opinions in the next question: "What are the strengths and weaknesses of today's biology education?" Selected examples of excerpts from the interviews are provided below:

> Curriculum is not distributed equally throughout all the grades: The curriculum is light for 9th grade, very heavy for 10th grade and suitable for 11th grade. (Teacher 20 [F, A, 8 y.o.e])

Some teachers talked about insufficient time for the dense curriculum:

> The amount of content to be covered is dramatically high. I think there are topics that should be eliminated. Besides class hours devoted to biology lesson are also insufficient. If enough class hours are provided then we can increase students' interest and achievement by making different kinds of activities. Now for grade 11 there are 3 class hours for biology and 2 class hours for biology practice lesson. Only when we combine these two is it sufficient to cover the content. (Teacher 13 [F, P, 29 y.o.e])

> ...I think either class hour for biology should be increased or the curriculum should be narrowed. (Teacher 28 [F, A, 8 y.o.e])

Some stressed repetition of topics in different courses:

> Curriculum is too dense. Another weakness is that some environment-related topics are covered both in biology lessons and environment lessons. There is no need to repeat the topics. (Teacher 35 [F, S, 8 y.o.e])

Some teachers complained about unavailable economical conditions:

> Economical conditions are insufficient. It is more effective for students to study in laboratory environment. However in this school there is only a physics laboratory. Furthermore I can't find necessary materials in the school. (Teacher 37 [F, S, 15 y.o.e])

One of the teachers who worked in Ministry of Education talked about weakness and strengths of biology education based on her experiences as in the following:

> I think curriculum is better and more meaningful than before; the expressions and the pictures in the textbooks are better. These are positive sides of today's biology education. On the other hand, The Ministry of National Education doesn't make the necessary announcements. For example there are many new equipment and materials, such as CDs, but the schools do not hear about this. Then teachers complain about the lacking of equipment and materials. Teachers do not request these materials from Ministry. They think these materials are expensive however the materials sold by Ministry of Education are the cheap ones. (Teacher 44 [F, S, 12 y.o.e])

On the other hand, some of the teachers were pleased of the current curriculum:

> The curriculum has been recently changed. Previous curriculum was unorganized. This curriculum has a better order, the sequence of topics is well established; it covers the topics from the simplest to the most complex one. The distribution of topics in the current curriculum is OK. (Teacher 11 [F, P, 8 y.o.e])

Another teacher talked about the textbook of M.E.B:

> For example I don't like the biology textbook. There are mistakes in the textbooks. We are trying to get rid of these mistakes. (Teacher 16 [M, P, 12 y.o.e]).

Teachers' responses are presented in Table 4.9.

Table 4.9 Teachers' opinions about strong and weak points of today's biology education.

Teachers' responses	N	%
Strong points		
Content of curriculum	10	22
The textbook of the Ministry of Education	8	18
The order of topics	6	13
Involvement of current biological developments in the curriculum	5	11
Parallelism between curriculum and the objectives of biology education	4	9
The distribution of topics throughout the grade levels	3	7
Weak points		
Time allocated to biology lessons	14	31
Dense curriculum	12	27
The biology textbook of the Ministry of Education	6	13
The amount of experiments	5	11
The distribution of topics, especially for grade 10	7	11
Unnecessary details and topics in the curriculum	7	11

As understood the responses teachers' opinions were diverse, there is not a consensus among their ideas. Of the teachers 14(31%) complained about the

insufficient time for biology teaching and 12(27%) about the curriculum being too dense especially for grade 10. Five (11%) teachers stressed the need for more experiments in the curriculum. Besides a few teachers stressed their unpleasure that there isn't a curriculum and a manual for biology laboratory courses (practice course) although they are separate courses with 2 class hours. In addition there are contradictions between teachers' responses. For example, while some teachers (18%) liked language and explanations of biology textbook of M.E.B, some teachers (13%) didn't like it. While some of the teachers liked distribution of the topics, a few of them didn't like. Although several of the teachers mentioned their negative feelings about curriculum, ten (22%) of the teachers stated that the content of the curriculum was well established. Five (11%) of the teachers stated as a strength of biology education that biology curriculum included new biological developments which increased students interest. In addition 9(20%) of teachers didn't find any strength in biology education.

Similar results are revealed by the responses to the question of "What is (are) the greatest problem(s) that you encounter during teaching biology?". Some examples of responses are as follows:

> There are many terms and students perceive these terms as the things to be memorized. Furthermore they don't want questions depended on comment. This is my greatest problem. I'm trying to make students get rid of this idea. (Teacher 7 [F, P, 8 y.o.e])

> Students have problem with the abstract nature of biology, they memorize the concepts rather than learn. Students think that biology depends on memorization. Actually the topics of grade 10 are really depending on memorization. This is a problem for me. (Teacher 32 [M, A, 9 y.o.e])

One teacher defined students' deep concentration on the exams to be his greatest problem:

> While I am teaching the topic, students interrupt in a very exciting point of the topic and ask 'Sir, are we responsible of this topic in the exams' or 'Is this topic included in the university examinations?' At that time I lose all my

willingness to go on. Students focus their thoughts only on the university examination. (Teacher 14 [M, P, 13 y.o.e])

The greatest emphasis was on the students' point of view of biology depending on memorization (47% of the teachers). Several of the teachers (37%) agreed that not enough time was available to cover the curriculum including many topics. Another complaint was students' lack of interest, students wanted to learn something only when it was included in topics of the university entrance exams. In addition to the statements presented in the table, a few teachers complained about the time being less and a few about the insufficiency of economical resources. Besides some of the teachers were upset to know that students thought that biology was boring and a verbal lesson.

The problem of curriculum covering high amounts of topics is revealed when teachers' comments were asked about the curriculum with the question of "What do you think about biology curriculum; the sequence of topics, its denseness, its contents, appropriateness to students' level?". Teachers' opinions were as follows:

The curriculum is too dense, it is very detailed. There is no need for this much details. However dense it is, we're trying to teach in the most effective way. So this tires us so much. For example if you want to discuss a topic, it may take 1-2 class hours. After that we put great efforts to compensate that time. (Teacher 5 [M, P, 4 y.o.e])

Curriculum has been changing frequently. This irritates me. I didn't like last changes in the curriculum: The most difficult topics which should be studied repetitively are placed in the curriculum of 11^{th} grade. They should be placed in earlier grades. (Teacher 15 [F, P, 27 y.o.e]).

We should teach topics in the order of their importance, but instead curriculum developers develop it, as if, on the criteria that how can we make students have trouble in the biology questions of university entrance exams. Necessary importance isn't given to the topics that deserve that importance. In addition there is a gap between primary and secondary school biology education. It should be somehow bridged. Basic biology knowledge should be give in 8 years, then in high schools the topics should be constructed upon that knowledge. (Teacher 14 [M, P, 13 y.o.e])

...actually curriculum is not dense, but time is insufficient. (Teacher 2 [F, P, 2 y.o.e])

Curriculum should be made simpler. Instead of giving that much information, information that will stay in mind through the life should be given. (Teacher 23 [F, A, 20 y.o.e])

In university entrance exams the questions are asked out of the curriculum developed by National Ministry of Education. This situation makes your work difficult. ÖSS and university preparatory courses ask questions from details that you didn't teach to the students. This makes you feel awful. (Teacher 30,F,A, 8 y.o.e)

Curriculum is above students' level and it is too dense for grade 10; if some of the topics of grade 10 is transferred to 9^{th} and 11^{th} grades, it will be better. Besides there are missing information or badly explained topics in M.E.B biology textbooks and this interferes with the students' real understanding of the concepts. (Teacher 37 [F, S, 15 y.o.e])

Actually the content of the curriculum is sufficient on the criteria of biology education. Yet, if you take ÖSS preparation take into account, this curriculum isn't sufficient. University examination preparatory courses broaden the topics. (Teacher 38 [F, S, 5 y.o.e])

Curriculum is squeezed; for example I need 4 class hours to teach some topics, but only 1 class hour is allocated to that topic in the curriculum. I mean not available time is allocated for some of the topics. (Teacher 43 [F, S, 14 y.o.e])

Like the results of responses to other questions showed, according to the responses of this question, most of the teachers (69%) indicated that curriculum was so heavy and dense with many details. There were teachers who thought this situation was due to unnecessary topics such as the ones about environment which are taught also in "environment course". While some of the teachers mentioned increasing class hours can be a solution for high amounts of topics in the curriculum, a few stated that both class hours should be increased and the curriculum should be narrowed. Responses indicated also that although teachers are complaint about

coverage of many details in the curriculum, most of them found its content sufficient (67%), liked the sequence of topics (67%), and found it appropriate for students' level (67%). On the other hand, teachers finding it not sufficient stated that curriculum should be frequently renewed. Some of them stated that the textbooks didn't meet the curiosity of students. In addition some topics were given importance more than enough while some topics were given importance less than enough. Furthermore teachers stated that there were many terms and Latin words in the curriculum over students' level which forced students memorizing biology.

The next question was "Do you think that biology class hours are sufficient? If not, what do you think what is the appropriate biology class hour for each grade?". They again complained about the curriculum:

> With this curriculum, I don't think that it is sufficient. Using different kinds of methods is tiring, nevertheless we try. With this large curriculum, we try to make students like biology and make them investigate topics. Then how can it be sufficient? (Teacher 5 [M, P, 4 y.o.e])

> If we take into account biology practice class hours, then biology class hours are sufficient at the moment, but I think biology practice courses should be must course for each grade so that we can cover all the topics on time. (Teacher 24 [F, A, 5 y.o.e]).

Teachers were also asked their suggestions considering the curricula of each grade about the appropriate biology lesson hours for each grade. Their opinions are presented in Table 4.10.

Table 4.10 Teachers' opinions about the appropriate lesson hour for biology

Teachers' responses	N	%
Grade 9		
3 hours	24	53
4 hours	6	13
6 hours	1	2
Grade 10		
3 hours	16	36
4 hours	15	33
6 hours	3	7
5 hours	2	4
Grade 11		
4 hours	12	27
6 hours	4	9

Except only 3 teachers(7%), most of the teachers (93%) found biology class hours not available for covering the curriculum. At the moment biology class hour for grade 9 is 2, for grade 10 is 2 and for grade 11 is 3. Teachers indicated that the greatest problem was with the grade 10 which covered many topics. In general, from the teachers who were finding class hour to be insufficient, 8 (19%) teachers thought it was sufficient for grade 9, 1 (2%) teacher thought it was sufficient for grade 10, and 20 (48%) thought it was sufficient for grade 11. So it can be deduced that there is not a great problem with biology class hour of grade 11. Furthermore teachers claimed that 'biology practice course' with 2 class hours provided additional time for biology teaching.

4.1.7 Improvements at Profession

In service training contributes to improvements in teaching profession. Therefore teachers were asked the question "Have you ever participated in any in service training about biology?". Some selected examples of teachers' responses are provided below:

> I took part in 11-12 seminars about biology education. I think they are so much useful since they contribute to improvements in the profession. You can experience different kinds of ideas and methods. You can get answers to the points of question in your mind. Briefly you improve yourself. (Teacher 16 [M, P, 12 y.o.e])

> I have never joined any seminars. I think there is a need for seminars about methods and techniques of teaching. In my opinion biology courses are given dependent on memorization. We teach biology dependent on memorization too. Seminars should have a content about how to teach biology effectively. For example sometimes I say "I wish I taught this topic in this way". Whereas if I had joined a seminar I wouldn't have said this....Ah, I want to note something seminars should be given by people competent on subject matter. (Teacher 28 [F, A, 8 y.o.e])

> I had joined a seminar about science education before, but I didn't get benefit. If the seminars weren't the ones that improve us it would be meaningless to go and join to a seminar. (Teacher 35 [F, S, 8 y.o.e]).

> There is a need for seminars, because in university biology is usually taught theoretically. Practice is learnt after starting to work. I mean seminars about designing experiments are necessary. (Teacher 37 [F, S, 15 y.o.e])

> No, I haven't. We get announcements about seminars lately or the seminars are made in inappropriate times, I think seminars can be about, for example, biology practice course. There isn't a manual or a curriculum of this course. (Teacher 43 [F, S, 14 y.o.e])

Seventeen (47%) teachers had joined seminars about biology. Nine of these teachers found those seminars beneficial. On the other hand, 8 of them didn't find

beneficial. Besides 19 (53%) of the teachers had never attended any seminar about biology teaching. Teachers indicated that the seminars should meet its purpose, and 17 teachers mentioned that they might join these kinds of seminars. Some teachers stated that the seminars made today were not the good ones because these seminars were made perfunctorily. In addition 28 (78%) of the teachers indicated that if seminars weren't organized this was a fault of the Ministry of National Education. Many teachers emphasized that seminars should be about the practice in biology teaching, include exchange of new information and biological developments, be given by people competent on subject matter.

4.1.8 Reasons of Low Biology Achievement

According to the responses that teachers gave to the questions, the reasons that underlie the low biology achievement are summarized in Table 4.11.

Table 4.11 Teachers' reasoning about the low achievement of students in biology in university entrance exams

Teachers' responses	N	%
Reasons related to students' perception of biology		
Students' ideas that biology depends on memorization	25	56
Students' ideas that biology is not important	19	42
Students' ideas that biology is difficult	12	27
Students' negative attitude towards biology	5	11
Reasons related to characteristics of biology lesson		
High amount of topics in biology lesson	26	58
Connectedness among topics	13	29
Verbal nature of biology lesson	9	20
Reasons related to characteristics of questions asked in university entrance exams (ÖSS)		
Less number of biology questions asked in ÖSS	22	49
The need of reasoning ability to answer biology question in ÖSS	16	36
The need of knowledge of more than one topic to answer a single biology question in ÖSS	12	27
Place of biology questions in ÖSS (being at the very end of other questions)	9	20
The biology questions in ÖSS being above students' level	4	9
Students' fear of long biology questions dependent on comment in ÖSS	3	7
Reasons related to students' perception of other science lessons		
Students' idea that other science lessons are more important	13	29
Other science lessons being enjoyable for students (including numerical operations and formulas)	12	27
Reasons related to biology education		
The biology education depending on memorization	18	40
The role of biology in ÖSS being less effective	9	20
Biology lesson not receiving importance enough by M.E.B or ÖSYM	5	11
Teachers not educated as biology teachers	5	11
Teachers not improving themselves	4	9

The reasons may be categorized under the headings of reasons related to students' perceptions of biology, reasons related to characteristics of biology lesson, reasons related to characteristics of questions asked in ÖSS, reasons related to characteristics of other science lessons, and reasons related to biology education. The curriculum which covers high amounts of topics took the greatest emphasis (58%). Teachers stated that all the content of biology curriculum should be covered, students should learn each topic and detail because questions may be asked from any topic in ÖSS. On the other hand, teachers also stated that in other science lessons some topics might not be covered although present in the curriculum, because questions from these topics aren't asked in ÖSS. Most reasons are related to characteristics of questions of university entrance examinations. In this category teachers (49%) mostly emphasized that the number of questions asked in ÖSS are lower in number than the other science lessons. Teachers stated that accordingly students give importance to biology to the extent of the number of biology questions asked in ÖSS. Therefore teachers (42%) stated that students don't consider biology important, whereas they give much more importance to the other science lessons and mathematics. In addition memorization issue was another point to be emphasized frequently as the reason of low achievement by most of the teachers. Of the teachers 25(56%) related low achievement students' perception that biology depended on memorization in addition to 18 (40%) teachers who reasoned that biology education is dependent on memorization. Besides teachers also stated that biology topics are related to each other and in one ÖSS biology question there includes many topics together. Some high school biology teachers stated that there are teachers not educated as biology teachers but work as biology teachers in the schools. Another reason mentioned was that teachers do not improve themselves to meet students needs and curiosity about biology.

4.2 Student Interview Results

In this section the results of student interviews are presented. A total of 45 individual interviews of semi-structured type were held with 22 female and 23 male students. The 21 questions were prepared after teacher interviews had been conducted. The information obtained from teacher interviews were used to prepare

student interview protocol. The students were selected purposively with the help of teachers who were asked to select volunteer 11th grade science students who were good at other lessons but not in biology or who were believed to really be able to inform researcher about the topics of interest

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4.2.1 Students' Perception of Biology Lesson

The first six questions in the interviews sought to reveal students' perception of biology lesson because perception affect students' interest toward biology and accordingly their achievement in biology. The questions and students responses are presented in Table 4.12.

Table 4.12 Students' perception of biology

	Yes		No		Partially / sometimes	
Questions	N	%	N	%	N	%
Do you like biology?	31	69	10	22	4	9
Do you think that it is necessary to learn biology?	34	76	6	13	5	11
Do you think that biology depends on memorization?	32	71	10	22	3	7
Do you think that biology is boring?	22	49	23	51	-	-
Do you think that biology has an abstract nature?	23	51	18	40	4	9
Does biology take your interest?	34	76	8	18	3	6

The first question revealed what made students like or dislike biology. Some examples of excerpts are as follows:

Yes, because I'm interested in human beings. (Student 5 [F, S])

I don't like studying biology. It just makes me feel like closing the book. (Student 31 [F, A])

Last year I didn't like biology, all we did was reading the textbook...but now I like my teacher's instruction and biology. (Student 8 [F, S])

No, it's boring. (Student 8 [F, S])

I don't like because it is like a verbal lesson but I like numerical operations. (Student 28 [F, P])

Responses revealed that teacher is an important factor to affect students' perception of biology because biology teachers made some students like biology while they made other students not like biology. Of 45 students, 31 (69%) liked biology. Ten (22%) of the students stated that they didn't like biology. Two out of 10 reasoned that they couldn't succeed, 3 of them reasoned that biology depended on memorization, and others said either biology was boring or wasn't the field that they were interested in. It is necessary to note that of 10 students who didn't like biology 3 were females and 7 were males.

One of the goals of biology education is to relate biology knowledge to everyday life. Therefore the next question asked that "Do you think that it is necessary to learn biology?". Some examples of responses are provided below:

We learn, in biology, our body structure and some health issues that we can use in daily life. (Student 1 [M, S]).

Well, it is necessary to learn biology only when it deals with human. (Student 17 [M, P])

...only when it deals with human. It doesn't interest me to learn digestive system of a spider. (Student 19 [M, P]).

We learn circulatory system but go to doctor. (Student 20 [M, P])

No, I want to be an engineer, so I won't use biology knowledge after I win university. (Student 21 [M, P])

Sure, biology is life itself. (Student 23 [M, P])

It is necessary, because biology tells you the world around you. (Student 40 [F, A])

Students expressed a relation between human related biology topics and daily life, therefore most of them (76%) found it necessary to learn biology. Six students (13%) who thought biology was unnecessary reasoned that they wouldn't use their biology knowledge in their future, they think it is necessary for university entrance exams.

As indicated in Table 4.12, the responses to the next questions showed that most of the students thought that biology is dependent on memorization and about half of them thought that biology has an abstract nature and is boring. On the other hand, although students have somehow negative perception of biology, most of them (76%) stated that biology engaged their interests.

4.2.2 Teachers' Instruction

Questions 7 through 10 examined teachers' instruction which is among the factors that affect students' perception of and achievement in biology.

One of the elements of teacher's instruction is students' active involvement in the lesson which contributes to meaningful learning. Therefore students were asked "Do you involve in the lessons?". Some of the responses are provided below:

I think, to involve in the lessons is a nonsense action but anyway if there is a discussion I find it enjoyable to involve in the lesson" (Student 1 [M, S]).

Yes, but due I am concentrated on ÖSS; I can't participate in the lesson anymore. (Student 6 [F, S])

> I used to involve lessons at grade 9, but I don't anymore. Our biology teacher of grade 9 had you to involve in the lessons by his excellent instruction. (Student 10 [F, S])
>
> Yes, this semester I do involve. (Student 21 [M, P])
>
> No, there is nothing to make me involve in the lesson. (Student 33 [F, A])
>
> Yes, our teacher makes us involve. (Student 40 [F, A])
>
> I completely gave up biology because I don't know anything, may be, I don't know how to study. (Student 6 [F, S]).

Thirty of students (67%) stated that they involved in the lesson.. As can be understood from the responses teachers' instruction is might engage students' participation in the lesson. While some students already started to involve in the lesson by their teachers' instruction, others stopped involving due to their teachers' methods. Students who didn't involve in the lesson reasoned that they weren't interested in the lesson. In addition according to responses students' concentration on ÖSS interferes with their interest in the lesson.

The next question investigated teachers' instructional methods. Students were asked the question of "How do the teachers teach biology, what methods do they use most frequently?". Selected examples of excerpts from the interviews are provided below:

> We cannot answer ÖSS-type questions with the education given in this school. Our teachers do not have sufficient biology knowledge. At grade 9 we always memorized the topics and presented them in class. Teacher wanted this. It was terrible. On the other hand, at grade 10, a different teacher came and taught everything in details, solved many questions, perform laboratory studies (I think if wanted it is possible to do laboratory studies), used models; but these kinds of instruction was used only by that teacher who made us love biology. The others taught in a monotonous way. (Student 3 [F, S])

Teachers give you the textbook information. It's all bang, bang, bang, and then they go. On the other hand, our 9th grade biology teacher taught biology far from memorization, he made us love biology very much. I want to mention additionally that students generally don't like biology. For example from 38 students in our class I think about 35 of them don't like biology. Only 3 or 4 students like biology. For example today we have 2 hours of biology lesson. Everyone says 'oh, how can 90 minutes pass?'. Because teachers teach biology in the way we have to memorize. They don't improve themselves. They admitted that biology isn't liked by students, they don't put an effort to make us love biology. They don't use any materials. They always said that 'we will go to laboratory', but it never happened. (Student 10 [F, S])

Our 10th grade biology teacher used the textbook style, she memorized a textbook and in the lesson by looking at that textbook she taught biology. Even I can do this. On the other hand, all the students were responsible from the topic and our biology teacher used questioning method, everyone liked that. Now the lesson is monotonous; a few students who are responsible for the topic present that topic. Teachers do not use any kind of materials. (Student 12 [F, S])

It seems to me that the biology is taught dependent on memorization even if our teacher uses many kinds of materials. (Student 17 [M, P])

We do some experiments, but it is not enough. Teacher uses many kinds of materials such as overhead projector, models, and computer. We also perform discussions. In addition teacher gives examples from real life. (Student 18 [M, P])

Biology is taught dependent on memorization, we do experiments but it is not enough. (Student 20 [M, P])

I'm really pleased of our teacher's biology instruction: She uses many materials even internet. We have a separate biology classroom and do laboratory studies. She teaches by demonstration, asking questions or by discussing. (Student 23 [M, P]).

The lessons go kind of fast, all we do is listen to the teacher who lectures. (Student 37)

Our teacher teaches by questioning, he doesn't use any kind of materials, we don't do laboratory studies. I have never seen the laboratory. (Student 45 [F, A])

Based on the responses of 21 students (47%), it was found that teachers mostly used questioning method. While many students (38%) stated that no instructional materials were used, others (31%) stated that their teachers used. On the other hand, students' responses revealed that in the same school while one teacher was enriching the lesson with different kinds of materials, another teacher didn't use any materials and taught the lesson in a traditional way. Some of the students (18%) mentioned that their teachers lecture. Many of the students, who liked biology, mentioned that the teachers made them like biology. Students (11%) didn't like the way that some teachers used in which teacher chose a student to present the topic. Some of them (18%) emphasized that the lessons in which there was an interaction between students and between students and teacher by way of discussing were the attractive and effective ones. Moreover they stated students should be made come to the class well-prepared for the topics, so students would be much more interested in the lesson and better learning would occur. They expressed a frustration with a biology classroom that pushes them to memorize the concepts.

Students were asked in the next question that "Do you perform laboratory studies?". To this question twenty one (47%) of the students replied "no", 18 (40%) of the students replied "yes" and 6 (13%) of the students stated that they seldom did laboratory studies.

Some responses were as in the following:

> Only one of my biology teachers made laboratory studies up to now. (Student 3 [F, S])
> Yes, but not enough. (Student 22 [M, P])

One of the students with whom interview was conducted in a laboratory said:

> This is my first time to come to the laboratory in this school. (Student 45 [F, A]).

Accordingly the next question investigated students' opinions about the instruction that provide them with the most understanding: "What do you think how should a good biology education be?". Selected examples of excerpts from the interviews are provided below:

> The teacher shouldn't choose a student and say 'you're going to present this topic'. Teachers must make all the class be responsible for the topics. Lesson should be dynamic, students should be ready to answer any question. There should be questioning. Furthermore teachers should improve themselves. Besides biology should absolutely be made concrete by visual aids. Laboratory studies should be conducted.(Student 10 [F, S])

> I should see everything in biology, so the lesson needs to include visual aids in order to prevent memorizing. Besides I think questioning is also important. (Student 13 [M, S])

> First of all the teacher should be competent on subject matter. Teachers shouldn't teach in a monotonous way. They should give examples from daily life, ask questions. In addition student should involve actively in the lesson. Yet, I don't think laboratory studies are very necessary.(Student 14 [F, S])
> We should design experiments, the lesson should be visual... and we should have fun in the lesson. (Student 16 [M, P])

> In my opinion, the lesson should be fun. Better learning takes place more in this way than in the lesson including visual aids such as overhead projector, CD or video. (Student 27 [M, P])

> Since biology is a verbal lesson the teacher shouldn't bore students and provide an enjoyable and humorous classroom environment. Questioning method should be used in addition to different kinds of materials. Besides teachers should relate topics to the daily life. (Student 42 [F, A])

> Instruction should engage our attention. Real life connections need to be addressed well...experiments are also necessary. (Student 44 [F, A]).

Students' responses are presented in Table 4.13.

Table 4.13 Students' thoughts about how the best biology learning occurs

Students' responses	N	%
Use of visual aids	30	67
Practical studies (experiments)	21	47
Questioning/discussion	21	47
Examples, especially from real life	15	33
Enjoyable lessons	13	29
Far from memorization	9	20
Active involvement of students	5	11
Competency of teachers on subject matter	4	9

As can be understood from the responses, most of the students (67%) requested use of visual aids for the lesson to be more meaningful and far from memorization. Besides they suggested more experiments, real life connections,. Several of the students want to have fun in the classroom therefore they want to be enjoying themselves when they are learning. They don't like lectures. In addition some of them mentioned that teachers should allow them to be fully involved in the learning process via questioning or discussions. They wanted a dynamic lesson neither teacher- nor student-centered, but both should be active. On the other hand, a few of them pointed out the importance of teachers' competency on subject matter.

4.2.3 Students' Learning Difficulties

In the following three questions, the topics that students perceive as most difficult are investigated. Accordingly their learning difficulties which are clear to affect students' achievement are depicted.

Students were asked in the 10th question that "Do you think that biology is difficult especially compared with other disciplines?". Selected examples of excerpts are provided below:

> ... biology is a complicated lesson. In addition topics are connected each other. I mean If you miss any point in biology you cannot understand the whole picture. You should always be alerted on biology lessons. (Student 1 [M, S])
> Well, for me, it is not hard, because I don't memorize, I make the connections among the topics. (Student 8 [F, S])

> Yes...because it is not like Maths or Turkish lessons. You should have a continuos interest in biology.. you have to study regularly. If you don't do this everything goes out of your mind. (Student 10 [F, S]).

> Biology lesson is difficult for me, because it depends on memorization. Yet, I'm not good at memorizing. (Student 14 [F, S])

> I am not good at biology, and I have difficulties. Perhaps I posses a prejudice that since I don't like biology, I don't want to study biology. (Student 17 [M, P])

> I'm not very good at biology because, biology topics involve many facts which are quickly forgotten. I'm better in making comment than memorizing. (Student 18 [M, P])

> Biology is so much dependent on memorization that it is so easy. (Student 20 [M, P])

> Difficult ...because I couldn't get the logic of biology, as a result I memorize it. (Student 29 [M, P])

> Knowing one formula or rule it is possible to do well in many topics of other science lessons or of maths, but we should know the whole biology knowledge to succeed at biology lesson, because the topics are linked to each other. (Student 24 [M, P])

> I sometimes have trouble, because there are so many terms and we should know everything. (Student 26 [M, P])

I am good at biology, but my other lessons are better than biology. I think biology is difficult because, it is so much dependent on memorization; there are many Latin words which have no meaning in Turkish. (Student 32 [F, A])

I have difficulty in making comment. (Student 36 [F, A])

The reasoning of students why biology is difficult is presented in Table 4.14.

Table 4.14 Students' reasoning about having difficulty in biology

Students' responses	N	%
Biology depending on memorization	16	36
Presence of many topics and terms	5	11
Difficulty in making comment	5	11
Connectedness among topics	5	11
Lack of interest	4	9

As responses reveal, 31(69%) of the students thought that biology was difficult especially when compared to other science lessons. Of the students 16 (36%) reasoned that biology depended on memorization, while some (11%) reasoned that biology included many topics and details and therefore it was so difficult. On the contrary one student found biology easy because it is dependent on memorization. They reasoned that they should always be alert about biology and interested in biology. Furthermore they emphasized that they should review topics frequently. They stated that if they missed any point about a topic, they could miss the whole. They also mentioned that since the other science lessons were numerical they were easier. To them difficulty in making comment is another factor that makes biology difficult. These results showed that students did not assimilate the prerequisite knowledge into their cognitive structure which is necessary for a meaningful understanding of the new topic.

Students' thoughts that biology depends on memorization was also depicted by the responses of the next question "How do you study biology?". Some of the responses are as in the following:

> I study from many resources because an important point which is not present in a book, may be hidden in another source. (Student 8 [F, S])
>
> Indeed I just memorize! (Student 11 [F, S])
>
> I'm creating stories with biology topics so that retention of knowledge is possible. I study a topic many times. I repeat it, then I solve questions. (Student 15 [F, S])
>
> I read the topic, then I summarize it, but nevertheless I can't do well. (Student 20 [M, P])
>
> I try to relate biology knowledge to everyday life so that I can get rid of its abstract nature. (Student 27 [M, P])
> I memorize the topic. I know I learn it for a test but I don't really understand it. (Student 28 [F, P])
> I memorize for school exams, but for ÖSS I try to understand. (Student 31 [F, A])
>
> Ah, I read, read and again read until I get mad anyway I can't understand. Then somebody teaches then I understand. Or I memorize. (Student 43 [F, A])
>
> I memorize but since I'm not good at memorizing I can't do well. (Student 45 [F, A])

As can be understood from the responses, 38% of the students put efforts to memorize. Therefore students might have learnt concepts which are not retained in their minds, but forgotten after some time. It is also indicated that when failing to grasp the basic concepts, students tend to employ rote learning strategies in studying biology to pass examination. However some of them are aware that making relations with everyday life makes it easier to better understand biology.

The next question "What are the topics that you perceive as most difficult?" also revealed the similar results with the previous question. Some examples of students' responses are as follows:

> I think, to me, respiration and photosynthesis are difficult. These topics are complicated... they seem to be abstract. (Student 13 [M, S])

> I have trouble with the systems of several animals that I will never meet, because I'm not curious about those animals. (Student 19 [M, P])

> The topics that do not deal with human, such as plant. Human is a known creature, so I learn human related topics by really understanding. On the other hand, I learn about plants by memorizing. Honestly speaking, I'm not interested in how a flower is pollinated. Furthermore there are unnecessary details in M.E.B biology textbooks. (Student 34 [F, A])

Their responses are presented in Table 4.15.

Table 4.15 The topics that students perceive as most difficult

Students' responses	N	%
Photosynthesis & Respiration	12	27
Animal systems	12	27
Genetics	4	9
Cellular divisions	4	9
Reproduction	3	7

Responses revealed that students were curious about biology concepts that were related to human. As indicated in Table 4.15 twelve (27%) students perceived photosynthesis and respiration, 12 (27%) students perceived animal systems in general as most difficult. Besides, protein synthesis and reproduction system were also perceived as difficult. Students stated that because photosynthesis and

respiration were complicated and depended on memorization while animal systems included a lot of information, they found these topics to be difficult. Some responses revealed that whether they perceive a topic difficult or not depend on their level of interest.

4.2.4 Students' Problems When learning Biology

Similar results were also apparent in the responses to the next question "Do you have any problem while learning biology?" which investigated students problems that might interfere with their meaningful biology learning therefore with their achievement in biology. Selected examples of excerpts are provided below:

> Our biology teacher is not competent on subject matter. Therefore she can't meet our curiosity about learning biology (Student 1 [M, S])

> I think biology is a verbal lesson and dependent on memorization and I can't understand why this lesson is included in science lessons. (Student 4 [M, S])
> I don't study biology on time, so the topics I have to study are accumulating. I give more importance to other science lessons, because I like studying those lessons. (Student 11 [F, S])

> I don't like biology as much as other lessons... because... I think we have to learn a lot of things at the same time. We have to memorize a lot of knowledge and the meaning of new terms. If you don't have complete biology knowledge there is no chance to answer a single biology question asked in ÖSS. (Student 21 [M, P])

> Well...sometimes I don't want to study because there are many things to read and memorize. This is boring. It is more enjoyable to do something using your reasoning ability. (Student 27 [M, P])

> There are so many Latin words in biology and I have difficulty in learning them. (Student 41 [F, A])

> The greatest problem for me is that biology is so much dependent on memorization. I study biology, but I forget it soon. For example in the lesson I think that I learnt well, but after some time when I ask myself about the

concepts, I can't remember. I don't know how to deal with it. (Student 42 [F, A])

The responses of students are presented in Table 4.16.

Table 4.16 The greatest problem students having during biology learning

Students' responses	N	%
Biology depending on memorization	15	33
Lack of interest	6	13
Difficulty in retention of knowledge	5	11
Biology being boring	5	11
Presence of many topics	3	7
Biology requiring comment	3	7
Lack of teachers' competence on subject matter	2	4

As can be seen in Table 4.16 again that biology was dependent on memorization took the greatest emphasis by many of the students (33%). Some students were upset of having biology teachers who were not competent on subject matter or even were not biology teachers. A few students complained about verbal and abstract nature of biology. Besides they stated that there were many Latin words.

4.2.5 Students' Opinions about Biology Education

The next three questions in the interviews sought to explore students' ideas about biology education; time devoted to biology, biology curriculum, and biology textbook of Ministry of National Education all of which are clear to affect meaningful learning and achievement in biology.

Some examples of students' responses to the question "Do you think that biology class hours are sufficient?":

> It is absolutely insufficient. In my opinion 2 more class hours should be added in order to do laboratory studies. So there should be 3 class hours of biology theory and 2 hours of biology practice (Student 2 [F, S]).
>
> I think it's more than enough, it should be 2 hours at maximum. (Student 27 [M, P])
>
> I think more than 2 biology class hours bores us (Student 31 [F, A]).
>
> In the university entrance examinations the questions of mathematics or physics would add points to us to enter a university then, why more time to biology. (Student 34 [F, A]).
> There are so many topics in biology, so some more time should be added. (Student 41 [F, A])

Responses revealed that 20 of the students (44%) thought that current biology class hour is sufficient. On the contrary some of the students do not enjoy biology lesson, moreover they find it boring. These kinds of students (20%) students responded that biology class hour was more than enough. On the other hand, some of the students (36%) found biology class hour insufficient because of the curriculum covering many topics. Accordingly their suggestions for appropriate time to be allocated to biology are requested. Their responses are presented in Table 4.17.

Table 4.17 Students' opinions about the appropriate lesson hour for biology

Students' responses	N	%
3 – 4 hours	7	16
4 – 5 hours	5	11
6 – 7 hours	1	2

Students were asked in the next question that "What do you think about biology textbooks of Ministry of National Education?" (This question was answered by 31 students since in private high schools M.E.B biology textbooks aren't used). Their opinions were as follows:

> I think the textbook is not explanatory because it isn't detailed enough. In addition the textbook should be visualized with different kinds of figures. (Student 2 [F, S])

> The textbook is boring. Some of the topics aren't explained enough while some are explained very detailed, like a story. (Student 9 [F, S])

> There is so much unnecessary information but its language is OK. (Student 13 [M, S])

> I like the textbook very much. There are detailed explanations which makes you better understand the topic. You can understand the topics clearly. (Student 41 [F, A])

> The textbook is not good. For example the figures and shapes are not well-presented. Besides the texts are not explanatory. If someone doesn't teach the topics I'm not able to understand them from the textbook. (Student 44 [F, A])

There didn't appear a consensus among students' views. Sixteen (52%) of the students stated that the narration of textbook was good. On the contrary some of them (23%) liked its narration. On the other hand, ten (32%) students' opinion was that the textbook was very detailed. Some of these students found these detailed explanations useful since this helped them to better understand while some didn't find this beneficial to better understand since this made the textbook boring. A few students mentioned that the details were unnecessary. Besides a few of them didn't like the presentation of the figures.

In the next question they were asked that "What do you think about biology curriculum?". Selected examples of excerpts from the interviews are provided below:

I think there are some unnecessary topics; for example scientific method, classification. I don't like these topics since they are so dependent on memorization. (Student 3 [F, S])

Well, I think the topics that biology curriculum covers are not more than enough. Biology is a large area. (Student 8 [F, S])

It covers many more topics compared to other lessons. (Student 17 [M, P])

I think the curriculum is very detailed, besides some topics are taught again and again. In my opinion at first the basic topics should be given and then others should be added on them. (Student 24 [M, P])
The curriculum is too dense. There is to much information that we should know. Teacher says "I must teach these" and teaches everything. As a result students don't want to these huge amounts of knowledge. (Student 31 [F, A])
It is dense, and there are some unnecessary details... it is meaningless to learn some details. For example what if I know Rh was first identified in blood of Rhesus monkeys. (Student 34 [F, A])

In biology lesson we cover many topics, but I think all of them are necessary. (Student 42 [F, A])

... curriculum is good...no not good there are unnecessary topics. For example "cell", why should I know it, I will never meet it in my life... I won't use cell knowledge... Oh! biology is completely unnecessary! (Student 43 [F, A])

Students' responses revealed a contradiction that while more than the half of the students (58%) thought that it was dense some of them (40%) didn't agree. On the other hand, some of the students emphasized unnecessary details present in the curriculum.

4.2.6 Reasons of Students' Low Achievement in Biology

Question types affect students' perception of biology and study type which is evident to affect students' achievement in biology. Therefore students were asked "Do you notice any difference between questions of university entrance exams and

questions asked in your schools by your biology teachers?". Some responses are as follows:

> There is no correspondence of ÖSS questions with the questions that our biology teachers ask in the schools. To solve ÖSS biology questions, we have to comment on the situation using our existing knowledge...but in here they ask about knowledge. (Student 14 [F, S])

> ÖSS questions are dependent on comment... less detailed...but here they ask many details. (Student 21 [M, P])
> In university entrance exams they measure our ability to make comment about things that we learnt, whereas here at the school they measure if we memorized well the things we learnt. (Student 34 [F, A])

> ÖSS biology questions are dependent on reasoning ability. In ÖSS type questions some prerequisites are given and then you comment on the question...whereas here they ask knowledge. (Student 45 [F, A])

As can be understood from the responses, most of the students (80%) were clear to express a difference between biology questions asked in the ÖSS and asked in the schools by their biology teachers. They claimed that they observe such a difference that ÖSS questions were dependent both on comment and knowledge, whereas at school questions mostly depended on details and memorization.

The most intriguing investigation of the interviews was the reasons of low biology achievement. Therefore students' opinions were explored after they were shown the table of comparative point averages of science and mathematics lessons in university exams between the years 1996-2002 (see Table 1.2). Then they were asked the question of "What do you think what are the reasons of low achievements in biology as indicated by the results of university entrance examinations between the years 1996-2002?". Selected examples of excerpts from the interviews are provided below:

They emphasized the difference between biology and other science lessons and mathematics:

For other science lessons the topics from which questions will be asked in the university exams are almost known. Whereas this is not the case for biology. Every year the topics from which questions are asked changes, every year questions are asked from different topics in university entrance exams. For example every year questions are asked from the topic of "numbers" of mathematics in university entrance exams; one year 8 questions another year 10 questions it doesn't matter, but absolutely questions from this topic are asked. In biology questions are diverse, it is possible to ask a different question from different topics every year, and biology is a broad area. There are formulas in other science lessons and by applying those formulas it is possible to solve many questions. Besides there aren't sufficient questions from biology in university exams; and I think biology isn't given importance enough. (Student 2 [F, S])

Students don't like biology and since it depends on memorization they don't study either. In addition it seems verbal. Whereas other science lessons are numerical and easier. (Student 12 [F, S])

Biology is not given sufficient importance because pupils think it is easy. The other science lessons and maths are more important. This may be due both that more questions from other lessons are asked in ÖSS and that class hours of other lessons are higher. So biology is not liked and studied. At the times closer to ÖSS people [students] memorize biology. In addition it is more enjoyable to deal with numerical questions. (Student 42 [F, A])

They reasoned that students perceive other lessons more important than biology:

Science students give more importance to other science lessons and maths which have greater coefficient in ÖSS. In addition we can understand other lessons more easily since we are interested in lessons including numerical topics...but biology is a kind of verbal lesson. Besides other lessons seems more enjoyable so we study these lessons. On the other hand, people [students] don't consider biology as important, this may be due that it depends on memorization or that it is boring. (Student 3 [F, S])

Biology seems unnecessary, students don't like very much. Actually I have trouble with biology, too. Maths, on the other hand, is given more importance

than biology. I can say instead of answering one biology question I had better solve 2-3 maths question which will add higher points. (Student 15 [F, S])

Science students perceive other lessons more important. Since biology is verbal it seems as if it depends on memorization, but it depends on comment. In addition there are many topics in biology and it is possible to ask different kinds of question. For example from one sentence in biology, 4-5 questions may be asked. (Student 39 [F, A])

They stressed the number of questions asked in ÖSS:

Biology is not given sufficient importance. In my opinion however it is the most important lesson because it is the science of living things. In addition number of questions in ÖSS is low. It should be increased. Furthermore biology is a very huge area, any question may be asked from any topic in university exams. This is not the case for other lessons; if teachers say "2 questions will be asked from this physics topic in ÖSS", then approximately 2 questions are asked. (Student 8 [F, S])

They stressed students' perception of biology:

Biology isn't generally liked by students, there is so much information. On the other hand, mathematics is always important. Even at grade 1 we had mathematics courses. Biology isn't given sufficient importance. (Student 21 [M, P])

People are frightened of biology, most of the people start to study biology at the end in the times close to the date of ÖSS, or do not deal with it. People have a prejudice that they can't do well in biology. Besides biology is very detailed. In addition in my opinion biology is a verbal lesson. (Student 31 [F, A])

They reasoned that biology depended on memorization:

Students escape from biology since it depends on memorization and includes details. Other lessons from which more questions are asked in ÖSS, are more important. Maths is the most important, physics and chemistry are similar to maths in that they are also numerical lessons. So achievement is better in these

> lessons. Furthermore curriculum is another reason: The biology curriculum of all 3 grades is included in ÖSS while curriculum of other lessons of the last grade is not included in ÖSS. (Student 24 [M, P])

> While solving problems of other science lessons and mathematics we enjoy. On the other hand, biology is dependent on memorization, if you don't know something you can't do well, you can't make a comment. You should know everything. Sometimes I open my biology textbook to study and say "I don't know this topic", then I close it. (Student 26 [M, P])

According to the responses that students gave to the questions, the reasons that underlie the low biology achievement are summarized in Table 4.18.

Table 4.18 Students' reasoning about the low achievement of students in biology in university entrance exams

Students' responses	N	%
Reasons related to point of view of students about biology		
Biology is a memorization lesson	27	60
Negative attitude towards biology	22	49
Biology is a verbal lesson	21	47
Biology is not considered as important by students	10	22
Students think biology is difficult and they are frightened	8	18
Biology is boring	5	11
Biology is unnecessary	4	9
Biology is considered as easy and so not studied	2	4
Reasons related to characteristics of biology		
There are so many topics and details	14	31
The topics in biology are related to each other	6	13
Reasons related to characteristics of questions of university entrance exams (ÖSS)		
ÖSS questions are long and not clear	5	11
Number of questions in ÖSS is less	4	9
Biology questions are always changing, they are not always in the same format	4	9
Biology questions are dependent on comment	3	7
Reasons related to students' perception of other science lessons		
Other science lessons, especially mathematics, include numerical operations and formulas, so they are enjoyable	21	47
Other science lessons, especially mathematics, are considered much more important	15	33
Reason related to biology education		
Biology education is dependent on memorization	3	7

As indicated in Table 4.26, the reasons may be categorized under the headings of reasons related to students' perceptions of biology, reasons related to characteristics of biology lesson, reasons related to characteristics of questions asked in ÖSS, reasons related to characteristics of other science lessons, and reasons related to biology education. Most of the reasons are related to students' perception of biology. The greatest emphasis was on that biology depends on memorization (60%). Twenty two (49%) of the students indicated that, based on their observations in their surrounding, biology was not liked by most of the students because they find it boring due to its verbal nature. Responses also revealed that students consider a lesson as important by regarding the number of questions from that lesson asked in ÖSS. On the other hand, 21 (47%) of the students stated that other science lessons, especially mathematics, included numerical operations and formulas which made these lessons more enjoyable, besides in other science lessons it was possible to solve many questions with only one formula or rule. However for biology as they pointed out even to make a comment for a simple case; everything, the whole content of biology should be known. In addition coverage of many topics in biology frightens students and causes them not study. On the other hand, a few students stated that since students think that biology can be achieved by just memorizing the concepts, they don't study enough; they think that it can be studied in a short time. However, some of the students stated that students have difficulty in making comment whereas ÖSS biology questions depend on comment.

CHAPTER 5

DISCUSSION AND IMPLICATONS

This study aimed at investigating the reasons underlying low biology achievement of students through the analysis of interviews conducted with biology teachers and 11th grade science students. This chapter presents a summary of the study, conclusions, discussion of the results and implications for practice and future studies.

5.1 Discussion

Results of this study revealed that there are serious problems in biology education that cause achievement to decrease. Students' perceptions of biology comes the first, that is, their thoughts are in the way that biology depends on memorization. This situation seems a great problem to both teachers and students. Curriculum covering a high amount of topics and details is another reason causing low achievement in biology. In addition class hour allocated to biology lesson appears to be another problem. Furthermore the role of biology in ÖSS profoundly affects students' perceptions of biology. Besides there are opinions in the way that biology isn't given sufficient importance by the authorities Student Selection and Placement Center and Ministry of National Education. In the following paragraphs these issues are going to be discussed.

5.1.1. Teacher interview Results

The analysis of teacher interviews revealed that for a meaningful biology education, the lesson should be visual, include practice in addition to theory. Students should actively participate in the lesson besides it should be far from

memorization and the topics should be connected to everyday life. Out-of-school observations are found to be an important component of efficient biology education. These findings parallel with both aims of Turkish biology education (Journal of Announcements of Ministry of National Education- T.C. Milli Eğitim Bakanlığı Tebliğler Dergisi, 1998, No: 2485) and the findings of ERDD (Need Assessment Report of High School Biology Lessons, 1995). On the other hand, teachers' instruction doesn't meet these prerequisites completely because of insufficient economical conditions and time devoted for biology lessons and dense curriculum. Actually from the responses of teachers, it can be deduced that after some time teachers become traditional teachers who don't make different kinds of activities. Surprisingly, there were teachers who even don't believe benefits of laboratory studies anymore, although laboratory studies are proven to contribute to better learning (Sabri and Emuas, 1999). There were also teachers who defined strengths of their instruction as coming well-prepared to the class, improving themselves, following innovations and recent developments, teaching biology far from memorization. Unfortunately, although all these are the matter of the fact that teachers should perform as their usual own works, these teachers are now thinking that these are extraordinary actions. Because current instruction of biology teachers emphasize the learning of factual information and transferring knowledge from textbooks to students. Therefore teachers adapt themselves to this situation some time after they were graduated.

The findings also revealed that about half of the teachers thought students have positive attitudes towards biology, whereas the other half thought that students partly or don't have positive attitudes toward biology. However, the importance of having positive attitudes is evident (TIMSS, 1999; Singh et al, 2002).

According to the results teachers are aware of their students' expectations to better learn biology. Teachers' responses revealed that students wanted both to be actively involved in the lessons and lessons including practice and visual aids, students also expect that lessons be enjoyable and connected to daily life. An important conclusion is that generally, public high school teachers mentioned that

their students anticipate their teachers be confident on subject matter and dictate the topics to them.

Another demonstration of views of teachers (of all school types) is about the weaknesses of Turkish biology education. The main problem is insufficient time allocated to biology lessons. This have been an important problem in Turkey for many years although the needs assessment study of ERDD, made in 1995, revealed that time devoted to biology was a problem. However, today in 2003, it still appears to be a problem. This finding is in accordance with the results of needs assessment study of ERDD (1995). Another problem revealed is that biology curriculum covers too many topics and details. Teachers, mostly, thought that these details are unnecessary. Chiapetta and Fillman (1998) also stressed the overwhelming quantity of the content of high school biology courses which doesn't permit meaningful learning through inquiry methods, in addition, this situation makes students memorize the terms.

Teachers talked about the strengths of biology education as well. Sadly, some teachers were so pessimistic that they thought that there wasn't any success in Turkish biology education. On the other hand, content of biology curriculum, the biology textbook of M.E.B, the sequence of topics and presence of current biological developments in the curriculum are considered as strengths of Turkish biology education by most of the teachers.

The results revealed teachers' greatest problems about teaching biology. The main problem that teachers of all three types of schools agreed is about students' point of views that biology is dependent on memorization. Since students tend to learn subject matters in isolation, they cannot connect and fully understand concepts. So they put great effort in memorizing, as indicated by Tsai et al (2002). In the teaching and learning of biology, concepts do not exist in isolation. Each concept is closely related to others (Novak, 1970; Fisher, 1985). However students tend to memorize the concepts without thinking about the reason behind them. As a result of rote memorization, they could not make any connection between the concepts. Thus, they shoe a wide range of difficulties in understanding the basic biological concepts.

Teachers' another problem is about curriculum which includes many terms and details, consequently is dense. Furthermore that students aren't interested in biology is another complaint. This manner may be attributed to, as aforementioned, large content area and denseness of curriculum which discourage teachers to cover all the topics on time. Besides teachers stated that students concentrate on ÖSS so much that they aren't interested in biology lesson, they are interested only in how to solve more questions for ÖSS. Additionally, public high school biology teachers also complained about crowd of classes.

Although contributions of field trip to effective biology teaching is evident (Killerman, 1998; Çilenti, 1991; Scherf, 1986), very few teachers make use of this method, because administrative procedure and control of students are discouraging factors for out-of-school activities such as observations in the nature, visiting museums, exhibitions or zoos. Teachers mainly emphasized the importance of visual aids, experiments, combination of different teaching methods and active involvement of students for a better biology education.

Teachers' responses showed that teachers mostly use questioning along with the other methods like lecturing, demonstration, discussion, experimental teaching. What is also worth noting, based on the responses, is that generally teachers working in private high schools use different methods together. These teachers were the ones who said that they do experiments, bring articles to the classes, use internet, make discussions, give research projects to support their instruction. It is said that learning takes place through seeing with 83 %, hearing with 11 %, smelling with 3,5 %, touching 1,5 %, and tasting with 1 %. The higher the number of senses involved in learning process, the better the learning and the later the forgetting (Çilenti and Özçelik, 1991). So demonstrative materials are important that is, the presence of good materials provides activity-based teaching (Killerman, 1998; Vaidya, 1993). It is known that, different kinds of sensory experiences like listening, viewing, reading and doing contribute to overall learning and retention. This information emphasizes the importance of supportive materials and active involvement of students for meaningful learning.

When material usage is taken into account, the difference among school types appears again. According to the responses, the majority of the teachers working in private schools benefit from many kinds of resources like book, CD, video, models, overhead projector, laboratory, and internet. They do experiments. In Anatolian high schools some of the teachers use models, overhead projector, CD and laboratory. Some of them do not use these aids due to lack of economical resources while others do not use although they have appropriate materials. Public high school teachers on the other hand, complained about insufficient laboratory conditions so they can't do experiments. To their sayings, though they have video and overhead projector they don't use these tools. The difference among the school types may rely on that private school teachers put greater efforts in addition to sufficient economical resources. Whereas in public high schools it is certain that there is the problem of lack of economical resources (Ekici, 1996). On the other hand, teachers' willingness and effort are important for a meaningful teaching. It was understood from the responses that in the same school while one teacher uses a material such as a chart, the other does not use that available materials. This finding shows that there is a difference among three types of schools with respect to teachers' efforts and willingness needed to teach biology in their best way.

In the light of results of teacher interviews, students have difficulties in concepts due to the presence of many terms and Latin words in addition to the different words having same meanings. This finding parallels with the findings of needs assessment study of ERDD (1995). Besides teachers notice students' misconceptions which come from their primary school teachers who are very important in students' life. Photosynthesis, respiration, tissues and endocrine system are among the topics that the teachers mentioned to be perceived as most difficult topics by students The results of needs assessment study of ERDD (1995) and the study of Lazarowitz and Penso (1992) support these findings. Tekkaya et al. (2001) concluded that learning difficulties in biology rely on terminology, large number of foreign terms, insufficient teaching methods, and curriculum covering a quantity of subject matter, abstract and interdisciplinary nature of concepts and insufficient laboratory conditions and equipment.

Asking questions in the class, bringing articles to the class, making comment are all indications of students' interest in biology lesson. Besides the content of question may indicate the level of thinking of the students who raised it (Yarden et al., 2001). Results at the present study revealed that mostly public high school teachers thought that their students aren't successful in biology lesson. In addition these teachers stated that their students asked only few questions about scientific developments, while most of the private high school teachers were pleased of sufficient questions asked by their students about scientific developments. What is more, again the teachers who said the students made no comments were from public high schools. Furthermore it should be noted that the majority of teachers who stated that both themselves and their students brought articles to be read in the class, were from private and Anatolian high schools.

It is known that most of the concepts in biology are closely related to concepts present both in chemistry and in physics. Berthelsen claimed that many biological concepts such as genetics, evolution, metabolic processes, ecosystems, might have their foundation in physical science and students' understanding of biological processes breaks down because of physical science misconceptions. She says "Students understand that living things are made up of cells, but do not extend their understanding to include the concept that those cells are made up of atoms and molecules." Similarly the concept of conservation of energy is essential to understanding of many feeding relationships in a food web, photosynthesis and respiration. Therefore it is reasonable to think that the lack of prior knowledge in chemistry and physics contributes to low achievement in biology. As Liras (1994) states biology must be understood as a complementary discipline to other sciences providing formal thought which can afterwards be transferred to other knowledge areas. Besides subject matters in biology are connected to each other and cannot be thought in isolation. Teachers' responses supported these statements but according to some teachers, students have difficulties to relate biology topics with other science disciplines. The sequence of topics in biology curriculum may be inappropriate which may account for this difficulty.

Knowing one's prior knowledge can help teachers design appropriate teaching strategies and students connect past experiences and new incoming information, and so enhance meaningful learning (Prosner, Strike, Hewson and Gertzog, 1982). All of the participant teachers believed the importance of knowing students' prior knowledge which they measure through questioning.

Time allocated to biology lessons have been an important issue for Turkish biology education for many years. This study also showed that, as aforementioned, insufficient time for biology topics to be covered is among the greatest problems of teachers. There was an agreement in teachers' views among school types that the biology class hours were found insufficient in this study which is in accordance with the findings of pilot study report of high school biology curriculum of ERDD (1996). Today 2 class hours for Biology I, 2 hours for Biology II and 3 hours for biology III are allocated. Teachers mostly mentioned that the greatest problem is with the 10^{th} grade biology curriculum which covers so many topics, but to which only 2 class hours are allocated. At grades 9 and 10, two class hours are allocated for biology practice lessons which is optional to be chosen by students. Most of the participant teachers agreed that time for biology lessons should be increased or, at least, the practice courses should be compulsory for students to choose.

Teachers indicated their thoughts about curriculum. That the curriculum covers a high amount of content has been aforementioned. Except this denseness of curriculum, teachers like the present biology curriculum; its content, sequence and appropriateness for students' level. This finding is in accordance with the pilot study of ERDD (1996).

The results revealed that multiple choice type questions are used most frequently by teachers. The focus of this type of instrument is recalling specific content. This type of assessment sends the message to the students that memorization of content is important, reasoning is not required. Although multiple choice tests have been used to evaluate students' content knowledge, they had limitations with determining students reasoning behind their choices (Odom and Borrow, 1995). Even if some students give the right responses, they may only be using correctly

memorized words. When questioned more closely, these students reveal their failure to understand fully the underlying concepts. Then comes essay, fill-in-the-blanks, matching, and true-false type questions. Case questions are asked the least. Mintzes et al. (2001) suggest that teachers reduce testing methods that reward and reinforce rote learning (including multiple-choice, true-false, matching questions) and consider the use of collaborative or co-operative assessment methods in which students work on a product that demands division of labor or specialization of knowledge in addition to the use of students' work products such as written or oral reports.

The most intriguing part of this study is exploring the reasons of low biology achievement of students as indicated by the results of university entrance exams. Based on the results, the first three explanations for low achievement are: The amount of content covered in biology is high, (which makes students think biology is difficult), students think that biology is dependent on memorization and the number of biology questions in ÖSS is the least of mathematics and science lessons. Teachers thought that Turkish biology education is dependent on memorization which leads to rote learning. They related low achievement in biology to the characteristics of biology questions of ÖSS that is questions are dependent on comment, placed at the very end of the other questions. Furthermore teachers reasoned that one biology question of ÖSS includes more than one subject matter and the questions are long and above students' cognitive level. However students have difficulty in commenting on biological situations. On the other hand, since biology includes reading more than numerical operations, students do not enjoy biology. Accordingly they like other science lessons and mathematics which include numerical operations and formulas. Likewise, teachers thought that Ministry of National Education and ÖSYM do not give sufficient importance to biology and reasoned this pattern that both the number and the coefficient of biology questions are low in addition to less class hours than other science and mathematics lessons, consequently students consider these lessons more important than biology. What is more, teachers mentioned that since student finds biology dependent on memorization they think that they can study biology for ÖSS in a short time. But when they meet huge number of topics "to be memorized" they fail.

It has been mentioned above that high number of topics and low number of biology questions are the most important reasons of low achievement. Actually, the biology subject matters included in ÖSS are numerous. Here another point is that, based on teachers' responses, not all the topics in the curriculum of other science lessons and mathematics are included in ÖSS, that is, the topics of 11th grade curriculum of these lessons are not involved in ÖSS. Whereas all the topics of biology curriculum of all grades are included in ÖSS. In biology curriculum really there are 22 main topics while more than 110 subtopics are present (Journal Of Announcements of Ministry of National Education- T.C. Milli Eğitim Bakanlığı Tebliğler Dergisi, 1998, No: 2485). On the other hand, the number of biology questions asked in ÖSS is really low that is, in ÖSS 45 questions from mathematics, 19 questions from physics, 14 questions from chemistry whereas 12 questions from biology are asked. Another issue was the less class hours devoted to biology lesson than to other science lessons that teachers emphasized. At high schools, at grade 9 class hour allocated to biology, physics and chemistry are equal which is 2. At 10th grade 4 class hour s to physics, 3 class hours to chemistry and 2 class hours to biology lesson are allocated. At 11th grade, 4 class hours to physics, 3 class hours to chemistry and 3 to biology are allocated. At total the least time is devoted to biology. However, in the light of teachers responses, students take into account class hours and number of questions asked in ÖSS to perceive a lesson as important.

In addition some of the teachers mentioned that biology questions of ÖSS are over students' cognitive level. Besides a few teachers stated that not only the biology questions of ÖSS but also the biology questions of other standardized tests made in Turkey countrywide were above students' cognitive level. For example Köksal's (2002) study which examined biology questions of secondary school institutions student selection and placement tests between the years 1998-2001 supports this finding. Her study resulted that most of the biology questions in this 4 year period were at comprehension level, some of them were at science process level. Only one question was at problem solving level while there were no questions at knowledge level in this 4 year time period. Another saying of teachers was that all the subject matters present in the curriculum are included in ÖSS but whether question from any topic may or may not be asked isn't known.

Some of the teachers attached importance to subject matter knowledge. It is a very threatening fact, as teachers mentioned, that there are teachers who teach biology in Turkish high schools but aren't biology teachers in fact. It should be noted that, mostly public high school teachers complained about this situation. Those teachers teaching outside their field cause low achievement in biology because they are not knowledgeable enough in biology thus they can't meet students' needs. In addition they offer explanations and analogies that reinforce misconceptions in pupils (Tobin et al., 1994) and provide inappropriate and misleading representations (Hashweh, 1987).

Finally the teachers agreed that there is a need for seminars that will improve teaching strategies and laboratory skills of teachers. Teachers can gain insights about developments in science and science education therefore Ministry of National Education should organize these kinds of useful seminars that should be given by people who are competent in their profession.

5.1.2. Student Interview Results

Student interview results (no difference in the responses among school types) showed that students generally like biology. Yet there are students who don't like biology. For this finding there appears a gender difference; of the students who didn't like biology most were males. So as Schibeci (1984) stated females may have more positive attitude toward biology than males. On the other hand, based on students' responses, teacher is central factor to affect students' attitude toward biology. Teachers' instructional methods, behaviors towards students affect biology lesson to be liked by students.

Most of the students of all three types of schools found biology necessary but especially human related topics engage students' interest. Again most of the students had difficulties in biology, because according to them biology is dependent on memorization and is boring, verbal and unnecessary. They stated that there were many topics and terms in biology. These findings parallel with teachers' opinions.

The analysis of results showed that students perceive photosynthesis, respiration and systems as the most difficult topics. These topics were also mentioned by the teachers that students perceive as most difficult. No difference was found across school types for this finding. Photosynthesis and respiration seem confusing besides depend on memorization according to students. They thought that inclusion of much information made animal systems difficult to understand. On the other hand, there were students who had difficulties in genetics, cellular division and reproduction.

The results revealed students' greatest problem during learning biology that students think that biology depends on memorization. This pattern seems to be the greatest problem for both teachers and students (with no difference between responses across school types). Indeed the responses of most of the questions asked to teachers or students beckoned the problem of memorizing as a challenging issue. Therefore this pattern should be examined with care. Ward and Wandersee (2002) stated that current science textbooks and instructional methods emphasize the learning of factual information and test for recall. Teachers present the textbook information by providing only one point of view of complex, abstract concepts. Teachers reward rote memorization and value isolated facts. This makes students continue memorizing. As Novak (1998) stated students who learn by rote memorization fail to develop knowledge integration and fill the gaps in their minds with alternative conceptions to support their conceptual understanding. However what should be is that learner must, after learning facts, assimilate and integrate their prior knowledge into concepts, constructs, principles, and conceptual frameworks (Ward and Wandersee, 2002). In addition some students stated their problems during biology learning as forgetting the topics quickly which is again an outcome of memorization. As Eraut (1994) stated unless knowledge is constantly used in daily life is forgotten. On the other hand, some students stated that they didn't like studying biology which appears as a problem to them. This situation may be attributed to the nature of biology itself which includes texts rather than numerical operations, and also the way of instruction that teachers follow.

With regard to the teachers' instruction, based on students' responses, teachers mostly used questioning method. As noted earlier, teachers' responses also revealed that most of the teachers use questioning method. Students from public and Anatolian high schools stated that their teachers didn't use different kinds of materials, while private high school students had biology lessons enriched with kinds of demonstrative materials. This difference among school types was also apparent in the results of teachers' responses. Compared to the teachers, number of students who said demonstration and discussion methods were used in biology lessons is much lower. Some of the students were not pleased of instruction of their teachers who didn't teach but "told" biology then went out and made students "tell" the topics whereas "teaching" is not "telling". Most of the students stated that they didn't do laboratory studies. This finding is consistent with Yaman's (1998). It is also worth noting that of the students who expressed that they did laboratory studies, the majority were from private schools. This pattern can be explained by private schools' better economical conditions and teachers' beliefs in benefits of laboratory studies. Furthermore these teachers working in private high schools feel that to do laboratory studies is compulsory. Whereas from schools other than private high schools, there were students who stated that they never made a study in the laboratory: "This is my first time to come to the laboratory" (Student 45 [A, F] with whom interview was conducted in the school's laboratory).

As teachers, students also were aware of importance of visualization, experiments, active involvement of students through discussion or questioning, and examples from real life for a good biology learning to occur. In addition they stated that teachers should be confident on subject matter. Researchers confirm students' expectations. Watts et al. (1997) considered students' questions as important indication of their thinking. Thus students should involve the lessons by asking questions. Thomas (1993, as cited in Harlen, 2001), indicated that the more students are involved in knowing what they should be trying to do, the more likely their motivation and effort are enlisted. With regard to the laboratory studies, Zitoon and Al-Zaubi (1986) concluded that laboratory method is more effective in developing scientific thinking skill of Jordanian science secondary students than traditional method.

The results revealed that most of the students (of all three types of schools) think that biology has an abstract nature and is dependent on memorization. Therefore they consider biology difficult. Although most of the students are interested in biology, many of them find biology boring. As Delpech (2002) stressed, absence of practical, hands-on activities might make science lessons boring.

With regard to the biology class hours, surprisingly, in contrast to the teachers' views some of the students found biology class hours more than enough. The reasons lie under the role of mathematics and physics in ÖSS in addition to verbal, consequently boring nature of biology. Thus they don't like biology and get bored in the lessons. On the other hand, students' thoughts confirm teachers' about denseness of curriculum which, as they expressed, contains unnecessary details such as digestive system of an earthworm.

Another finding is about biology textbook of Ministry of National Education which, according to the students, has a good language with clear and detailed explanations.

The main exploration of this study was the reasons of students' low biology achievement as indicated by the results of ÖSS for many years. The findings from students' responses show similarities with teachers'. No difference in the views of students among school types was apparent. Students' reasoning was concentrated on their point of views about biology, that is, to them biology is dependent on memorization, verbal lesson, not liked and not considered as important. Besides they stated that there are too many topics and details to study whereas other science lessons, especially mathematics, include numerical operations and formulas which make these lessons more enjoyable. Furthermore students considered other science lessons especially mathematics as more important. These results confirm teachers' reasoning. In addition there were students, as teachers, who stressed that biology questions in ÖSS are long and not clear, and are low in number. Some of the students stated that since biology is difficult, students don't study while few students stated that since biology is easy, students don't study.

Students' responses revealed that there is a difference between questions asked in ÖSS and asked in high schools by biology teachers in the way that, the former measure students' reasoning ability as well as knowledge while the latter measure knowledge and their memorizing ability. Additionally, Dindar's study (1995) supports students' thoughts that biology teachers generally ask questions at knowledge level.

5.1.3 Students' Biology Achievements in High Schools

Although biology achievement of students is low in ÖSS, some of the teachers stated that they thought it is not low in the schools, even higher than some other lessons. Therefore researcher investigated this situation in some schools and obtained the average achievements of students in mathematics, physics, and chemistry and biology lessons of previous year. It was seen that, really, biology average achievement wasn't the lowest of all. So this pattern may be explained by that there may be a difference between biology education given in high schools and what ÖSS biology questions request and measure. It can be deduced from both teachers' and students' responses that students have difficulties in making comments by using their existing knowledge. On the other hand, ÖSS biology questions require integrating facts and applying them to the situation.

However it is apparent that, in general, a biology education dependent on memorization is given to Turkish students. In high schools, students are tested for their factual knowledge and are given textbook information. As a result students memorize to pass a test and cannot apply knowledge outside of the class. Therefore real biology learning does not take place accordingly even the students with highest biology grades in high schools fail in the standardized exams such as ÖSS.

5.2 Implications

5.2.1 Implications for Practice

Demirsoy (1993) stressed the importance of biology education: He attributed 50 % of problem in Turkey to biological issues. If biological effects behind events were taken into account then there wouldn't have occurred problems related to crowd of people, environmental pollution, genetic illnesses, malnutrition. Therefore there is a need for a conscious biology education. Thus biology should be integrated into the life and culture as an inevitable component.

This study showed that there are problems in Turkish biology education that deeply affect students' biology achievement. Indeed the problems are linked to each other, that is, there is a cause-effect relationship. One of the main problems to be considered is that students feel that biology depends on memorization. Furthermore verbal and abstract nature of biology frightens students. These feelings of students might be attributable to the fact that teachers (not all of them) do not use different kinds of materials and do laboratory studies. This pattern might be an outcome of inadequacy of economical resources, but the results of this study showed that though they are present in their schools teachers don't make use of these materials (consistent with Yaman's finding). Therefore schools should be provided with necessary equipment and materials. Besides while some schools possess these kinds of aids, others don't. Thus schools should be equalized about the presence of necessary aids. On the other hand, all of the biology teachers should be aware of the importance of visualization of biology lessons by way of using different kinds of materials.

Many researchers have long considered it necessary to go out of school and make observations in the field. Çilenti and Özçelik (1991) emphasized that in the field trip studies all senses are involved in learning, besides field trips give the opportunity to students to observe the organisms of interest in their natural environment. On the other hand, it is obvious that to make out-of-school activities like observations in the nature, visits to museums or exhibitions both the administrative process and controlling crowded groups of students are difficult. But

instead the Ministry of National Education can prepare cassettes including these kinds of activities to be watched by students.

It is apparent from the results of this study that teachers suffer from both the curriculum including many subject matter and details and insufficient time allocated to teaching biology. It is therefore not surprising that this pattern decreases or discourages efficiency of biology teaching-learning process. Teachers are in trouble both to cover all the topics in the allocated time and to enrich their instruction with different kinds of activities. Accordingly the amount of details in the biology curriculum should dramatically be reduced. Furthermore time should be increased and balanced with the content of curriculum.

This study revealed that both biology teachers and students are complaint about the teachers who are not competent on subject matter furthermore teaching outside their expert areas. Therefore to meet students' curiosity teachers should absolutely be competent on subject matter, they should improve themselves about the developments and already changed information. Furthermore they should do additional background reading in the subject area prior to teaching the lesson.

Students' responses revealed that teachers made students feel positive or negative toward biology and involve in the lesson. For that reason teachers should motivate the desire to know, stimulate curiosity and cognizance and develop a creative and critical learning environment.

Teachers shouldn't use a textbook style during teaching but instead should use the textbook as a resource rather than the curriculum. Biology teaching shouldn't be in the traditional way in which information from teacher and text is transmitted to the students (Ward and Wardersee, 2002). Teachers should improve instructional strategies that lead students to grasp the meaning of a learning task. They should de-emphasize rote learning of large numbers of facts. It is teachers' role to take the students from where they are and help them to better understand by making connections to things in the world. So that students can apply knowledge learnt in the class to the real world. Besides teacher role should be determined as a facilitator who

engages student-centered instruction as consistent with the objectives of Turkish biology education (T.C. Milli Eğitim Bakanlığı Tebliğler Dergisi, 1998, No: 2485).

The results showed that biology teachers ask questions at knowledge level to evaluate their students' learning while ÖSS biology questions are mostly at comprehension and problem solving levels. Consequently biology teachers should develop and use evaluation mechanisms that assess students' higher-level thinking, process-skills and conceptual understanding. Accordingly they should teach biology in such a way to increase motivation and strengthen problem solving skills. This is possible through lessons wherein both hands-on and minds-on activities take place. Thus it is reasonable for teachers to discuss scientific developments and controversial issues in the class so that student will involve actively.

To provide meaningful learning, teachers should relate the subject maters to everyday life and connect subject matters to each other since concepts in biology do not exist in isolation. Furthermore teachers should consider students' prior knowledge upon which they should build new coming information. Therefore teachers should be competent on both knowledge of subject matter and knowledge of teaching strategies for the subject matter. Accordingly education in the universities should be improved in the way that beginning teachers feel confident, especially on designing experiment.

Some of the teachers complained that there isn't a curriculum of biology practice lessons which are optional to students' choice. Since practice is complementary to theory in biology, these courses should be compulsory for science students and a curriculum should be prepared.

A vital reason of low biology achievement in ÖSS; as the results showed, is ÖSS itself. Biology questions of ÖSS are the least in number and the last in place of all others. These are the factors that make students consider biology not important. In addition, teachers stated ÖSS biology questions are above students' cognitive level and questions even out of curriculum are asked. So a balance in place and number

of questions between biology and other lessons should absolutely be provided in ÖSS.

To conclude, teachers are apt to involve in seminars about efficient biology teaching, that are organized with a great care. Therefore Ministry of National Education should organize seminars given by scholars in the filed about teaching strategies, improvements in science, laboratory studies in a suitable time and place.

5.2.2 Implications for Research

This study gives insights about reasons of low biology achievement, but it is evident that many more studies can be conducted. On the basis of the findings of this study the following implications are deduced for future studies:

This study was conducted in private, Anatolian and public high schools in Ankara. Thus to increase generalizability of the results, it is worth to conduct a similar study in high schools of Turkey.

In this study the sample of students were science students at 11^{th} grade. It is also worthwhile to conduct researches on other grades including both science students and other students.

This study included secondary schools. On the other hand, it is apparent that there are reasons of low biology achievement depending on primary school science education. It will be useful to conduct research with primary school science teachers to determine students' views about science lessons and the problems of biology education.

This study showed that there are problems about curriculum. Thus another study can be conducted to explore these problems deeply and compare with other countries' biology curricula.

The results indicated that most of the students find biology difficult. It is therefore worthwhile to develop a test to measure students' formal reasoning ability

on biology and therefore determine whether biology is at the level of high school aged people.

The findings of this study depicted that students are upset about teachers who are not competent on subject matter. Therefore it is recommended to make a study to explore current situation and problems of higher education with undergraduate biology teachers at university.

There were differences in the results among school types. A study to explore differences in biology education between private, Anatolian, public and also science high schools would be beneficial.

The results showed there are differences between biology questions asked in ÖSS and asked in high schools. Thus a study can be conducted to investigate the differences deeply. Furthermore average achievements in science lessons of examinations (other than ÖSS) made in Turkey countrywide can be compared.

This study was conducted with qualitative technique to investigate the reasons of low biology achievement. A quantitative study can be conducted with a larger sample to support the findings of this study.

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APPENDIX A

TEACHER INTERVIEW SCHEDULE

Hello, my name is Nesrin. I am a graduate student in Secondary Science and Mathematics Department at Middle east Technical University. I am performing a research for master thesis about the reasons of students' low biology achievement which is indicated by the results of university entrance examinations for many years. Accordingly to identify these reasons I am conducting interviews with high school biology teachers. I am going to ask you some questions in the interview which will last in about 30-40 minutes.

If you allow I want to use a tape recorder during the interview in order to gain time and not to miss anything. You can be sure that noone will listen these records except researchers. All the records will be kept confidential.

ABOUT THE TEACHER

Gender: Interview No:

School Type: Date:

Professional Experience:

University, Faculty Graduate:

Do you have a master and/or doctorate degree?

Do you have a certificate of pedagogical courses?

QUESTIONS

1. What do you think about biology in general?
2. What is the aim of biology education?
3. Do you enjoy teaching biology?
4. Do you think that it is necessary for students to learn biology?
5. What are the expectations of students from you as a biology teacher for a better understanding of biology?
6. Do you believe that you do everything that you can do to teach biology? Can you describe strengths and weaknesses of your instruction?
7. Which methods do you use mostly?
8. What are the materials that you most frequently use?
9. Do you use methods other than the ones that you usually use (field trips, museums, story telling, laboratory studies)?
10. How should a good biology education be?
11. What are the topics that students perceive as difficult?
12. Do you think that students have positive attitudes toward biology?
13. Do you think that your students are good at biology?
14. Do the students ask questions about the scientific developments?
15. Can your students make any comments about any topic?
16. Can the students relate the biology knowledge to the daily life?
17. Do you talk about current scientific developments in your lessons? Do you bring articles and read them in the class?
18. Do you relate topics with other disciplines while teaching biology?

19. Do you relate new topics with the previous ones?
20. Do you measure students' prior knowledge before teaching the new topic?
21. What question types do you ask in your exams?
22. What are the strengths and weaknesses of today's biology education?
23. What is(are) the greatest problem(s) that you encounter during teaching biology?
24. What do you think about biology curriculum; the sequence of topics, its denseness, its contents, appropriateness to students' level?
25. Do you think that biology class hours are sufficient? If not, what do you think what is the appropriate biology class hour for each grade?
26. What do you think what are the reasons of low achievements in biology as indicated by the results of university entrance examinations between the years 1996-2002?
27. Have you ever participated in any in service training about biology?

APPENDIX B

ÖĞRETMEN GÖRÜŞME FORMU

Merhaba, ismim Nesrin. Orta Doğu Teknik Üniversitesi Biyoloji öğretmenliği bölümünde yüksek lisans yapıyorum. Çalışmam için öğrencilerin biyolojideki başarılarının düşüklüğünün (yıllardır üniversite sınav sonuçlarının da gösterdiği gibi) sebepleri ile ilgili bir araştırma yapıyorum. Böylece bu sebepleri belirlemek amacıyla lise biyoloji öğretmenleriyle görüşme yapıyorum. Size 30-40 dakikalık bir görüşme süresince bazı sorular soracağım.

İzin verirseniz görüşme boyunca bir kayıt cihazı kullanmak istiyorum. Bunun sebebi zamandan kazanmak ve hiçbir şeyi kaçırmak istememdir. Kayıtların araştırmacılar dışında kimse tarafından dinlenilmeyeceğinden emin olabilirsiniz. Bütün bilgiler saklı tutulacaktır.

ÖĞRETMEN HAKKINDA

Cinsiyetiniz: Görüşme No:

Çalıştığınız okul türü: Tarih:

Mesleki tecrübeniz:

Mezun olduğunuz üniversite/fakülte:

Yüksek lisans ve/veya doktora yaptınız mı?

Öğretmenlik sertifikasına sahip misiniz?

SORULAR

1. Genel olarak biyoloji hakkında ne düşünüyorsunuz?
2. Biyoloji öğretiminin amacı nedir?
3. Biyoloji öğretmekten zevk alıyor musunuz?
4. Öğrencilerin biyoloji öğrenmelerinin gerekli olduğuna inanıyor musunuz?
5. Öğrencilerin, biyolojiyi daha iyi öğrenmek adına, bir biyoloji öğretmeni olarak sizden beklentileri nelerdir?
6. Biyoloji öğretmek için her şeyi yaptığınıza inanıyor musunuz? Kendinizde eksik bulduğunuz ve başarılı bulduğunuz yanlarınız nelerdir?
7. Biyoloji dersinde en çok hangi yöntemleri kullanıyorsunuz?
8. Biyoloji dersinde en çok hangi materyalleri kullanıyorsunuz?
9. Genel olarak kullandığınız yöntemlerin dışına çıkıyor musunuz? (arazi gezisi, müze, hikaye anlatımı, laboratuar çalışmaları)
10. İyi bir biyoloji öğretimi nasıl olmalıdır?
11. Öğrenciler en çok hangi konularda zorluk çekmektedirler?
12. Öğrencilerin biyolojiye karşı olumlu yaklaşımları olduğunu düşünüyor musunuz?
13. Öğrencilerinizin biyoloji dersinde başarılı olduklarını düşünüyor musunuz
14. Öğrenciler bilimsel gelişmelerle ilgili soru soruyorlar mı?
15. Öğrenciler herhangi bir konuda kritik yapabiliyorlar mı?
16. Öğrenciler derste öğrendiklerini günlük hayatla ilişkilendiriyorlar mı?
17. Siz güncel gelişmelerden bahsediyor musunuz? Makale getirip sınıfta okuyor musunuz?
18. Biyoloji dersini anlatırken diğer alanlarla ilişkilendiriyor musunuz?

19. Konuyu anlatırken geçmişte işlenen konularla ilişkilendiriyor musunuz?
20. Konuyu anlatırken öğrencinin ön bilgisini ölçüyor musunuz?
21. Sınavlarınızda ne tür sorular soruyorsunuz?
22. Bugünkü biyoloji öğretiminde başarılı ve başarısız olunan noktalar nelerdir?
23. Biyoloji öğretirken yaşadığınız en büyük problem(ler) ne(ler)dir?
24. Müfredat hakkındaki görüşleriniz nedir?
    - Konu sıralanışı uygun mu?
    - Yoğun mu?
    - İçerik yeterli mi?
    - Öğrencinin seviyesine uygun mu?
25. Biyoloji ders saatlerinin yeterli olduğunu düşünüyor musunuz? Değilse ideali ne olmalıdır?
26. Biyoloji öğretimi ile ilgili herhangi bir seminere katıldınız mı?
27. 1996-2002 yıllarında üniversite sınav sonuçlarının gösterdiği üzere, sizce biyoloji dersindeki başarının düşük olmasının sebepleri nelerdir?

APPENDIX C

STUDENT INTERVIEW SCHEDULE

Hello, my name is Nesrin. I am a graduate student in Secondary Science and Mathematics Department at Middle east Technical University. I am performing a research for master thesis about the reasons of students' low biology achievement which is indicated by the results of university entrance examinations for many years. Accordingly, to identify these reasons I am conducting interviews with high school 11^{th} grade science students. I am going to ask you some questions in the interview which will last in about 15-20 minutes. I want you to feel comfortable, this is not an exam!

If you allow I want to use a tape recorder during the interview in order to gain time and not to miss anything. You can be sure that noone will listen these records except researchers. All the records will be kept confidential.

ABOUT THE STUDENT

Gender: Interview No:

School Type: Date:

Age:

QUESTIONS

1. Do you like biology?
2. Do you think that it is necessary to learn biology?
3. Do you think that biology depends on memorization?
4. Do you think that biology is boring?
5. Do you think that biology has an abstract nature?
6. Does biology take your interest?
7. Do you involve in the lessons?
8. How do the teachers teach biology, what methods do they use most frequently?
9. Do you perform laboratory studies?
10. What do you think how should a good biology education be?
11. Do you think that biology is difficult especially compared with other disciplines?
12. How do you study biology?
13. What are the topics that you perceive as most difficult?
14. Do you have any problem while learning biology?
15. Do you think that biology class hours are sufficient?
16. What do you think about biology textbooks of Ministry of National Education?
17. What do you think about biology curriculum?
18. Do you notice any difference between questions of university entrance exams and questions asked in your schools by your biology teachers?
19. What do you think what are the reasons of low achievements in biology as indicated by the results of university entrance examinations between the years 1996-2002?

APPENDIX D

ÖĞRENCİ GÖRÜŞME FORMU

Merhaba, ismim Nesrin. Orta Doğu Teknik Üniversitesi Biyoloji öğretmenliği bölümünde yüksek lisans yapıyorum. Çalışmam için öğrencilerin biyolojideki başarılarının düşüklüğünün (yıllardır üniversite sınav sonuçlarının da gösterdiği gibi) sebepleri ile ilgili bir araştırma yapıyorum. Böylece bu sebepleri belirlemek amacıyla 11. Sınıf fen öğrencileriyle görüşme yapıyorum. Sana 15-20 dakikalık bir görüşme süresince bazı sorular soracağım. Kendini rahat hissetmeni istiyorum. Bu bir sınav değil!

İzin verirsen görüşme boyunca bir kayıt cihazı kullanmak istiyorum. Bunun sebebi zamandan kazanmak ve hiçbir şeyi kaçırmak istememdir. Kayıtların araştırmacılar dışında kimse tarafından dinlenilmeyeceğinden emin olabilirsin. Bütün bilgiler saklı tutulacaktır.

ÖĞRENCİ HAKKINDA

Cinsiyetiniz: Görüşme No:

Okul türü: Tarih:

Yaş:

SORULAR

1. Biyolojiyi seviyor musun?
2. Biyoloji öğrenmenin gerekli olduğunu düşünüyor musun?
3. Biyoloji dersini ezber dersi olarak görüyor musun?
4. Biyoloji dersini sıkıcı buluyor musun?
5. Biyolojinin soyut olduğunu düşünüyor musun?
6. Biyoloji ilgini çekiyor mu?
7. Derse katılıyor musun?
8. Genel olarak ders nasıl anlatılıyor, öğretmenler en çok hangi yöntemleri kullanıyor?
9. Laboratuar çalışması yapıyor musunuz?
10. Sence iyi bir biyoloji öğretimi nasıl olmalı?
11. Biyoloji dersini zor bir ders olarak görüyor musun, özellikle diğer sayısal derslerle karşılaştırdığında?
12. Biyolojiye nasıl çalışıyorsun?
13. En çok zorlandığın konular neler?
14. Biyoloji öğrenirken her hangi bir problem yaşıyor musun?
15. Ders saatlerini yeterli buluyor musun?
16. Milli Eğitim Bakanlığı'nın biyoloji kitaplarını nasıl buluyorsun?
17. Biyoloji müfredatını nasıl buluyorsun?
18. Size liselerde sorulan biyoloji soruları ile üniversite giriş sınavlarında sorulan biyoloji soruları arasında bir fark görüyor musun?
19. 1996-2002 yıllarında üniversite sınav sonuçlarının gösterdiği üzere, sence biyoloji dersindeki başarının düşük olmasının sebepleri nelerdir?