THE ROLES OF MOTIVATIONAL BELIEFS AND LEARNING STYLES ON TENTH GRADE STUDENTS' BIOLOGY ACHIEVEMENT

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ABSTRACT

THE ROLES OF MOTIVATIONAL BELIEFS AND LEARNING STYLES ON TENTH GRADE STUDENTS' BIOLOGY ACHIEVEMENT

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This study aimed to explore the roles of students' motivational beliefs (self-efficacy, intrinsic value, test anxiety) and learning styles on tenth grade students' biology achievement. In this study Turkish version of the Motivated Strategies for Learning Questionnaire, Learning Style Inventory, and Biology Achievement Test were used as measuring instruments.

Motivated Strategies for Learning Questionnaire was adapted into Turkish and pilot tested with 238 tenth grade students from two representative schools. The main study was conducted in 11 randomly selected schools throughout the

Çankaya and Yenimahalle districts of Ankara with a total of 980 tenth grade students in fall 2002-2003 semester.

The data obtained from the administration of the measuring instruments were analyzed by using analyses of covariance (ANCOVA) and bivariate correlations. Results of the statistical analyses indicated that students' learning styles had a significant effect on their biology achievement when students' motivational beliefs were controlled. The most common learning style type was found to be assimilating for the subjects of this study. Moreover, the biology achievement test mean scores of assimilators were found to be higher than that of convergers, divergers, and accommodators. Bivariate correlations revealed low positive correlations between each of the three components of motivational belief and students' biology achievement.

Keywords: Biology Education, Biology Achievement, Motivational Belief, Self-Efficacy, Intrinsic Value, Test Anxiety, Learning Style.

ÖZ

GÜDÜSEL İNANÇLARIN VE ÖĞRENME STİLLERİNİN ONUNCU SINIF ÖĞRENCİLERİNİN BİYOLOJİ BAŞARISINDAKİ ROLÜ

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Bu çalışmanın amacı ; onuncu sınıf öğrencilerinin güdüsel inançlarının (öz-yeterlik, içsel değer, sınav kaygısı) ve öğrenme stillerinin biyoloji başarısındaki rolünü araştırmaktır. Bu çalışmada, ölçüm araçları olarak Öğrenmede Güdüsel Stratejiler Anketi'nin Türkçe versiyonu, Öğrenme Stilleri Envanteri ve Biyoloji Başarı Testi kullanılmıştır.

Öğrenmede Güdüsel Stratejiler Anketi Türkçeye adapte edilmiş ve iki okuldan toplam 238 öğrencinin katılımı ile pilot çalışması gerçekleştirilmiştir.

Esas çalışma, 2002-2003 sonbahar döneminde, Çankaya ve Yenimahalle ilçelerindeki 11 okuldan seçilen 980 onuncu sınıf öğrencisi ile yapılmıştır.

Elde edilen veriler, tek yönlü varyans (ANCOVA) istatistiksel tekniği ve basit ilişki analizi kullanılarak değerlendirilmiştir. İstatistiksel sonuçlar, öğrencilerin güdüsel inançları kontrol edildiğinde, öğrenme stillerinin biyoloji başarısına anlamlı bir etkisi olduğunu göstermiştir. Çalışmaya katılan öğrenciler arasında özümseyen öğrenme stilinin son derece yaygın olduğu ve bu öğrenme stiline sahip olan öğrencilerin biyoloji başarı testi ortalamalarının diğer öğrenme stillerine sahip olan öğrencilerinkinden daha yüksek olduğu saptanmıştır. Basit ilişki analizleri, güdüsel inanç bileşenlerinden her birinin öğrencilerin biyoloji başarısıyla düşük pozitif bir ilişki içerisinde olduğunu göstermiştir.

Anahtar Kelimeler: Biyoloji Eğitimi, Biyoloji Başarısı, Güdüsel İnanç, Öz-Yeterlik, İçsel Değer, Sınav Kaygısı, Öğrenme Stili

To My Parents

Zekiye and Necmettin ÖZKAN

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TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

LIST OF SYMBOLS

SYMBOLS

MSLQ-TV	:	Turkish version of the Motivated Strategies for Learning Questionnaire
LSI	:	Learning Style Inventory
BAT	:	Biology Achievement Test
SES	:	Self-efficacy scores
IVS	:	Intrinsic value scores
TAS	:	Test anxiety scores
BACH	:	Biology achievement test scores
MOTB	:	Motivational beliefs of students toward biology
LS	:	Learning style
DV	:	Dependent Variable
IV	:	Independent Variable
ANCOVA	:	Analysis of covariance
Df	:	Degree of Freedom
N	:	Sample Size
α	:	Significance Level

CHAPTER 1

INTRODUCTION

The state of biology education in Turkish high schools has been very poor for many years and there is a great need for improvement. Over the years, learning biology without understanding has been a common outcome of biology instruction. Students have seemed to memorize facts without fully understanding and such students often are not sure when or how to use what they know. The results of such learning are evident in the number of questions answered correctly in the university entrance examinations in Turkey over the last few years. It is clear that many students are not learning science they need in order to be productive citizens in the 21st century.

The need to understand and make use of science in the workplace and daily life has been greater today than past, and will continue to increase. The level of science required for intelligent citizenship and the scientific knowledge required in the workplace and in professional areas has increased dramatically. Consequently, all students need to receive a high quality science education and learn science in order to guarantee the production of quality in many professional areas ranging from education to health care to technology and to engineering.

As a result of the apparent deficiencies in science education and the need for science in a changing world, there have been many calls from researchers, national commissions, schools, educators, and students for instructional innovations in secondary school science education in Turkey.

Finding the answers of two questions ‘Why do learners differ?’ and ‘Why do some students perform better than others even when everyone is given the same material?’ would probably be the first step in the attempts to increase the level of science achievement and to lead possible instructional innovations. The problem is not that individuals cannot learn the material, but that they do not want to learn it or do not know how to learn meaningfully (Wong & Csikszentmihalyi, 1991). Current studies in education and psychology have pointed out the importance of both cognitive and motivational variables as essential elements of successful academic performance (Paris, Lipson, & Wixson, 1983; Pintrich & DeGroot, 1990). However, the educational literature deals almost entirely with the cognitive dimensions of the problem, especially how to break down, present and transmit information to students and avoids constructs such as individual’s expectations, values, goals, intentions, values and beliefs. Such constructs are believed to vary significantly from learner to learner and have an important effect on their learning. Consequently, there is a need for more research examining constructs emphasized in both cognitive and motivational models of learning.

Cognitive models of learning provide information regarding 'how' students develop an understanding of classroom academic task through the use of cognitive resources and tools (e.g., learning styles), whereas models of motivation provide an understanding of the 'why' of student choice, level of activity and effort, and persistence at classroom academic tasks (Yu, 1996). Therefore, cognitive or motivational models alone cannot account for the different aspects of students learning. In classroom environment, both cognitive and motivational factors operate simultaneously, so both types of constructs are needed to be examined in the school setting.

With respect to cognitive factors, research has shown that what students learn is significantly affected by their learning styles. Learning style can be defined as the way each learner perceives and processes new information for storage and retrieval (Williams, 2001). Students have different learning style preferences for taking in and processing information (Felder, 1996). Learning style is not an ability, but rather a preference, and is facilitated by the individual's perceptual and sensory strengths (Taylor, 1997). It is known that learning styles are identifiable, and greater academic achievement results when students' learning styles are considered in the selection of instructional methods (Shaughnessy, 1998). Thus, one of the purposes of this study is to examine the effect of students' learning styles on their biology achievement.

Despite the benefits that cognitive factors can afford learners, students must be motivated to become engaged with the course material.

Current models of learning tend to take a less isolated view toward cognition by including more 'hot' constructs like affect and motivation (Yu, 1996). Motivation can be defined as the process by which goal-directed activity is initiated and sustained and it is an important quality that pervades all aspects of education (Pintrich & Schunk, 1996, as cited in Yu, 1996). A number of constructs have been theorized to play a role in motivation to learn. These constructs include, among many others, self-competence and self-efficacy, task value, intrinsic goal orientation, and test anxiety (Yu, 1996). Thus, this study also intended to examine the relationship between students' motivational belief and their biology achievement.

The dynamic interaction of cognitive and motivational factors with students' science achievement in Turkey has not been widely acknowledged by researchers. Affective constructs have been usually avoided. Instead much emphasis has been given on the effects of different treatments and teaching methods on student understanding. Models of academic achievement that attempt to improve students' science achievement without determining the underlying reasons of low school performance generally do not seem to do a very good job for solving our educational problems in science. For the reasons already discussed, we can confirm that there is an urgent necessity of specifying both cognitive and affective determinants of science education in our schools. Since students' learning styles and motivational beliefs were found as important determinants of school performance by previous researches and little study exists on how learning styles and motivational factors influence science achievement in our schools, this study attempts to investigate the relationship between motivational belief and biology achievement and the effect of learning style on biology performance of students.

1.1 Main Problems and Sub-problems

1.1.1 The Main Problems

The two main problems of this study are stated as follows;

1) Do students' learning style and gender have significant effects on the biology achievement of the tenth grade students?
2) Is there a significant contribution of students' motivational beliefs to their biology achievement?

1.1.2 The Sub-problems

1) Is there a significant difference between the biology achievement test scores of tenth grade students with different learning styles when the effect of student motivational belief is controlled?
2) Is there a significant difference between the biology achievement test scores of tenth grade female and male students when the effect of student motivational belief is controlled?

3) Is there a significant difference between the biology achievement test scores of tenth grade male and female students with different learning styles when the effect of student motivational belief is controlled?
4) Is there a significant contribution of students' self-efficacy beliefs to their biology achievement test scores?
5) Is there a significant contribution of students' intrinsic value beliefs to their biology achievement test scores?
6) Is there a significant contribution of students' test anxiety beliefs to their biology achievement test scores?

1.2 Hypotheses

The problems stated above were tested with the following hypotheses which are stated in null form.

Null Hypothesis 1: There will be no significant difference between the biology achievement test scores of tenth grade students with different learning styles when the effect of student motivational belief is controlled.

Null Hypothesis 2: There will be no significant difference between the biology achievement test scores of tenth grade female and male students when the effect of student motivational belief is controlled.

Null Hypothesis 3: There will be no significant difference between the biology achievement test scores of tenth grade female and male students with different learning styles when the effect of student motivational belief is controlled.

Null Hypothesis 4: There will be no significant contribution of students' self-efficacy beliefs to their biology achievement test scores.

Null Hypothesis 5: There will be no significant contribution of students' intrinsic value beliefs to their biology achievement test scores.

Null Hypothesis 6: There will be no significant contribution of students' test anxiety beliefs to their biology achievement test scores.

1.3 Definition of the Important Terms

Motivational Belief: As used in this study, motivational belief is defined in terms of self-efficacy, intrinsic value and test anxiety.

Self-Efficacy: A measurement of the extent to which the learner perceives his ability to master a task. It includes the learner's judgments about his ability to complete a task and confidence in his skills to conduct the task. Involves students' answers to the question, 'Can I do this task?'

Intrinsic Value: The value component of motivational belief involves students' goals for the task and their beliefs about the importance of, interest in, and value of the task. Involves students' answers to the question, 'Why am I doing this task?'

Test Anxiety: Anxiety is the affective component of motivational belief which includes students' emotional reactions to the tasks and taps into students' worry and concern over taking exams. Involves students' answers to the question, 'How do I feel about this task?'

Learning style: The interaction of cognitive, affective, and physiological behaviors as the learner perceives, interact with, and responds to the learning environment. As used in this research, learning style is a measure of an individual's relative emphasis on the four learning modes or orientations as identified by Kolb in his Learning Style Inventory (Concrete Experience-CE, Reflective Observation-RO, Abstract Conceptualization-AC, and Active Experimentation-AE) and on two combinations scores that indicate the extent to which the individual emphasizes abstractness over concreteness (AC-CE) and action over reflection (AE-RO).

Biology Achievement: Biology performance of students as measured by the grades taken from the Biology Achievement Test (BAT) used in the study.

Science-Mathematics Group: One of the groups selected by tenth grade high school students in Turkey in which students heavily take mathematics and science lessons during their education.

1.4 Significance of the Study

Current study can provide a framework for the recognition of some of the affective and cognitive variables underlying science education in Turkey. One of the major priorities of science educators should be to identify those variables and to help all students improve their science learning. In a world where the focus of science education has begun to shift from the preparation of a few students for scientific and technical careers to the preparation of all students for scientifically and technologically rapid changing life, the need to improve science education in Turkey has been greater than ever. Consequently, one of the initial attempts for improving science learning is to identify the affective and cognitive determinants of science education. Only after specifying the determinants of science achievement, the efforts for improvement would be meaningful.

Further research is needed to identify the importance of both cognitive and motivational variables as predictors of success in school performance. Accordingly, this study represents an effort to address and fill this gap in the literature and is designed to add to the growing body of literature regarding learning styles, motivational beliefs, and their relationships to biology achievement. It is hoped that this investigation will serve as a motivating force for future interest and research in the area of learning styles, motivational beliefs and their effects on school performance in different areas; thereby enhancing systematic educational approaches for optimum learning success and increasing the awareness of learners and educators on the fact that cognitive factors together with motivational variables play an important role in school performance and science achievement.

CHAPTER 2

LITERATURE REVIEW

Some students perform better than others at acquiring knowledge about a new topic, even when everyone was given the same instruction (Vollmeyer & Rheinberg, 2000). Why do learners differ? One possible reason is that successful learners start with a good learning strategy and know how to find out ways for acquiring the new material. This is a cognitive explanation. However, there can also be a motivational explanation: Learners may vary in the nature of their motivation to learn the new topic. Highly motivated students may try harder to learn whereas lowly motivated ones do not struggle enough to learn. Combining these two explanations related to learner difference yields a third alternative: a cognitive-motivational explanation (Vollmeyer & Rheinberg, 2000).

This literature review starts by discussing how motivation can affect learning and then continues with the effects of cognitive characteristics, specifically the effects of students' preferred learning styles on learning.

2.1 Literature on Student Motivation

Simon (1967, p.29) defined motivation as a ‘goal terminating mechanism, permitting goals to be processed serially’. People have many goals in their lives and according to Simon, motivation is the mechanism that determines which goal is activated. If the goal to learn about a new topic is activated, the learner tries to reach it and starts learning. Learning itself, however, is a cognitive process.

Rheinberg (1997, as cited in Vollmeyer & Rheinberg, 2000) defined motivation as something that acts as a driving force towards a goal for all current processes. By doing so, motivation influences the way people learn.

Bandura (1991, p.158) combines motivation and cognition into a cognitive-motivational perspective. He defined motivation as a ‘multidimensional phenomenon indexed in terms of selection of pursits from competing alternatives, intensity of effort, and persistence of exerion’. In terms of learning this means that motivation not only affects what people learn, but also the intensity and the duration of the learning activities.

The interaction between motivation and cognition is described in a more detailed way by Schiefele and Rheinberg (1997, as cited in Vollmeyer & Rheinberg, 2000). They claimed that motivation can affect three aspects of learning: (1) persistence and frequency of learning activities; (2) mode of performed learning activities; (3) motivational and functional states of the learner during learning.

Motivation is considered as a critical determinant of students' classroom learning and achievement in part because students who are more highly motivated tend to provide greater effort and persist longer at academic tasks than do students who are less motivated (Wolters & Rosenthal, 2000). In cognitive models of motivation, this greater effort and persistence for academic tasks is thought to result mainly from various beliefs, attitudes, and perceptions of the student (Weiner, 1990). Among these beliefs, the extent to which students value the material or skills they are learning, students' perceived self-efficacy, and the goals or reasons students adopt for completing academic tasks, have often been used to understand and explain students' motivation, effort, and persistence for academic task (Wolters & Rosenthal, 2000).

In their conceptualization of the expectancy-value model of achievement, Pintrich and De Groot (1990) describe three factors that characterize student motivation: an expectancy component, a value component, and an affective component. The expectancy component includes students' beliefs about their ability to perform a task. The value component includes students' goals and beliefs about the importance and interest of the task. The affective component includes students' emotional reactions to the task. Each component of student motivation and their interaction with student performance is described in more detail below.

2.1.1 Expectancy Component of Student Motivation

The expectancy component of student motivation has been conceptualized in a variety of ways in motivational literature like perceived competence, self-efficacy, attributional style, and control beliefs, but the basic construct involves students' beliefs that they are able to perform a task and that they are responsible for their own performance (Pintrich & De Groot, 1990). In this study, the expectancy component of student motivation was evaluated by be assessment of students' self-efficacy.

Students' perceived self-efficacy for a task has been used to understand and explain students' choice, effort, and persistence for academic tasks and it is defined as their judgments about their ability to complete a task successfully, (Schunk, 1991). In an achievement context, self-efficacy involves students' confidence in their cognitive skills to learn and perform the academic course work (Pintrich, 1999). Bandura (1993) has stated that individuals with greater self-efficacy set higher goals, provide greater efforts and persist longer when faced with difficulties than people with lower levels of self-efficacy for the same activity. Similarly, Schunk (1990, 1991) has shown that perceived self-efficacy affects many aspects of student motivation including their choice, effort, and persistence for a task. Students may avoid tasks for which they have a low sense of self-efficacy while they are likely to choose challenging tasks when they feel efficacious, and are more likely to work harder and persist longer when engaged in these task (Schunk, 1991). As a specific indicator of students' effort, previous research has also found that self-efficacy can be used to predict students' use of self-regulated learning strategies (Wolters & Pintrich, 1998; Zimmerman, 1990). Further, self-efficacy has also been tied more directly to students' performance level on academic tasks. For example, Zimmerman, Bandura, and Martinez-Pons (1992) found that self-efficacy for academic achievement was predictive of final grades among high school students. According to Pintrich (1999), self-efficacy was strongly related to academic performance including examinations, lab reports, papers, and overall final grades of students. Self-efficacy also has been hypothesized to influence individuals' thought pattern and emotional reactions (Pajares, 1996). Individuals with low self-efficacy may believe that tasks are harder than they really are and this belief may lead to anxiety and ineffective strategies (Pajares, 1996).

2.1.2 Value Component of Student Motivation

The value component of student motivation includes students' goals for the task and their beliefs about the importance and interest of the task (Pintrich & De Groot, 1990). Although this component has been conceptualized in a variety of ways (e.g., learning vs. performance goals, intrinsic vs. extrinsic orientation, task value, and intrinsic interest), this motivational component primarily focus on the reasons why students engage in an academic task (Pintrich & De Groot, 1990). In this study, the value component was examined in terms of students' intrinsic task value.

Task value reflects students' beliefs about whether the material or skills they are learning are useful, important, or intrinsically appealing for them (Eccles & Wigfield, 1995; Wigfield, 1994; Wigfield & Eccles, 1992). Theoretically, students who view what they are learning as more useful, more important, or more appealing are more likely to engage in a task, to provide greater effort for completing the task, and persist longer at the task than other students (Wolters & Rosenthal, 2000).

Eccles (1983, as cited in Pintrich, 1999) has suggested that three components of task value are important in achievement dynamics: the learners' perception of the importance of the task, their personal interest in the task, and their perception of the utility value of the task for future goals. The importance component of task value refers to the individuals' perceptions of the task's importance for them. Interest is assumed to be learner's general attitudes or linking of the task that is somewhat stable over time and a function of personal characteristics. Utility value is determined by the learner's perceptions of the usefulness of the task for them. For students utility value may include beliefs that the course will be useful for them immediately in some way (e.g., help them cope with college), in their major (e.g., they need this information for upper level course), or their carrier and life in general (e.g., this will help them somehow in graduate school) (Pintrich, 1999).

Empirical research in this area has found a relation between students' value for the material they are learning and their choice behavior.

For example, Eccles and her colleagues (Meece, Wigfield & Eccles, 1990; Wigfield & Eccles, 1992) have found that students who believe skill in mathematics to be valuable are more likely to report that they will take additional math courses in the future when compared to students who do not value the material in math. With respect to learners' effort or level of cognitive engagement, other researches have found a positive relation between students' valuing of academic tasks and their use of cognitive and self-regulatory strategies (Pintrich & De Groot, 1990). Wolters and Pintrich (1998) found that middle school students who showed greater valuing of the material in a specific subject area were more likely to report using cognitive and self-regulatory strategies with regard to that subject area. Pintrich and his colleagues (Pintrich, Smith, Garcia & McKeachie, 1993) also found that task value was correlated to performance but those relations were weaker than those for self-efficacy.

2.1.3 Affect Component of Student Motivation

The third motivational component is concerned about students' affective or emotional reactions to the task. Affect component of student motivation involves students' answer to the question, 'How do I feel about this task?' (Pintrich & De Groot, 1990). There are a variety of affective reactions that might be relevant like anger, pride, or guilt, but in a school context one of the most important seems to be test anxiety (Wigfield & Eccles, 1989).

Current theories of test-anxiety is based primarily on an interference model. High anxiety level produces task-irrelevant responses like concern of passing, error tendencies, thoughts of leaving, etc. in the testing situation that interfere with the task-relevant responses necessary for good test performance. A different approach was taken by Culler and Holahan (1980), who studied the role of ability and study habits in academic performance for low and high test-anxious students. Their results show that high test-anxious students have poorer ability and poorer study skills. They concluded that at least some part of the decrement in academic performance for high test-anxious students might be due to less knowledge of the relevant material as a function of differential study skills. According to this conclusion, high test-anxious students have good reason to be anxious. Not only anxiety produces poor performance but also poor ability results in anxiety. These two approaches to test anxiety show that the problems of high test–anxious students may lie along the continuum from poor study habits to worry in the test situation that cause attention defect so that they are not able to retrieve the required information (Benjamin, McKeachie, Lin, & Holinger, 1981).

Research on test anxiety has been linked to learners' metacognition, cognitive strategy use, and effort management (Benjamin et al., 1981; Culler & Holahan, 1980; Tobias, 1985). Benjamin et al., (1981) found that even though high anxious students seemed to be as effortful and persistent as low-anxious students, they appeared to be very ineffective and inefficient learners who often did not use appropriate cognitive strategies for achievement. On the other hand, other research shows that high-anxious children are not persistent or avoid difficult tasks (Hill & Wigfield, 1984).

Studies conducted in the last 30 years have most of the time supported the view that high test anxiety is correlated with performance decrements (Benjamin et al., 1981). Correlations ranging to -.60 show that anxiety has a strong negative relationship to performance in evaluative situations (Hill & Wigfield, 1984).

2.1.4 Expectancy-Value Theory of Achievement Motivation

Achievement motivation theorists have identified a variety of constructs to explain how motivation influences people's choice of achievement tasks, persistence on those tasks, and performance on them (Wigfield & Eccles, 2000). One long-standing perspective on achievement motivation is expectancy-value theory. Theorists in expectancy-value perspective believe that individuals' choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity (Wigfield, 1994; Wigfield & Eccles, 1992). Researchers using the expectancy-value model of achievement motivation are interested in how different aspects of an individual's valuing of academic tasks, together with the individual's expectancies for success, contribute to achievement behaviors (DeBacker & Nelson, 1999).

The expectancy-value model was proposed by Eccles and her colleagues (Eccles et al., 1983, as cited in Greene, DeBacker, Ravindran, and Krows, 1999; Wigfield, 1994; Wigfield & Eccles, 1992). An overview of the model is described below and shown in Fig. 1.

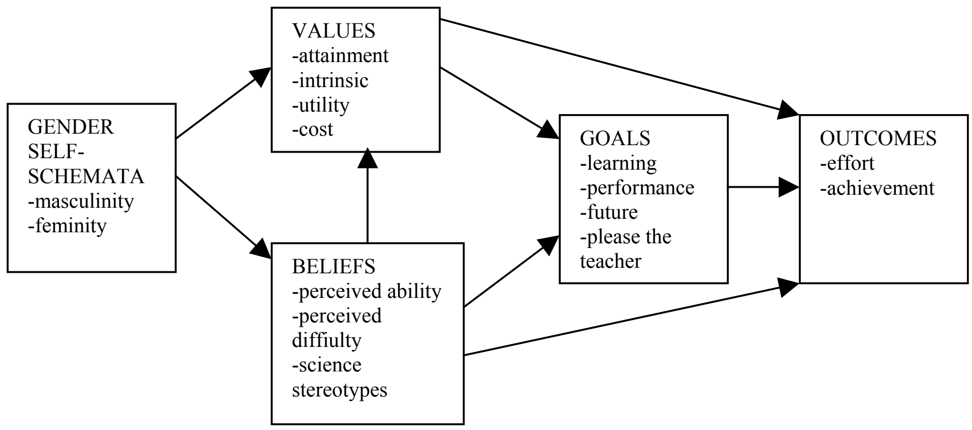

Figure 2.1 The Revised Expectancy-Value Model

2.1.4.1 The Role of Task Values

There are four task values (intrinsic, utility, attainment, and cost) proposed in the model that are interested in how a task meets the different needs of an individual (Wigfield, 1994; Wigfield & Eccles, 1992). Intrinsic value is the measurement of one's personal enjoyment or satisfaction from engaging in tasks in science domain. Utility value is the degree to which students value science for its usefulness in a future endeavor. Attainment value is the importance an individual places on accomplishments in the science domain. The fourth aspect of valuing, cost value is conceptualized as the worthwhileness of the time and effort for learning tasks in science. Debacker and Nelson (1999) reported that valuing variables predicted effort and persistence in science for both girls and boys, and science achievement for boys.

2.1.4.2 The Role of Task-Specific Beliefs

Like task values, expectancies for success are indicated to be direct predictors of achievement-related choices in the Eccles et al. model (Greene et al., 1999). Expectancies for success are a learner's beliefs about whether she/he will be successful on a future task. In their earlier work Eccles et al. showed expectancies and ability perceptions as separate constructs, but they have expressed that competence beliefs and expectancies are often not separate (Wigfield, 1994; Wigfield & Eccles, 1992). Other researchers have also found that these two constructs are indistinguishable (Greene et al., 1999), so a single perception of ability construct which includes both task-specific competency and expectancy beliefs was used in the model.

The second task-specific belief is the perceived task difficulty. According to Eccles and Wigfield (1995, as cited in Greene et al., 1999), task difficulty perception should be negatively related to perception of ability and task values. If a task is viewed as very difficult, the learner should be less confident in his/her ability to succeed in the task, which should decrease the valuing of that task.

The last task-specific belief is the measurement of the extent to which a learner believes that science is a male domain. The literature indicates that stereotypical beliefs related to science exist among students (DeBacker & Nelson, 2000). Studies of motivation to learn science suggest that perceptions of the gender appropriateness of a task or academic domain may affect motivation to learn (Greene et al., 1999). Studies using the Draw-A-Scientist test with follow-up interviews reported that both male and female students of all school ages have stereotypic images of science as male domain (Mason, Kahle, & Gardner, 1991). With regard to motivation to learn science, DeBacker and Nelson (1999) found that viewing science as a male domain was correlated negatively with achievement and persistence for high school girls. Those relationships were not found for boys.

2.1.4.3 The Role of Task-Specific Goals

Task-specific goals are the reasons students report for doing the work in a particular achievement situation (Miller, Greene, Montalvo, Ravindran, & Nichols, 1996). The two goals primarily described in goal theory literature were the learning goal and the performance goal (DeBacker & Nelson, 1999). Learning goals which are also called as mastery or task-oriented goals, have been characterized by reflecting a desire for mastery of a task and deep understanding. DeBacker and Nelson (1999) indicated that learning goals are related to greater effort and persistence in science learning and higher achievement. Performance goals which are also called ego-oriented goals, reflect a wish to perform better than others and protect one's ego. Findings from studies of learning and performance goals have been consistent in showing that students' effort, engagement, and achievement in science are related to the extent to which they persue the two goals (DeBacker & Nelson, 2000). There is a much smaller, new appearing, literature that expands the range of goals beyond learning and performance goals to include future goals and pleasing the teacher (Miller et al., 1996). Future goals refer to distant goals (e.g., eligibility for extracurricular activities, college admission, and carrier opportunities) that to some extent are rely on current task performance but not inherent in the performance itself. Pleasing the teacher is one of the examples of social responsibility goal that has been found in Wentzel's (1989) research, to have a positive influence on achievement. Miller et al. (1996) provided evidence for positive relationships between both future goals and desire to satisfy the teacher and self-regulation, which was positively linked to achievement.

2.1.5 Science Achievement and Student Motivation

Researchers have proposed that science achievement in secondary school is a function of many interrelated variables such as students' ability, attitudes and perceptions, socioeconomic variables, parent and peer influences and school-related variables (Singh, Granville, & Dika, 2002). Many of these variables are home- and family-related and consequently are difficult to change and are outside the control of educators. However, there are school-related variables such as motivation, interest, attitudes, and academic engagement that can be improved and modified and amenable to change by educational interventions. Thus, comprehending the role of such affective factors on achievement in science has attracted serious attention in recent years (Singh et al., 2002).

A considerable amount of research has accumulated in the last two decades that has examined the correlates of success in academic achievement in general and in science in particular. Attitudinal and affective constructs such as self-concept, confidence in learning science, science interest and motivation, and self-efficacy have emerged as salient predictors of science achievement. (Singh et al., 2002).

Motivation to learn is of special interest in science education (Pintrich, Marx, & Boyle, 1993). Evidences suggest that decisions to engage in effortful learning in science may be influenced by individual students' motivation, including their goals for engaging in an activity, their beliefs about their abilities and the nature of the task, and their valuing of the task (Greene & Miller, 1996).

Many studies have investigated the relations between students' motivation to learn and their achievement in science, mainly their performance and scores in science tests (Trumper, 1995). In Uguroglu and Walberg's (1979) survey of 40 studies which contained more than 200 correlations between motivation and achievement, 11.4% of the variance in achievement was accounted by motivation. Kremer and Walberg (1981) reviewed 20 studies dealing with student motivation and concluded that there is a positive relationship between motivational constructs and science learning. Later, Napier and Riley (1985), in a study that analyses various affective determinants, found that the highest correlate to achievement in science was student motivation.

2.2 Literature on Learning Style

There has always been great interest in the analysis of individual variations in educational psychology. Educational psychologists have understood that an important key to facilitate individuals' learning is to deal with the differences in their cognitive functions (Cano-Garcia & Hewitt Hughes, 2000). Part of the research literature is mainly focused on the analysis of the most relevant differences not only from the point of view of intelligence but also from the point of view of learning (intellectual styles and learning styles).

Most educators have recognized that understanding the ways in which individuals learn is a key element for the improvement of education (Collinson, 2000). All people show differences in how they perceive and acquire information, conceptualize, form ideas, process and memorize, form value judgments, and in the way they behave (Hickson & Baltimore, 1996). In the classroom, each student has unique personality and motivational factors that influence the way they respond to school and gain basic educational skills (Collinson, 2000).

A substantial amount of research in education and psychology has been directed toward identifying the effects of individual differences in learning styles (Collinson, 2000). Educators are becoming increasingly aware that an essential element in improving the academic success of learners is recognizing the way in which they learn.

As Brandt (1990) has indicated, the last ten years have witnessed considerable experimentation with learning styles and their relation to student learning. Proponents of this approach believe that, by exploring learning styles, positive effects upon student motivation and achievement are produced (Matthews, 1996).

2.2.1 Definitions of Learning Style

There has been an extreme increase in the number of learning style theories and definitions presented by educational researchers over the past 25 years. Many researchers have built upon the works of others, and as a result, many theories and definitions overlap. However, each researcher who develops a new theory originates new terms to establish originality, authenticity and ownership (Collinson, 2000).

Although learning style may be simply defined as the way people understand and remember information, the literature is filled with more complex variations on this theme. Learning styles are defined and classified in many different ways. It is very difficult to offer one particular definition of `learning style'; each researcher gives his or her own individual definition for various reasons (Cano-Garcia & Hewitt Hughes, 2000). First, because they are usually only interested in one of the dimensions of the learning process. Second, because they use different measurement instruments. Third, because their theoretical bases are very different.

According to Kirby (1979, as cited in Collinson, 2000) the term "learning style" came into use when researchers began looking for ways to combine course presentation and materials to match the needs of each student.

In 1978, Claxton and Ralston stated that learning style is an individual's typical way of reacting to and utilizing stimuli in the context of learning (Claxton & Ralston, 1978, as cited in Bailey, Onwuegbuzie, and

Daley, 2000). In the following year a new definition was added to the literature and Keefe (1979, as cited in Park, 2001) described the learning style as cognitive, affective, and physiological characteristics that are relatively stable indicators of how learners perceive, interact with, and respond to the learning environment.

More recently, Davidson (1990) and DeBello (1990) suggested that learning style refers to an individual's characteristic mode of acquiring, processing, and storing information. Similarly, Felder and Henriques (1995) described the learning style as the manner through which individuals typically gain, retain, and retrieve information. In the same year, James and Gardner (1995) defined learning style as the complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store, and recall what they are trying to learn.

As described by Vermunt (1996, 1998) learning style consists of four aspects: processing strategies, regulation strategies, mental models of learning and learning orientations. Processing strategies are thinking activities students utilize to process information to obtain certain learning outcomes like knowing the most important points in the study material (Busato, Prins, Elshout, & Hamaker, 2000). Regulation strategies are the activities learners use to monitor, to plan and to control the processing strategies and their own learning process (Busato et al., 2000). Mental models of learning are conceptions/misconceptions students have about learning processes and learning orientations are personal aims, intentions, expectations, doubts that students may experience during education (Busato et al., 2000).

According to Dunn and Dunn (1993, as cited in Dunn & Stevanson, 1997), learning style is the way each learner begins to concentrate on, process, internalize, and remember new and difficult academic information or skills.

Dunn and Dunn (1993) describe learning style in terms of each individual's ability to master new and difficult knowledge

1. Environmentally (with either sound versus quiet; soft versus bright light; warm versus cool temperatures; or formal versus informal seating),
2. Emotionally (through consistent versus inconsistent motivation, persistence, conformity or non-conformity, and either internally or externally imposed structure),
3. Sociologically (alone, with peers, with either a collegial or authoritative teacher, and/or with varied approaches as opposed to in patterns or routines),
4. Physiologically (auditorially, visually, tactually, and/or kinesthetically; with identifiable time-of-day energy highs and lows; with or without intake; and by sitting for long periods of time versus by frequently moving from one location to another),
5. Globally versus analytically as determined through correlations among sound, light, design, persistence, sociological preference, and intake.

Learning style may also be thought of as ways learners concentrate, process, internalize, and remember new and difficult academic information or skills. Learning styles often show variations with age, achievement level, culture, global versus analytic processing preference, and gender (Shaughnessy, 1998).

While researchers may not agree with a common definition of learning style, there appears to be some general agreement that a person's learning style is composed of a number of personality and environmental traits (Williams, 2001).

2.2.2 Learning Theories

During the 20th century, there was a drastic shift in the views of the learning theorists regarding human learning. In the first half of the century, stimulus-response theories of human learning, developed by Watson and Thorndike, were dominant. These theorists limited their measurements to what was going into the brain (the stimulus) and what was coming out (the response). However, such a simplistic model of learning left many questions unanswered. In particular, this model could not explain what Piaget had observed, 'that children go through stages of development that have no relation to external stimuli.' (Kelly, 1997). Consequently, these theories were replaced by more complex theories of learning in the second half of the century. Cognitive and humanist theories were dominant during the sixties and seventies. Proponents of these theories acknowledged the importance of experience in the learning process, but they could not formulate an adequate theory as to its function in learning. The works of Kolb, Gregorc, Mezirow, and Freire all stressed that 'the heart of all learning lies in the way we process experience, in particular, our critical reflection on experience' (Kelly, 1997).

Today, a number of learning style models exists. These can be classified as: personality models, information processing (cognitive) models, social interaction models and instructional preference models (Teixeira, 2001).

Different layers of an onion can be used to illustrate the various learning styles. Personality models, which describe the fundamental characteristics of personality, are found at the core of the onion. Information processing models, which describe how learners tend to take in and process information, form the second layer of the onion. Social interaction models, which deals with how students tend to behave and interact in a classroom environment, forms the third layer. Learning environment and instructional preference models form the fourth and final layer (see Teixeira, 2001).

Regarding the stability of these various styles of learning Claxton and Murrell state that the traits at the core are the most stable and thus are least vulnerable to change in response to intervention by the researcher or instructor. As level proceeds outward, the characteristics are less stable and more likely to change (see Teixeira, 2001).

For the purpose of this study the information-processing model is appropriate since the researcher is interested in the cognitive aspects of students' learning style. That is, how students take in and process information.

2.2.3 Kolb's Model for Learning Style and Experiential Learning Theory

The model developed by Kolb is one of the various information-processing models. Kolb's learning style model is based on the works of Lewin, who emphasized that an student must be active in the learning process; Piaget, who believed that intelligence was more a result of one's interaction with the environment and not so much innate; and Dewey, who believed that learning is based on experience (Teixeira, 2001). His model was developed from a specific learning theory called 'experiential learning'.

The theory is called "Experiential Learning" to emphasize the key role that experience plays in the learning process, an emphasis that differentiates Experiential learning theory (ELT) from other learning theories. The theory defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience.

In ELT model, learning is conceived as a four-stage cycle. Kolb (1985) believes that people learn through experience, and as they learn they move through this four-stage cycle. The stages are:

1) Concrete Experience (CE) (Learning from feeling). This stage of the learning cycle emphasizes personal involvement with people in everyday situations. In this stage, individuals tend to rely more on their feelings rather than on a systematic approach to problems and situations. In a learning situation, people would rely on their ability to be open-minded and adaptable to change.

2) Reflective Observation (RO) (Learning by watching and listening). In this stage of the learning cycle, people understand ideas and situations from different points of view. In a learning situation individuals would rely on patience, objectivity, and careful judgment but would not necessarily take any action. People would rely on their own thoughts and feelings in forming opinions.

3) Abstract Conceptualization (AC) (Learning by thinking). In this stage, learning involves using logic and ideas, rather than feelings, to understand problems or situations. Typically, people would rely on systematic planning and develop theories and ideas to solve problems.

4) Active Experimentation (AE) (Learning by doing). In this stage learning takes an active form. Individuals would take a practical approach and be concerned with what really works, as opposed to simply watching a situation. People value getting things done and seeing the results of their influence and ingenuity.

Kolb states that there are two fundamental elements in the learning process: grasping the experience (taking in information) and transforming the experience (processing information). Kolb also clamims that experience is acquired by either concrete experience or abstract conceptualization and that this experience is transformed through reflective observation or active experimentation (Gusentine & Keim, 1996).

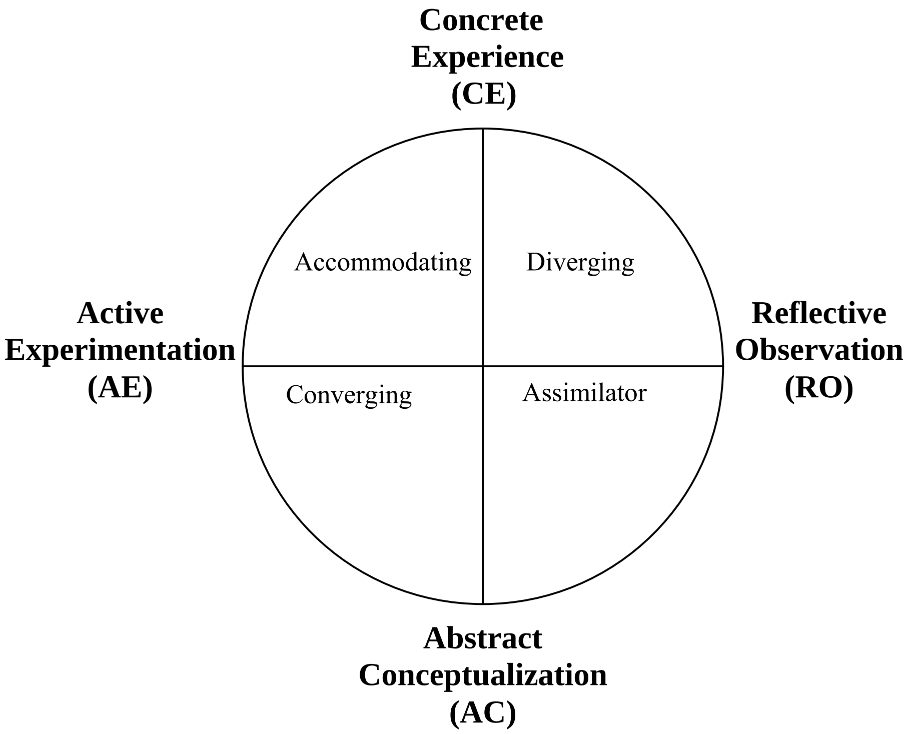

Figure 2.2 The Experiential Learning Cycle and Basic Learning Styles

According to Kolb, most individuals proceed through the stages in the following order: concrete experience, reflective observation, abstract conceptualization, and active experimentation. In other words, learners first have a concrete experience, and then observe and reflect on it from different perspectives. From these reflective observations, learners involve in abstract conceptualization, in which they form abstract concepts and generalizations that integrate their observations into sound theories. Finally, they utilize these theories to actively experiment, testing what they have learned in more complex situations. This results in another concrete experience and the cycle is repeated again. However, not every individual follows this sequence all the time. The needs and the aims of the individual determine the direction that learning takes.

In 1976, David Kolb developed the Learning Style Inventory (LSI) in order to measure the learning style preferences defined by his theory of experiential learning (Atkinson, 1991). In 1985, Kolb and his associates revised the LSI to improve its psychometric properties (Atkinson, 1991). With the revision, Kolb started a new phase of research in the attempt to measure learning styles effectively according to experiential learning theory.

While people tested on the LSI show many different patterns of scores, research on the instrument has identified four statistically prevailing learning styles: Diverger, Assimilator, Converger, and Accommodator. In his manual, Kolb (1985) describes individuals who fall into these four basic learning style categories. Brief descriptions of the four basic learning styles are presented below.

Diverger: The Diverging style's dominant learning abilities are concrete experience (CE) and reflective observation (RO). People with this learning style grasp the experience through concrete experience and transform the experience through reflective observation. Divergers are best at viewing concrete situations from many different points of view. It is labeled as "Diverging" because a person with it performs better in situations that call for generation of ideas, such as a brainstorming session. People with a Diverging learning style have broad cultural interests and like to gather information. Research shows that they are interested in people, tend to be imaginative and emotional, and tend to specialize in the arts. In formal learning situations, people with the Diverging style prefer to work in groups, listening with an open mind and receiving personalized feedback (Kolb, 1985).

Assimilator: The Assimilating style's dominant learning abilities are abstract conceptualization (AC) and reflective observation (RO). People with this learning style grasp the experience through abstract conceptualization and transform it through reflective observations. Assimilators are best at understanding a wide range of information and putting into concise, logical form. Individuals with an Assimilating style are less focused on people and more interested in ideas and abstract concepts. Generally, people with this style find it more important that a theory have logical soundness than practical value. The Assimilating learning style is important for effectiveness in information and science careers. Mathematics and science attracts individuals who are assimilators. In formal learning situations, people with this style prefer readings, lectures, exploring analytical models, and having time to think things through (Kolb, 1985).

Converger: The Converging style's dominant learning abilities are abstract conceptualization (AC) and active experimentation (AE). People with this learning style grasp experience through abstract conceptualization and transform it through active experimentation. The converger-type learners tend to have a good understanding of practical ideas and their application (Raschick & Maypole, 1998). They have the ability to solve problems and make decisions based on finding solutions to questions or problems. Individuals with a Converging learning style prefer to deal with technical tasks and problems rather than with social issues and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications (Kolb, 1985).

Accommodator: The Accommodating style's dominant learning abilities are concrete experience (CE) and active experimentation (AE). People with this learning style grasp the experience through concrete experience and transform it through active experimentation. Accommodators have the ability to learn from "hands on" experience and perform well in situations where they must adapt to new circumstances. They enjoy carrying out plans and involving themselves in new and challenging experiences. Individuals with an Accommodating learning style frequently use trial and error strategies and rely more heavily on people for information than on their own technical analysis when solving problems. This learning style is important for effectiveness in action-oriented careers such as marketing or sales. In formal learning situations, people with the Accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project (Kolb, 1985).

2.2.4 Learning Style and Achievement

Past research done on learning style preference and academic achievement appears to be relatively consistent and tends to support the theory that students show significant variations in how they prefer to learn in a classroom setting (Collinson, 2000). These variations are important and may have consequences for how successfully different learners perform on a variety of educational programmes (Van Zwanenberg, 2000).

It was hypothesized that lack of congruence between the preferred styles of learners and the nature of the subject matter and methods of teaching prevalent on their courses would be related to comparatively lower motivation and poorer performance and, at the end, possibly failure to complete the course (Felder & Silverman, 1988; Lumsdaine & Lumsdaine, 1993; Sternberg & Grigorenko, 1997). By contrast, it was expected that where there was a matching between preferred styles with subject matter and methods of teaching employed, the level of performance would be higher with consequently lower dropout rates (Felder et al., 1988). This follows from a 'matching' hypothesis between the preferences of learner, trainer or teacher and the nature of the material to be learned (Hayes & Allinson, 1993).

Studies have indicated that students achieve more when instructors teach according to the students' learning style. Throughout the United States, practitioners have reported statistically higher test scores and grade point averages for students whose teachers changed from traditional teaching to learning style teaching. This was observed at all levels-elementary, secondary, and college (Shaughnessy, 1998).

When researchers first perform experiments with learning-style prescriptions for teaching college students, significantly higher achievement resulted (Dunn & Stevenson, 1997).

Clark-Thayer (1987, as cited in Dunn & Stevenson, 1997) identified underachieving, college freshmen's learning styles by using the Productivity Environmental Preference Survey (PEPS). Trained instructors were assigned to teach freshmen to study with strategies that are complementary to their learning-style preferences. Students' achievement scores were found to be significantly higher (P >.01) when they studied with strategies congruent, rather than incongruent, with their learning-style preferences.

Nelson et al., (1993) obtained similar results when they identified individual freshmen's learning styles with the PEPS and provided directions for studying with complementary strategies The matched prescriptions had significant impact on student achievement (p >.01) and retention (p >.01) to the point where the college's annual dropout rate was reduced from 39 percent to 20 percent (Nelson, Dunn, Griggs, Primavear, Fitzpatric, & Miller).

In recent years, researchers and practitioners have shown great interest in David Kolb's model of learning styles based on his theory of experiential learning (Matthews, 1996). His model of learning is commonly used to identify students' preferred learning styles, and has a good empirical base (Healey & Jenkins, 2000). The Kolb LSI has been very popular and has been extensively used in academic research in various disciplines including higher education (Mark & Menson, 1982), organizational development (Dixon, 1982), medicine (Leonard & Harris, 1979), engineering (Stice, 1987), and agriculture (Pigg, Bush, & Lacy, 1980). A bibliography available on the website of Hay Resource Direct (2001) contains references on research using the Kolb LSI from 1971 to 2001 and the updated list has 1320 entries.

Given that most research is in an educational setting, it is surprising that very few research exists with the Kolb Learning Style inventory that investigates the relationship between academic achievement and learning style preference.

In her study that was aimed to investigate the relationship of perceived academic achievement and learning style preference in a large representative sample of high school students, Matthews (1996) noted that, learning style had a significant main effect on the perceived academic achievement of students. Kolb's learning style inventory was used to determine students' learning style. Students who selected the Converger style of learning rated themselves as higher achievers than students who selected the Diverger, Assimilator, or Accommodator styles. The results of this study verify the findings of other researchers who used various learning style instruments (Matthews, 1991; Miller, Alway & McKinley 1987; Witkin, Moore, Goodenough, & Cox, 1977) to examine the relationship between learning style and achievement. Even on self-ratings, a relationship is present between learning style and academic achievement.

Cano-Garcia and Hewitt Hughes (2000) investigated whether the students' academic achievement can be predicted by their learning styles. A learning style questionnaire, having the scales Concrete Experience, Abstract Conceptualization, Reflective Observation, and Active Experimentation, was administered to 220 college students. The results of the study indicated that students' academic achievement and learning styles were not independent; the students who obtained the best results preferred to learn in a certain way. More specifically, those students showing a style of learning directly related to experience (Concrete Experience), obtained higher academic achievement. The Concrete Experience scale significantly distinguishes between individuals with high or low academic achievement (the first scored higher than the second on Concrete Experience) consistent with a previous research (Cano & Justicia, 1994) which used the same Learning Style Questionnaire and revealed that students with better academic achievement scored higher in Concrete Experience, Abstract Conceptualization, and Reflective Observation than those with poorer academic achievement.

Lynch et al., (1998) conducted a study to determine if learning style correlates with objective multiple-choice type measures of performance of 227 third-year medical students. The Kolb's Learning Style Inventory was used in order to measure the students' preferences for different learning style types. The analysis of variance indicated a statistically significant ($p \leq 0.05$) relationship between learning style and performance. The results showed that convergers and assimilators perform better on the multiple-choice type measure of performance (Lynch, Woelfl, Steele, & Hanssen, 1998).

Although an extensive review of the literature has been carried out, scarcely any reported research study using the Kolb LSI has been found investigating the relationships between learning styles and science achievement. The only reference came from the study of Çakır, Berberoğlu, Alpsan, and Uysal (2002), in which they found that learning styles of tenth grade students in an Anatolian High School in Ankara did not have an observable effect on their biology performance.

2.3 Gender Differences in Science

It is well known that there are noticeable differences between academic performance of girls and boys in science and mathematics. According to National Assessment of Educational Progress (NAEP), data from 1976 to 1990 indicate that a male advantage in science achievement emerges and grows as learners progress through school: although gender differences are small or even nonexistent in 9-year-olds, by the age of 17, males significantly outperform females and this gender gap has known to be existed as early as 1969 (NAEP, 1991, as cited in Greenfield, 1995).

Jones and Wheatley (1989), have stated that gender differences in science achievement may be due to (a) innate differences in visual-spatial abilities, (b) differential socialization experiences at home and at school, (c) gender-role stereotypes, and (d) differences in boys' and girls' participation in science within and outside the school. Research has clearly showed that girls and boys do not seem to be receiving the same kinds of science-related experiences in schools even when they enroll in the same classes (Greenfield, 1996). For example, boys demand and receive more attention from their teachers, they are allowed to give answers more often than girls, they receive more process feedback than girls, and they are more likely to use science equipment and perform science activities than girls (Jones & Wheatley, 1989; Kahle & Lakes, 1983). Differences in science-related experiences extend outside the classroom environment. It has been found that girls are involved in much less out-of-school experience than boys with many of the kinds of skills and experiences that can later serve to enhance their interest and success in science, including exploration and assembly and even tinkering with science-related hobbies, exploration of toys, and so forth (Rennie, 1987, as cited in Greenfield, 1996).

Another possible reason of the observed gender difference may be the motivational disparities among students. Dweck (1986) suggested that girls are less likely than boys to develop a set of motivational traits that facilitate achievement in science and mathematics at higher grade levels. Dweck argued that girls are more likely than boys to exhibit a 'learned helpless' response pattern, because girls usually lack confidence in their abilities. As a result they show low persistence, attribute their failure to a lack of ability, and exhibit deterioration in performance when they face a difficulty or failure. Thus, motivational research suggests that girls may not have the confidence or motivational characteristics needed to enhance their learning in science and mathematics (Meece & Jones, 1996).

2.4 State of Science Education in Turkey

The number of science questions answered correctly in the university entrance examination every year was considered as an evidence of poor science education in Turkey. The mean values of correctly answered questions in physics, chemistry, and biology between years 1996-2002 were presented in Table 2.1. As indicated in Table 2.1, science achievement has been very poor for many years in Turkey. It seems that the image is getting even worse till 1999. Moreover, biology achievement appears to be the lowest when the mean values of questions answered correctly in physics, chemistry, and biology are compared.

Table 2.1 Mean Values of Correctly Answered Questions From Physics, Chemistry, and Biology in the University Entrance Examinations Between Years 1996-2001

Year	Physics	Chemistry	Biology
1996	2.72	2.14	**1.73**
1997	5.27	6.07	**3.36**
1998	7.12	4.10	**3.93**
1999	1.65	1.25	**0.65**
2000	1.58	1.70	**1.17**
2001	2.15	1.39	**0.61**

CHAPTER 3

METHOD

In the previous chapters, problems and hypotheses of the study were presented, related literature was reviewed accordingly and the significance of the study was justified. In the following chapter, population and sampling, description of the variables, instruments of the study, procedure, and methods used to analyze data and assumptions and limitations will be explained briefly.

3.1 Population and Sample

All tenth grade regular and Anatolian high school students attending Mathematics and Science group in Turkey were identified as the target population of this study. However, it is appropriate to define an accessible population since it is not easy to come into contact with this target population. The accessible population was determined as all tenth grade regular and Anatolian high school students attending Mathematics and Science group in Çankaya and Yenimahalle districts of Ankara. This is the population which the results of the study will be generalized.

The population being sampled in this study was 13078 students according to the Provincial Directorate of National Education in Ankara. This population is composed of all tenth grade students attending Mathematics-Science, Turkish-Mathematics, Turkish-Social Sciences, and Foreign Languages groups in high schools. Accordingly, the desired sample size was determined as 1300 students, which is approximately 10 % of the whole population. But since the population being sampled includes students attending all groups indicated above, a sample of 1000 students is thought to be enough to represent the accessible population.

Cluster random sampling integrated with convenience sampling was used to obtain representative sample. The two districts in Ankara from which the sample of the study was chosen, were selected by convenience sampling method. Schools which were thought as clusters were randomly selected from each of these districts.

Table 3.1 presents number of schools throughout the districts, number of selected schools throughout these districts and number of students from each of the districts. An average of 90-100 students per school corresponding to 2 or 3 classes were participated in the study.

Table 3.1 Numbers of Schools, Selected Schools, and Students Through the Districts

District	Number of Schools	Number of Selected Schools	Number of Students
Çankaya	23	7	621
Yenimahalle	17	4	359
Total	40	11	980

Figure 3.1 and Table 3.2 describe some characteristics of the sample. Figure 3.1 presented the distribution of the students' age and gender respectively. Students' ages range from 14 to 19, most with ages 16 (44,4%) and 17 (45,4%). The number of male students is approximately 10% higher than female students. The distribution of ages with respect to gender was given in Table 3.2.

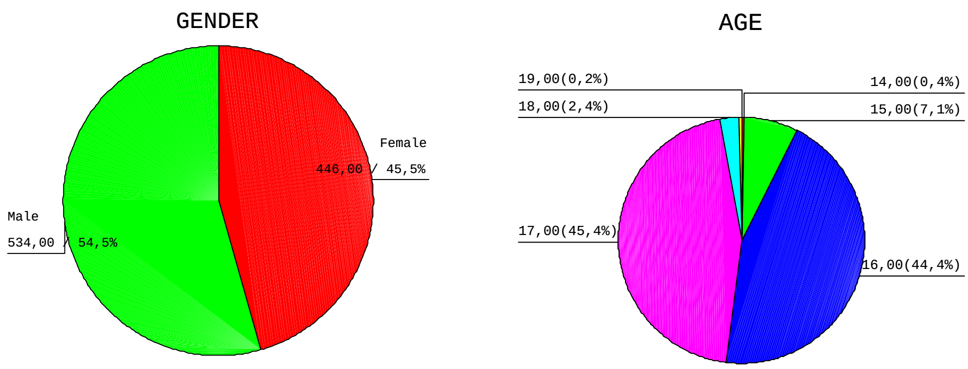

Figure 3.1 Distributions of Students' Gender and Age

Table 3.2 Distribution of Ages of Students with respect to Gender

Age	Females	Males	Total
14	1	3	4
15	30	40	70
16	198	237	435
17	212	233	445
18	5	19	24
19	0	2	2
Total	446	534	980

3.2 Variables

There are four variables involved in this study, which are categorized as dependent and independent variables. There is one dependent variable (DV) and three independent variables (IVs). Independent variables are divided into two groups as covariates and fixed factors. Table 3.3 presents all the characteristics of these variables.

Table 3.3 Identification of the Variables

Type of Variable	Name of Variable	Type of Value	Type of Scale
DV	BACH	Continuous	Interval
IV	MOTB	Continuous	Interval
IV	LS	Discrete	Nominal
IV	GENDER	Discrete	Nominal

3.2.1 Dependent Variable

The dependent variable of the study is students' biology achievement test mean scores as measured by the biology achievement test. It is a continuous variable and measured on interval scale. Students' possible minimum and maximum scores range from 0 to 20 for this variable.

3.2.2 Independent Variables

The independent variables included in the study are gender, motivational believes of students towards biology (MOTB), and learning styles of students (LS). MOTB is considered as covariate, gender and LS are considered as fixed factors in the analysis. MOTB is a continuous variable and measured on interval scale. Gender and PLS are considered as discrete variables and measured on nominal scale. Students' gender was coded as one for female and two for male. PLS was coded as one for Accommodator, two for Diverger, three for Converger, and four for Assimilator.

3.3 Data Collection Instruments

In this study three instruments were used in order to obtain data from students. These are the Turkish version of Motivated Strategies for Learning Questionnaire (MSLQ-TV), Learning Style Inventory (LSI), and Biology Achievement Test (BAT).

3.3.1 Motivated Strategies for Learning Questionnaire- Turkish Version (MSLQ-TV)

Motivated Strategies for Learning Questionnaire (MSLQ) was developed by Pintrich and De Groot (1990). It is a 44-item, self-report measure which includes five subscales. Three subscales (Self-Efficacy, Intrinsic Value, and Test Anxiety) in the questionnaire assess students' motivational belief and two subscales (Cognitive Strategy Use and Self-Regulation) measures students' self-regulated learning. On this questionnaire students are asked to respond each item by using a 7-point Likert scale (1=not at all true of me to 7=very true of me) in terms of their behavior in specific classes.

The items of the three subscales of the MSLQ (Self-Efficacy, Intrinsic Value, and Test Anxiety) were adapted into Turkish in order to assess students' motivational belief.

The Self-Efficacy subscale (α=.79) consisted of seven items regarding perceived competence and confidence in performance of class work (e.g., 'I expect to do very well in this class'). Students scoring high on this subscale were sure they could learn and understand the material being taught in the class and perform well in the class. The Intrinsic Value subscale (α=.82) consisted of eleven items concerning intrinsic interest in (e.g., 'I think that what we are learning in this class is interesting') and perceived importance of class work (e.g., 'It is important for me to learn what is being taught in this class') as well as preference and for challenge and mastery goals (e.g., 'I prefer class work that is challenging so I can learn new things'). Students scoring high on this scale viewed the material within a particular subject as personally useful, interesting, and important. Test Anxiety subscale (α=.74) consisted of four items (e.g., 'I worry a great deal about tests') concerning worry and cognitive interference on tests. Higher scores on this scale reflected greater anxiety associated with tests and classroom performance.

The questionnaire (MSLQ-TV) used in this study (see Appendix A) is different from original one (MSLQ) in three ways. The first difference is that, only three of the five subscales in the MSLQ were adapted and used in this study. Second, the items in the MSLQ are field independent and not specific to any class. For the purpose of this study however, all the items were adapted in such a way that they all reflect student behavior in the Biology class. The items were adapted in this fashion so that students were all aware of the fact that the MBQ measures their behavior in the Biology class, but not in any other class or not their behavior in general. The last difference was the type of the Likert scale used. The original questionnaire (MSLQ) is a 7-point Likert type, but the adapted form (MSLQ-TV) required students' responses to the items in a 5-point Likert scale.

3.3.2 Learning Style Inventory (LSI)

All research participants were administered the Turkish version of the revised Learning Style Inventory (Kolb, 1985) that was translated and standardized by Aşkar and Akkoyunlu (1993) (see Appendix B).

The Learning Style Inventory (Kolb, 1985) is a 12- item self-reporting instrument in which individuals attempt to describe their learning styles. The 12 items consist of short statements concerning learning situations and each of the items asks respondents to rank four sentence endings that correspond to the four learning modes- Concrete Experience (whose characteristic word is feeling), Reflective Observation (watching), Abstract Conceptualization (thinking), and Active Experimentation (doing).

The inventory measures the respondent's relative emphasis on the four modes of learning- Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). The raw scores for each of the four learning modes ranges from 12 to 48. Higher scores indicate greater emphasis on a particular learning mode. The inventory also measures an individual's relative emphasis across two dimensions, CE versus AC and AE versus RO. These two dimensions bisect on a learning style grid to form four quadrants reflecting four learning styles: accommodator, diverger, assimilator, and converger (Figure 3.2). In order to find the dominant learning style of an individual, the scores from four learning modes are combined and subtracted. The combination score (AC-CE) reflects the extent to which the respondent emphasizes abstractness over concreteness. The score (AE-RO) indicates the extent to which the respondent emphasizes action over reflection. The score of AC-CE and AE-RO are then plotted on the learning style grid to determine the learner's dominant learning style is accommodating, diverging, converging or assimilating.

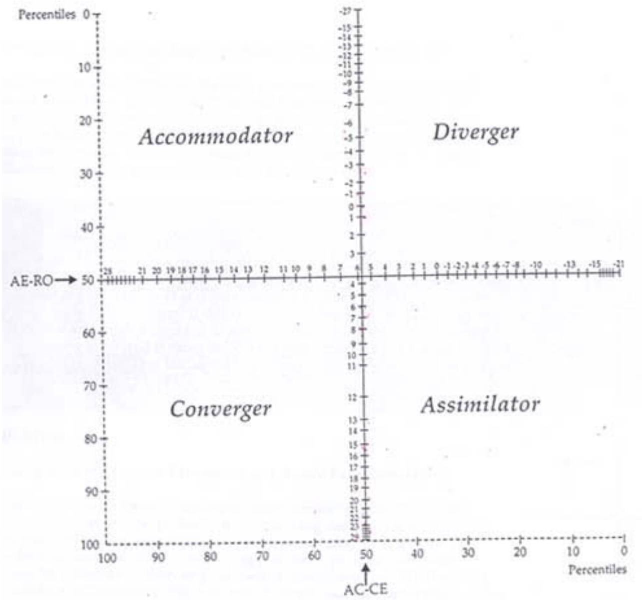

Figure 3.2 Learning Style Grid

3.3.3 Biology Achievement Test (BAT)

The biology achievement of students was assessed by using the Biology Achievement Test (BAT) (see Appendix C). The test was prepared by making use of the biology questions taken from the University Entrance Examinations between years 1981-2001 and consisted of 20 multiple-choice items. It covers the biology content taught in ninth grade curriculum which is the same in all schools due to the settings of Ministry of Education.

The following procedure was followed while developing the achievement test:

1. The content of the ninth grade biology curriculum was examined.
2. Six main units taught in ninth grade biology course and their proposed class hours were listed.
3. Different preparatory books for the University Entrance Examination and the web site of OSYM were searched for the questions which were asked in the University Entrance Examinations related with the ninth grade biology curriculum.
4. All related questions were collected and a multiple-choice question pool was formed.
5. Among six units, four of them were decided to be included in the test content since they account for the top highest-class hours in the ninth grade curriculum. The other reason of choosing four among six units is that, there were no questions asked about those two chapters ('Biology as a Science' and 'Science of 2000s: Biology') in the University Entrance Examinations.
6. Questions to be included in the test were selected from the question pool in coordination with the advisor and an instructor.
7. The number of questions representing each unit was decided according to the weight of the chapter in the ninth grade biology curriculum. The

higher the class hours of the chapter in the curriculum, the higher the number of items representing that chapter in the test.

8. Neither the body of the selected questions nor the distracters were modified during the preparation of the Biology Achievement Test.

Table 3.4 Names of the units, their proposed class hours in the ninth grade Biology curriculum, and the number of questions representing those units in the BAT.

Name of the Chapter	Proposed Class Hour	Number of Questions in BAT
Biology as a Science	8	-
Science of 2000s: Biology	4	-
Basic Compounds of Living Things	14	4
Cell Structure and Function	20	7
Diversity and Classification	10	3
Ecology	16	6

3.3.4 Validity and Reliability of the Measuring Tools

To establish face and content validity, MSLQ-TV was translated and adapted by one instructor from the Department of Modern Languages and one instructor from the Department of Foreign Languages. Regarding the same validity concerns, the adapted MSLQ-TV was then checked by three instructors from the Faculty of Education at METU according to content and format of the instrument. Their suggestions were taken into consideration;

the necessary changing was done accordingly and the final revision of the questionnaire was prepared.

During the pilot study, MSLQ-TV, containing three subscales and 22 items, was administered to 238 tenth grade students from two schools. The data were collected and a factor analysis together with a reliability analysis was performed. Factor analysis based on data from 238 students revealed that the items of the adapted questionnaire were fit to three distinct motivational factors (self-efficacy, intrinsic value, and test anxiety) when factor number is limited. Internal reliability coefficient of the questionnaire was obtained as .88 by using Cronbach alpha coefficient. The reliability coefficients of the self-efficacy, intrinsic value, and test anxiety subscales are .79, .82, and .74 respectively. All items of the questionnaire have discriminating powers more than .20 which means that all items were discriminating high and low motivational believes successfully.

Reliability analysis was also performed for the BAT and internal reliability of the test was calculated as .70. As a result, the validity and reliability estimates for MSLQ-TV and BAT imply that the scores obtained on these tests can be considered as valid and reliable.

3.4 Procedure

The study started with defining the research problem specifically and formulating the search terms pertinent to the problem of interest. Next, the related literature was reviewed in detail. Previous studies done abroad were searched systematically from Educational Resources Information Center (ERIC), International Dissertation Abstracts, Ebscohost, Social Science Citation Index (SSCI), and Science Direct. MS and PhD thesis made in Turkey were also searched from YOK, Eğitim ve Bilim Dergisi, and Hacettepe Eğitim Dergisi. Photocopies of available documents were obtained from METU library, library of Bilkent University and TUBITAK Ulakbim. Moreover, some of the documents that could not be reached were requested from abroad. All of the relevant documents were organized and read carefully by the researcher.

After a detailed review of literature, the measuring instruments were prepared. Following the selection of the schools which will be involved in the study, necessary permission was taken from the Ministry of Education for the administration of the measuring instruments.

In November 2002, MSLQ-TV was pilot tested with a sample of 238 tenth grade students from two representative schools. The results of the pilot study were analyzed and evaluated by the researcher.

The researcher administered all of the measuring instruments (MSLQ-TV, LSI, and BAT) to the selected 980 tenth grade students from 11 schools during the last four weeks of the fall 2002-2003 semester. One class hour was given to the participants to complete all instruments. Directions were made clear and necessary explanations were done by the researcher. Students were also assured that any data collected from them would be held in confidence and that the grades of the BAT would not effect their biology grades. They were warned to complete each measuring tool without leaving any empty item as well.

Due to the time restriction and impossibility of being present in each class during administration, the researcher occasionally requested teacher support. The teachers were informed about the study and about the directions that should be done prior to the administration. No specific problems were encountered during the administration of the measuring instruments.

3.5 Analysis of Data

The data obtained in the study were analyzed by using both descriptive statistics and inferential statistics.

3.5.1 Descriptive Statistics

The mean, median, mode, standard deviation, skewness, kurtosis and histograms of the variables were presented.

3.5.2 Inferential Statistics

In order to test the null hypotheses, statistical technique named Analysis of Covariance (ANCOVA) and Bivariate Correlations were used.

3.6 Power Analysis

An essential and primary decision in the power analysis is the determination of the effect size. The ratio of explained variance to unexplained variance should be preset before the study. At the beginning of the study, effect size was set to low (f^2= 0.08 for variance and 0.3 for mean differences). The significance level was set to .05 since it is the mostly used value in educational statistics. Therefore, the probability of rejecting the true null hypothesis (probability of making Type-1 error) was set to .05. The power was calculated for the sample (N=980) and four variables involved in the study. Power was found as close to 1. Therefore, the probability of failing to reject a false null hypothesis (probability of making Type-2 error) was calculated as approximately 0.

3.7 Assumptions and Limitations of the Study

As in any research study, several considerations may affect the overall findings, or effective usefulness of the results. The following assumptions and limitations should serve to enrich the conclusions of this study by identifying both positive and negative aspects of the basic study's design.

3.7.1 Assumptions of the Study

The researcher made the following assumptions for this study:

1. Multiple survey method was best for obtaining a large amount of information quickly and easily. Thus, all information-gathering instruments were administered at the same time.
2. The administration of the instruments was under standard conditions.
3. The students of the pilot study were assumed to have approximately the same characteristics as the actual subjects of the study.
4. Reducing the fear of personal exposure would be important in obtaining the most reliable self-report measures possible. Thus, a numeral coding system was used rather than names to ensure anonymity.
5. Multiple visits to the schools would be a problem, and that all data should be obtained in a single session. Thus, optimum cooperation of subjects and school personnel was ensured prior to test administration.
6. All cooperated instructors were pleased, as they were able to support educational research. Therefore, instructors were expected to be sincerely involved in the study.
7. All students involved in the study responded sincerely and correctly to the items of the BAT, LSI, and MBQ.

3.7.2 Limitations of the Study

The study was subjected to the following limitations:

1. The timing of the conduct of measuring instruments was less than optimal since all data should be obtained in a single class hour.
2. Learner characteristics (e.g., demographic variables, family characteristics, health related factors, financial insecurity etc.) were not considered beyond the determination of the learner's learning style, motivation and biology achievement.
3. The entry behaviors of the respondents such as depression, anxiety, attention-defect, or hyperactivity were not examined. While these behaviors can play a major role on the learner's achievement, the determination of these behaviors is beyond the scope of this study, and would be worthy of a future study.
4. The teaching styles of the instructors were not measured during the study. While it is recognized that the teaching style employed by the instructor has a significant impact on the learning outcome, there was no opportunity to modify or experiment with different teaching styles. Therefore, teaching style was not evaluated during the study.

CHAPTER 4

RESULTS

This chapter is divided into four different sections. First section deals with the descriptive statistics. The second section summarizes the results of the factor analysis of the items of the Turkish version of Motivated Strategies for Learning Questionnaire (MSLQ-TV). The third section presents inferential statistics in which the null hypotheses are tested. Finally, the last section summarizes the findings of the study.

4.1 Descriptive Statistics

4.1.1 Descriptive Statistics of the Biology Achievement Test

Descriptive statistics related to students' scores on the Biology Achievement Test (BAT) were categorized according to students' gender and presented in Table 4.1. Scores could range from 0 to 20 in which higher scores mean greater biology achievement. As Table 4.1 indicated, both male and female students had approximately close mean values but scores favor female students more than males' students. Female students had a mean of 10.10 from achievement scores while male students had a mean of 9.55, which means that female students' biology achievement is slightly higher than male students'. Table 4.1 also presents some other basic descriptive statistics of the sample like, standard deviation, skewness and kurtosis. The values for skewness were 0.126 and -0.020 for female and male students respectively, both of which could be accepted as approximately normal.

Table 4.1 Basic Descriptive Statistics Related to the Biology Achievement Test Scores

	Female	Male	Total
N	446	534	980
Mean	10.10	9.55	9.81
S.D	3.37	3.76	3.62
Skewness	0.126	-0.020	0.039
Kurtosis	-0.541	-0.846	-0.610
Range	17	18	21
Minimum	1	1	1
Maximum	18	19	19

4.1.2 Descriptive Statistics of the Self-Efficacy Component of MSLQ-TV

Descriptive statistics of self-efficacy scores measured by MSLQ-TV were also categorized according to students' gender and presented in Table 4.2. Students' self-efficacy scores could range from 7 to 35 in which higher scores mean that students are sure they can learn and understand the material being taught in the biology class and perform well. As Table 4.2 indicated, the mean score of male students is slightly higher than that of female students. While the male students had a mean of 24.39, female students had a mean value of 23.31. Table 4.2 also presents some other basic descriptive statistics about the self-efficacy subscale of the MSLQ-TV.

Table 4.2 Basic Descriptive Statistics Related to the Self-Efficacy Scores

Gender	Female	Male	Total
N	446	534	980
Mean	23.31	24.39	24.81
S.D	4.34	4.58	4.49
Skewness	-0.247	-0.365	-0.347
Kurtosis	0.099	0.494	0.353
Range	23	27	27
Minimum	12	8	8
Maximum	35	35	35

4.1.3 Descriptive Statistics of the Intrinsic Value Component of MSLQ-TV

Table 4.3 presents descriptive statistics of intrinsic value scores that was measured by MSLQ-TV and categorized according to students' gender. Students' intrinsic value scores could range from 11 to 55 in which higher scores mean that students view biology as personally useful, interesting, and important. According to the Table 4.3, female students mean score (44.06) is higher than the mean score of male students (40.31). Table 4.3 also presents some other basic descriptive statistics about the intrinsic value subscale of the MSLQ-TV.

Table 4.3 Basic Descriptive Statistics Related to the Intrinsic Value Scores

Gender	Female	Male	Total
N	446	534	980
Mean	44.06	40.31	42.02
S.D	5.59	6.95	6.64
Skewness	-0.750	-0.660	-0.774
Kurtosis	0.741	0.222	0.564
Range	33	38	38
Minimum	22	17	17
Maximum	55	55	55

4.1.4 Descriptive Statistics of the Test Anxiety Component of MSLQ-TV

Table 4.4 presents descriptive statistics of test anxiety scores that was measured by MSLQ-TV and categorized according to students' gender. Students' test anxiety scores could range from 4 to 20 in which higher scores reflects greater anxiety associated with biology tests and classroom performance. As shown in Table 4.4, female mean score is slightly higher than male mean score. While female students had a mean of 13.01, male students had a mean of 12.93. Table 4.4 also presents some other basic descriptive statistics about the test anxiety subscale of the MSLQ-TV.

Table 4.4 Basic Descriptive Statistics Related to the Test Anxiety Scores

Gender	Female	Male	Total
N	446	534	980
Mean	13.01	12.93	12.97
S.D	3.77	3.60	3.68
Skewness	-0.393	-0.156	-0.270
Kurtosis	-0.504	-0.463	-0.488
Range	16	17	17
Minimum	4	3	3
Maximum	20	20	20

Figure 4.1, Figure 4.2, Figure 4.3, and Figure 4.4 show the histograms with normal curves related to the biology achievement test scores (BACH), self-efficacy scores (SES), intrinsic value scores (IVS), and test anxiety scores (TAS). These are also an evidence for the normal distribution of those variables.

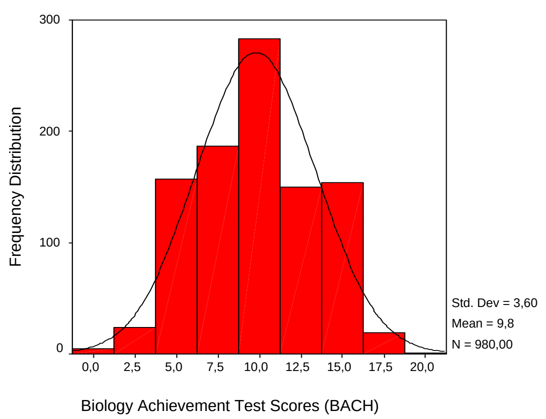

Figure 4.1 Histogram with normal curve related to BACH

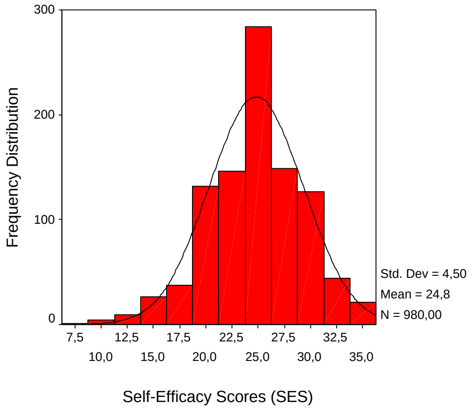

Figure 4.2 Histogram with normal curve related to SES

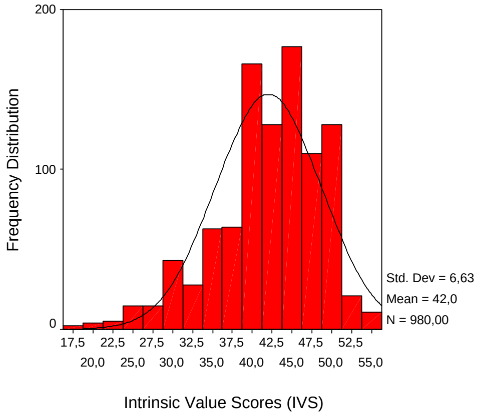

Figure 4.3 Histogram with normal curve related to IVS

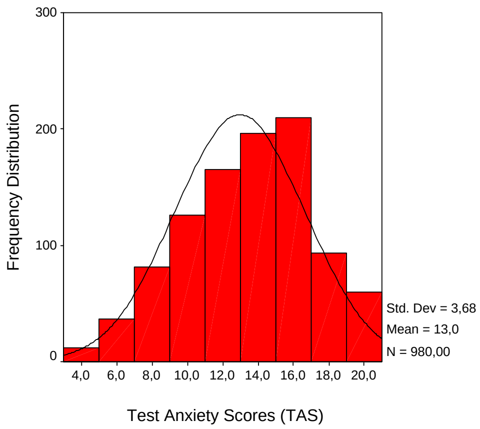

Figure 4.4 Histogram with normal curve related to TAS

4.1.5 Descriptive Statistics of the Learning Style Inventory

Descriptive statistics related to the types of learning style were categorized according to gender and presented in Table 4.5. As shown in the table, most of the female students (N=224) and male students (N=268) were assimilators. The next common learning style type was converger. The numbers of students having converger learning style type were 118 and 139 for female and male students respectively. The distributions of the accommodators, divergers, convergers, and assimilators according to gender were presented in Table 4.5.

Table 4.5 Distributions of Learning Style Types With Respect to Gender

LS	Female	Male	Total
Accommodator	42	41	83
Diverger	62	86	148
Converger	118	139	257
Assimilator	224	268	492
Total	446	534	980

The frequencies and the percentages of the accommodators, divergers, convergers, and assimilators were presented in Figure 4.5 and Figure 4.6 respectively. Assimilators had the highest frequency (492) and highest percentage (50.2%) when compared to the other learning style types. Convergers were the next common category with a frequency of 257 and a percentage of 26.2. The lowest frequency (83) and the lowest percentage (8.5%) were belong to the accommodators in the whole sample.

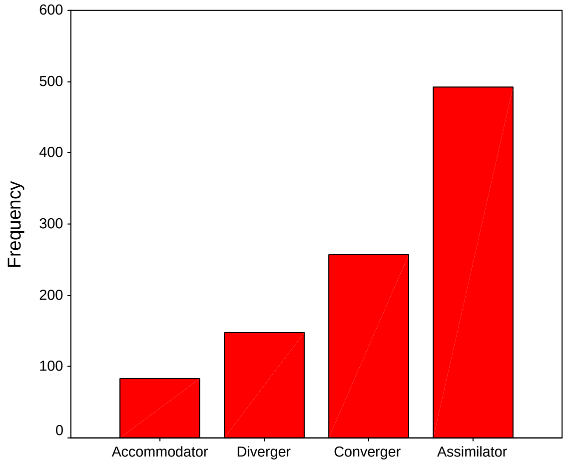

Figure 4.5 Frequencies of the four learning style types

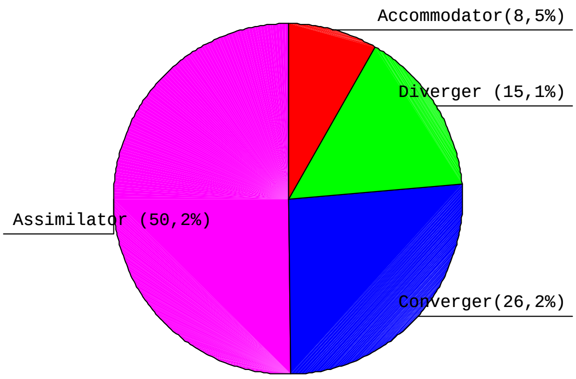

Figure 4.6 Percentages of the four learning style types

In Table 4.6, the biology achievement test mean scores of students with different learning style types were presented. According to the findings of the study, students with assimilating learning style had the highest mean value (M= 10.10), which may be interpreted as assimilators' biology achievement test mean scores were higher than others.

Table 4.6 Biology Achievement Test Mean Scores of Students Having Different LS

LS	Mean Scores
Accommodator	9.59
Diverger	8.90
Converger	9.85
Assimilator	10.10

4.2 Factor Analysis

Factor analysis in this study was conducted in two stages: factor extraction and factor rotation. Principal components analyses with Varimax rotation were run separately on the items of the MSLQ-TV.

4.2.1 Factor Extraction

In order to decide the number of extracted factors, eigenvalues based on the principal components solution were obtained. The results showing the initial factor extraction statistics and the scree plot from the principal components analysis were shown in Table 4.7 and Figure 4.7 respectively.

One criterion to decide the number of components is to retain all factors that have eigenvalues greater than one. As indicated in Table 4.7, only five of the components have eigenvalues greater than one. Another criterion is to examine the plot of eigenvalues (scree plot) and to retain all factors with eigenvalues in the sharp descent part of the plot before the eigenvalues start to level off. Based on the Figure 4.7, three of the factors were decided to be rotated.

Table 4.7 Total Variance Explained (Initial Factor Extraction)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.500	29.545	29.545	6.500	29.545	29.545
2	2.065	9.384	38.929	2.065	9.384	38.929
3	1.659	7.542	46.471	1.659	7.542	46.471
4	1.235	5.613	52.085	1.235	5.613	52.085
5	1.084	4.929	57.013	1.084	4.929	57.013
6	.951	4.323	61.336			
7	.864	3.925	65.261			
8	.804	3.653	68.914			
9	.762	3.466	72.380			
10	.708	3.218	75.598			
11	.665	3.025	78.623			
12	.623	2.831	81.454			
13	.593	2.694	84.148			
14	.544	2.471	86.619			
15	.498	2.262	88.882			
16	.437	1.987	90.868			
17	.394	1.790	92.658			
18	.366	1.663	94.321			
19	.332	1.510	95.831			
20	.325	1.478	97.309			
21	.304	1.384	98.693			
22	.288	1.307	100.000			

Extraction Method: Principal Component Analysis

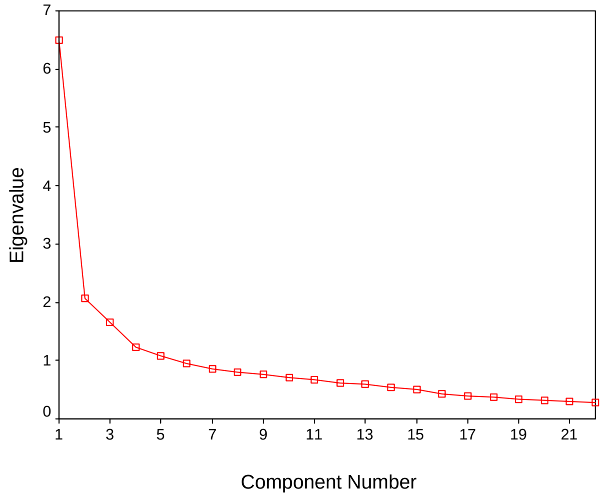

Figure 4.7 Scree plot of the eigenvalues

4.2.2 Factor Rotation

The results showing the second factor extraction with three factors and the rotated component matrix were given in Table 4.8 and Table 4.9 respectively. As reported in Table 4.8, the first, the second and the third factors accounted for 20.20%, 14.21%, and 12.06% variance of the 22 variables. In total, the three factors accounted for 46.47% of the variable variance.

Table 4.8 Total Variance Explained (Rotated Factors)

Component	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.500	29.545	29.545	4.444	20.202	20.202
2	2.065	9.384	38.929	3.126	14.208	34.410
3	1.659	7.542	46.471	2.653	12.061	46.471

Table 4.9 Rotated Component Matrix[a]

	Component		
	Intrinsic Value	Self-Efficacy	Test Anxiety
ITEM15	**,795**	,119	
ITEM21	**,758**		,158
ITEM4	**,747**		
ITEM5	**,735**	,161	,207
ITEM17	**,559**	,179	,111
ITEM11	**,536***	,337	
ITEM14	**,474**		,173
ITEM7	**,453**		
ITEM6	**,452***	,339	,361
ITEM19	**,437***	,429	,195
ITEM1	**,434**	,200	
ITEM10	**,370**	,171	
ITEM16		**,779**	
ITEM9	,119	**,737**	,129
ITEM2	,189	**,655**	
ITEM18	,120	**,596**	,142
ITEM8	,365	**,542**	,348
ITEM13	,242	**,517**	,413
ITEM20	,171	,149	**,793**
ITEM22			**,711**
ITEM3			**,706**
ITEM12	,315	,156	**,630**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a.Rotation converged in 5 iterations.

Items of the three components in the MSLQ-TV were presented in Table 4.9. According to the rotated component matrix presented above, all items except items 6, 11, and 19 were fit into their components correctly. Although item number 6, 11 and 19 were included in the intrinsic value component, they belong to the self-efficacy component of the MSLQ-TV. Since the factor loading of the 11 th item was in the acceptable loading range of the self-efficacy component, this item was considered in the self-efficacy instead of intrinsic value. However, no such consideration was possible for the remaining two items. Therefore, they were decided to be included in the intrinsic value component of the questionnaire. The number of items in intrinsic value, self-efficacy, and test anxiety components were obtained as 11, 7, and 4 respectively at the end of principal component analysis.

4.3 Inferential Statistics

This section deals with the determination of the covariate, the clarifications of the analysis of covariance (ANCOVA) assumptions, and the analysis of the hypotheses

4.3.1 Determination of the Covariate

Three independent variables (age, gender and students' motivational belief) were pre-determined as potential confounding factors of the study. To statistically equalize the differences among female and male students, these variables were set as covariates. All pre-determined independent variables were correlated with the dependent variable of the study. Table 4.10 presents the results of these correlations and their level of significance. As seen in the table, the three components of the motivational belief (self-efficacy, intrinsic value and test anxiety) had significant correlation with the dependent variable. However, gender and age did not have significant correlations with the dependent variable.

Table 4.10 Significance Test of Correlation Between Dependent Variables and Covariates

Variables	Correlation Coefficients (r)
Gender vs. BACH	-.077
Age vs. BACH	.059
Self-Efficacy vs. BACH	.179*
Intrinsic Value vs. BACH	.143*
Test Anxiety vs. BACH	.166*

*Correlation is significant at.01 level (2-tailed)

Since self-efficacy, intrinsic value and test anxiety were all components of the same independent variable (motivational belief); therefore correlations among those components should be significant. As it is shown in Table 4.11, there were significant correlations among the three components of the motivational belief. Hence, motivational belief with its three components (self-efficacy, intrinsic value and test anxiety) was determined as the covariate for the following inferential analyses.

Table 4.11 Significance Test of Correlation Among the Components of Motivational Belief

Components	Self-Efficacy	Intrinsic Value	Test Anxiety
Self-Efficacy		.464*	.406*
Intrinsic Value	.464*		.195*
Test Anxiety	.406*	.195*	

*Correlation is significant at the .01 level (2-tailed)

4.3.2 Assumptions of Analysis of Covariance

ANCOVA has four assumptions: Normality, equality of variances, homogeneity-of-slopes, and independency of scores on the dependent variable.

For normality assumption, skewness and kurtosis values given in descriptive statistics section were used. The skewness and kurtosis of scores on biology achievement test were in acceptable range for a normal distribution.

Levene's Test of Equality was used to determine the equality of variance assumption. As Table 4.12 indicates, the error variance of the dependent variable is equal across groups.

Table 4.12 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
BACH	1.581	7	972	.137

The third assumption that was checked before conducting the ANCOVA was homogeneity-of-slopes. The test evaluated the interaction between the covariate and the factors in the prediction of the dependent variable. As shown in table 4.13, there were no significant interactions between the covariate and the factors which means that the homogeneity-of-slopes assumption is validated.

Table 4.13 Results of the test of homogeneity of slopes

	df	F	Sig.
Gender*Self-Efficacy	1	1.217	.270
Gender*Intrinsic Value	1	.000	.996
Gender*Test Anxiety	1	.728	.394
Learning Style*Self-Efficacy	3	.917	.432
Learning Style* Intrinsic Value	3	.830	.478
Learning Style* Test Anxiety	3	.555	.645

As a last assumption, independency of scores was examined. This assumption was met with the observations of classes by the researcher during administration. It was observed that all participants did their tests by themselves. However, the researcher could not observe whole classes participating in the study. Teachers were requested to observe each class in order to validate this assumption.

4.3.3 Analysis of Covariance Model

The dependent variable of the study is BACH. The scores taken from the three components of the MSLQ-TV (self-efficacy, intrinsic value, test anxiety) are the covariates of the study. Students' learning styles and gender are the independent variables in the ANCOVA model. Table 4.14 indicates the results of the ANCOVA.

Table 4.14 Tests of Between-Subjects Effects

Source	DV	Type III Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared	Observed Power
Corrected Model	BACH	777.3	10	77.7	6.2	.000	.06	1.0
Intercept	BACH	608.5	1	608.5	48.9	.000	.05	1.0
SES	BACH	103.8	1	103.8	8.3	.004	.01	.82
IVS	BACH	9.9	1	9.9	.79	.374	.00	.14
TAS	BACH	128.7	1	128.7	10.3	.001	.01	.90
Gender	BACH	56.2	1	56.2	4.5	.034	.00	.57
LS	BACH	113.0	3	37.7	3.0	.029	.01	.71
Gender*LS	BACH	46.8	3	15.6	1.3	.289	.00	.33
Error	BACH	12054.9	969	12.4				
Total	BACH	107226.0	980					
Corrected Total	BACH	12832.2	979					

4.3.4 Null Hypothesis 1

There will be no significant difference between the biology achievement test scores of tenth grade students with different learning styles when the effect of student motivational belief (Self-efficacy, intrinsic value and test anxiety) is controlled.

ANCOVA was conducted to determine the effect of learning style on the BACH by controlling the effect of student motivational belief. This null hypothesis was rejected and ANCOVA was significant ($F (3,969) = 3.0$, $p = .029$). In other words, learning style had a significant effect on the BACH when the effect of student motivational belief is controlled.

In order to conduct the pairwise comparisons among the four types (accommodator, diverger, converger, and assimilator) of learning style, Tukey's Honestly Significant Difference (HSD) Test was performed following ANCOVA. As Table 4.15 indicates, there is a significant mean difference between divergers and assimilators which means that the observed mean difference in the BACH is due to the mean difference between divergers and assimilators. The results of the Tukey's HSD Post Hoc Test are given in Table 4.15.

Table 4.15 Multiple Comparisons

(I) LS	(J) LS	Mean Difference (I-J)	Std. Error	Sig.
Accomodator	Diverger	.685	.49	.508
	Converger	-.266	.45	.937
	Assimilator	-.513	.43	.626
Diverger	Accommodator	-.685	.49	.508
	Converger	-.951	.37	.052
	Assimilator	-1.198*	.34	.002
Converger	Accommodator	.266	.45	.937
	Diverger	.951	.37	.052
	Assimilator	-.248	.28	.808
Assimilator	Accommodator	.513	.43	.626
	Diverger	1.198*	.34	.002
	Converger	.248	.28	.808

*The mean difference is significant at the 0.05 level

4.3.5 Null Hypothesis 2

There will be no significant difference between the biology achievement test scores of tenth grade female and male students when the effect of student motivational belief (self-efficacy, intrinsic value and test anxiety) is controlled.

As seen in Table 4.14, the second null hypothesis was rejected ($F(1, 969) = 4.5$, $p = .034$). In other words, gender had a significant effect on the BACH when the effect of student motivational belief is controlled.

4.3.6 Null Hypothesis 3

There will be no significant difference between the biology achievement test scores of tenth grade female and male students with different learning styles when the effect of student motivational belief (self-efficacy, intrinsic value and test anxiety) is controlled.

As seen in Table 4.14, the third null hypothesis was not rejected ($F(3,969) = 1.3$, $p = .289$) which means that gender and learning style together do not have a significant effect on the BACH. This statistic therefore did not provide support for this research hypothesis.

4.3.7 Null Hypothesis 4

There will be no significant contribution of students' self-efficacy beliefs to their biology achievement test scores.

As indicated in Table 4.10, the fourth null hypothesis was rejected ($r= .179$) which means that there was a low positive correlation between students' self-efficacy beliefs and their biology achievement test scores.

4.3.8 Null Hypothesis 5

There will be no significant contribution of students' intrinsic value beliefs to their biology achievement test scores.

As indicated in Table 4.10, the fifth null hypothesis was rejected ($r=.143$) which means that there was a low positive correlation between students' intrinsic value beliefs and their biology achievement test scores.

4.3.9 Null Hypothesis 6

There will be no significant contribution of students' test anxiety beliefs to their biology achievement test scores.

As indicated in Table 4.10, the sixth null hypothesis was rejected (r=.166) which means that there was a low positive correlation between students' test anxiety beliefs and their biology achievement test scores.

4.4 Summary of Results

The results of this study can be summarized as follows:

- It can be easily understood from the mean achievement scores that biology achievement was very low for the subjects of this study.
- Females' biology achievement test mean scores were slightly higher than that of males.
- Males' self-efficacy mean scores were slightly higher than that of females.
- Females' intrinsic value mean scores were higher than that of males.
- Females' test anxiety mean scores were slightly higher than that of males.
- The most common learning style type was assimilating for the subjects of this study. Convergers were the second highest learning style type observed in this study.

- Diverging and accommodating learning style types were rare among the subjects of the study.
- The biology achievement test mean scores of the assimilators were higher than that of convergers, divergers, and accommodators.
- Students' learning styles had a significant effect on biology achievement test scores when the effect of student motivational belief was controlled.
- Students' gender had a significant effect on biology achievement test scores when the effect of student motivational belief was controlled.
- Gender and learning style together did not have a significant effect on biology achievement test scores when the effect of student motivational belief was controlled.
- There was a significant low positive correlation between students' self-efficacy beliefs and their biology achievement test scores.
- There was a significant low positive correlation between students' intrinsic value beliefs and their biology achievement test scores.
- There was a significant low positive correlation between students' test anxiety beliefs and their biology achievement test scores.

CHAPTER 5

CONCLUSIONS, DISCUSSIONS AND IMPLICATIONS

This chapter presents the summary of the research study, conclusions and discussion of the results, internal and external validity of the study, and finally announces the implications of the study and recommendations for further studies.

5.1 Summary of the Research Study

In order to investigate the specified purposes of this study, 980 tenth grade students chosen from an accessible population were administered the Turkish version Motivated Strategies for Learning Questionnaire (MSLQ-TV), Learning Style Inventory (LSI), and Biology Achievement Test (BAT) during the last four weeks of the fall 2002-2003 semester. To obtain the representative sample, clustered random sampling integrated with convenience random sampling was used. Correlational and causal comparative research were the two research methodologies utilized during the course of this study.

5.2 Conclusions

The results of the current study revealed that student's learning style had a significant effect on their biology achievement. Students having the assimilating learning style type were found to be were more successful than divergers, accomodators, and convergers in terms of their scores on the Biology Achievement Test. As expected, the most common types of learning style among the students of this study were assimilating and converging, the former being the highest.

Although most of the previous studies pointed out the fact that male students' science achievement were higher than females', results of this study indicated that females slightly outperform males in the Biology Achievement Test. However, learning style and gender together did not have an effect on students' biology achievement.

The results also underlined the relationship of the three motivational belief components with students' biology achievement. It was observed that there was a low positive correlation between students' self-efficacy believes, test anxiety believes, intrinsic value believes and their biology achievement. The highest correlate to biology achievement for this population was found to be students' self-efficacy believes.

5.3 Discussion of the Results

The identification of some of the variables affecting biology achievement and their relationships with achievement has been the major concern of this discussion. Contributions of specific affective determinants to biology achievement have been emphasized; the effects of gender and learning style on biology achievement have been discussed below.

When the results of this research were compared with those of previous ones, current research supports some findings from other studies while it contradicts with some of them.

As Singh, Granville, and Dika (2002) reported affective variables such as science interest and motivation have emerged as silent predictors of achievement in science. Also, in their review of 20 studies dealing with student motivation, Kremer and Walberg (1981) concluded that there is a positive relationship between motivational variables and science learning. Findings of our study are in agreement with the results of this review. There was a low positive correlation (r= .197) between students' motivational belief and their biology achievement. In their study of motivation and achievement, Uguroglu and Walberg (1979) concluded that the mean correlation between motivation and achievement from samples of studies in psychological and educational literature is .338 (with a standard error of .009), the highest and the lowest correlations being .71 and .07 respectively. They also suggested that motivation and achievement were more highly correlated in students in later grades and motivation accounts for 11.4 percent of the variance in achievement.

The correlation found between motivation and achievement in this study, however, is not as high as the mean correlation found by Uguroglu and Walberg (1979), but fall into the range of observed correlations stated above.

When the correlations of each motivational component (self-efficacy, intrinsic value and test anxiety) with biology achievement were examined, similar conclusions can be drawn out: There were low positive correlations between each component and student biology achievement. Among those three components, the highest correlate to biology achievement was students' self-efficacy beliefs. In an achievement context, self-efficacy includes students' confidence in their cognitive skills to learn and perform the academic course work (Pintrich, 1999). Although Pintrich (1999) stated that self-efficacy was strongly related to academic performance including examinations, no such strong relationship was found.

Pintrich and his colleagues (1993) suggested that intrinsic task value was correlated to performance but those relations were not as strong as those for self- efficacy. The findings of this research supported this suggestion. There was a low positive correlation between students' intrinsic value believes and their biology achievement and this correlation was smaller than those for self-efficacy. Accordingly, for the students involved in current study, their perceptions of the importance and usefulness of biology and their interest in biology were not highly correlated with their biology achievement.

The third correlate was the students' emotional reactions to the task in terms of test anxiety. According to the results of the study, there was a low but positive correlation between students' test anxiety believes and their biology achievement. This finding does not support previous research indicating that test anxiety interferes with students' achievement. Benjamin, McKeachie and Lin (1987) suggested that high test anxiety is correlated with performance decrements. Correlations ranging to -.60 indicate that test anxiety has a strong negative relationship to performance in evaluative situations (Hill & Wigfield, 1984). The disagreement of the findings from the study with the previous research shows that test anxiety is not an inhibitory factor in the study of science for the population under study. It appears that test anxiety may be a driving force in the efforts to study biology so that there is a positive relation between two.

Overall, the correlations between biology achievement and each component of student motivation were lower than expected. This 'lower than expected' finding suggest that the relationship between motivation and achievement may be somewhat weaker than previous findings indicate. It may also reveal that other affective characteristics may play more important role than motivation in explaining the observed difference in student performance for this population. Factors such as home and school environment, peer and teacher influences, socio-economic variations, family demands, and other student characteristics such as attitudes, interests, prior knowledge, cognitive strategies may account more in explaining the variations among student performance for the population of interest.

According to the results of this study, gender was one of the other determinants of biology achievement. Inconsistent with many other studies, the results of this study showed that girls outperform boys to a small extent. It is well known that there are disparities between academic performance of girls and boys in science and mathematics (Greenfield, 1995). According to National Assessment of Educational Progress (NAEP), data from 1976 to 1990 indicate that a male advantage in science achievement emerges and grows as students progress through school: although gender differences are small or nonexistent in 9-year-olds, by the age of 17, males significantly outperform females and this gender gap has existed as early as 1969 (NAEP, 1991, as cited in Greenfield, 1995). Research in science education also indicates that gender may also influence attitudes toward science (Weinburgh, 1995). It appears that, boys in general, have a more positive attitude toward science than girls. However, if specific disciplines of science are considered, this is not always the case. Schibeci (1984) reported that girls show a more positive attitude toward biology and boys toward physics and chemistry. Moreover, the results of few studies examining the correlation between attitude toward science and achievement in science by gender, reported a higher correlation between positive attitudes in science and higher achievement scores for girls than boys (Cannon and Simpson

1983). Therefore, the observed achievement difference favoring girls may be due to the attitudinal differences among girls and boys for biology. As Schibeci (1984) reported, girls' attitude for biology may be higher than that of boys' and this higher attitude may result in higher biology achievement for girls in this study.

Learning style has been emerged as an other factor affecting biology achievement at the end of current study. The variations on the learning style preferences are important and may have consequences for how successfully different students learn biology. Our findings showed that assimilators' biology achievement mean scores were higher than that of convergers, divergers, and accommodators. Since higher scores mean greater biology achievement, it can be concluded that assimilators were more successful in biology when compared with the others for this population. One possible reason of this result may be the teaching methods generally preferred by our teachers. The most commonly used teaching method is lecturing in our schools. People with assimilator learning style type prefer mostly readings and lectures (Kolb, 1985). Therefore, the matching between teaching and learning style may lead to higher achievement of students with assimilator learning style type. This finding supports the expectations of Sternberg and Grigorenko (1997) who stated that the level of performance would be higher when there was a congruence of preferred learning style and the teaching method.

The results of the study also supported the theory of Collinson (2000) that students manifest significant variations in how they prefer to learn in a classroom setting. Assimilators and convergers have emerged as the most frequent learning style types in our population. Kolb (1985), stated that mathematics and science attracts individuals who are assimilators and the findings of this research supported that view. Since our population included only students attending to mathematics and science groups, those results were not surprising. According to Raschick and Maypole (1998), the converger-type learners tend to have a good understanding of practical ideas and their application. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications (Kolb, 1985). Since science is accompanied closely with experimentation, laboratory work and application assignments, high frequency of convergers in the population was consistent with the statements of Kolb (1985).

As described in Chapter 3, small effect size was expected. The statistical result of the SPSS calculated R^2 as .051 for BACH. The observed value of effect size was calculated by using formula $f^2 = R^2 / (1 - R^2)$ for the dependent variable and found as .1. The effect size measured here matched the small effect size. Based on the findings presented the practical significance of this study is low.

5.4 Internal Validity of the Study

Internal validity means that the observed differences on the dependent variable are directly related to the dependent variable, not due to some other extraneous variable. Possible threats to internal validity and the methods used to cope with them are discussed in this section.

Although schools involved in this study were thought as clusters and randomly selected, random assignment of subjects was not possible. Since the groups were already formed, not the individuals, but the groups were randomly assigned. Hence, many subject characteristics (age, gender, attitude, motivation, socioeconomic status, previous knowledge) could be the major threat to the internal validity for this study. To be able to cope with some of these potential threats, age and gender were assessed with the questionnaire. However, they were not found to be highly correlated with the dependent variable. Instead, the correlation of the self-efficacy, intrinsic value, and test anxiety components of student motivation were correlated significantly with the dependent variable. Therefore, they were considered as covariates. The amount of previous biology knowledge of students was assumed to be equal.

Location and instrumentation could not be threats to the study since the instruments were administered to all groups in similar conditions and mostly by the researcher.

Data collector characteristics and data collector bias threats were assumed to be controlled by training and informing the teachers to ensure Standard procedures under which the data were collected.

Finally, confidentially was not a possible threat for this study since names of the students were not collected and used anywhere.

5.5 External Validity of the Study

Subjects of the study were randomly selected from the accessible population and 980 tenth grade students were involved in the study. Hence, generalization of this study’s findings does not have any limitations. So the results and conclusions found at the end of this study can easily be applied to accessible population.

Since all the administration procedure took place in ordinary classrooms during regular class hours, there were possibly no remarkable differences among the environmental conditions. Therefore, it was believed that external effects were sufficiently controlled by the settings used in the study.

5.6 Implications of the Study

Based on the findings of this study and previous research following suggestions can be offered:

1. Educators and teachers should be aware of the differences that exist among students rather than assuming that everyone learns the same way.
2. A preliminary mission of teacher educators can be to provide future teachers with the knowledge and skills needed to diagnosis their students' learning styles and adapt their instruction accordingly.
3. Kolb Learning Style Inventory can be used as an effective tool by teachers at the beginning of the semester to identify each student's learning style.
4. If students are able to accurately identify their preferred style of learning, then teachers may use the information gathered to design classroom environments, teaching strategies and classroom activities that may potentially enhance the learning of all students.
5. Lectures, model buildings, analogies, readings, papers, and projects may be preferred as instructional activities for assimilators.
6. Laboratory experiments, simulations, field works, problem solving, and practical applications may be preferred as instructional activities for convergers.
7. Group working, cooperative learning, and brainstorming may be preferred as instructional activities for divergers.

8. Hands-on activities, group working, field working, and projects may be preferred as instructional activities for accomodators.
9. Although there is no magic formula for motivating all students, teachers should try to motivate students in their classrooms by using the suggestions below:
    - De-emphasize grading (an extrinsic motivator) as much as possible and encourage students to develop their intrinsic motivation.
    - Overemphasizing exams and making them difficult to complete in the allotted time may promote anxiety and focus on rote memorization. To increase interest and motivation in learning, use evaluative methods that encourage conceptual learning without threatening students.
        - Try to encourage the growth of intrinsic satisfaction and the rewards of learning in students.
        - Communicate to students that you believe each of them can learn biology meaningfully without memorizing. The belief that some students cannot learn biology is a myth of our society that must be overcome. Students should know they can learn biology and that the teacher expects them to do so.
        - Praise student effort and performance only when it is deserved. Teachers must be specific with their praise and use their professional judgment to decide the frequency of praise that is most appropriate for each student in their class.

- Stress the importance of self-improvement rather than performing better than others in the class.
- Stress the usefulness and importance of biology. Students who believe that learning biology is necessary to succeed in school, daily life and in jobs will be more highly motivated than students who see no real purpose for learning biology.
- Employ a variety of teaching strategies and materials. A teacher who effectively uses models, pictorial aids, simulations, and activities instead of textbook explanations is likely to keep all students motivated.
- When students make a mistake or get a low grade, encourage them to try again and harder rather than letting them broad about their failure. Students who learn to keep trying are believed to go a long way toward becoming highly motivated and are more likely to learn how to handle with the classroom difficulties.

10. Teachers and teacher educators should work together to eliminate the strong belief in our society that girls remain behind boys in science achievement.
11. Not only boys but also girls should be encouraged in science classes.
12. Teachers, parents, educators, and even peers should try to develop girls' self-esteem towards science.

5.7 Recommendations for Further Research

Current study has suggested a variety of useful topics for further studies. These are briefly as follows:

1. The affective determinants found to correlate with biology achievement in this study cannot be shown to ‘cause’ achievement. Thus, experimental research is needed to help to determine a causal link between motivational belief and biology achievement.
2. Future research can examine gender differences in motivational belief.
3. Experimental research is needed to examine the effect of instruction done according to the students’ learning styles on students’ biology achievement.
4. Future research can perform a replication of this study for different grade levels.
5. Impacts of other affective and cognitive variables on students’ biology achievement can be investigated in future studies.

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APPENDIX A

TURKISH VERSION OF THE MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE (MSLQ-TV)

5: Kesinlikle Katılıyorum 4: Katılıyorum 3: Kararsızım
2: Katılmıyorum 1: Kesinlikle Katılmıyorum

	5	4	3	2	1
1) Biyoloji dersinde yeni bilgiler öğrenebilmek için, zorlayan ama zevkli sınıf çalışmalarını tercih ederim.					
2) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, biyoloji dersinde başarılı olmayı beklerim.					
3) Biyoloji sınavlarında o kadar heyecanlı olurum ki, öğrendiklerimi hatırlayamam.					
4) Biyoloji dersinde anlatılanları öğrenmek benim için önemlidir.					
5) Biyoloji dersinde öğrendiklerimden hoşlanırım.					
6) Biyoloji dersinde öğretilen konuları anlayabildiğimden eminim.					
7) Biyoloji dersinde öğrendiklerimi başka derslerde kullanabileceğimi düşünüyorum.					
8) Biyoloji dersinde çok başarılı olacağımı düşünüyorum.					
9) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, iyi bir öğrenci olduğumu düşünüyorum.					
10) Daha fazla çalışma gerektirse bile, bir şeyler öğrenebileceğim ödev konularını seçmeyi tercih ederim .					
11) Biyoloji dersi için belirlenen görevleri en iyi şekilde yapabileceğimden eminim.					
12) Biyoloji sınavlarında kendimi huzursuz ve mutsuz hissederim.					
13) Biyoloji dersinden iyi bir not alacağımı düşünüyorum.					

	5	4	3	2	1
14) Biyoloji sınavından zayıf alsam bile, sınavda yaptığım hatalardan öğrenmeye çalışırım.					
15) Biyoloji dersinde öğrendiklerimin benim için faydalı olduğunu düşünürüm.					
16) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, çalışma becerilerim mükemmeldir.					
17) Biyoloji dersinde öğrendiklerimi ilginç buluyorum.					
18) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, biyoloji konuları hakkında daha fazla bilgiye sahip olduğumu düşünürüm.					
19) Biyoloji dersinde verilen bilgileri öğrenebileceğime inanıyorum.					
20) Biyoloji sınavları ile ilgili çok fazla endişe duyarım.					
21) Biyoloji konularını anlamak benim için önemlidir.					
22) Biyoloji sınavları sırasında soruları yeterince iyi yanıtlayamadığımı düşünürüm.					

APPENDIX B

LEARNING STYLE INVENTORY (LSI)

4: en uygun olan
3: ikinci uygun olan
2: üçüncü uygun olan
1. en az uygun olan

1. Öğrenirken
   --- duygularımı gözönüne almaktan hoşlanırım.
   --- izlemekten ve dinlemekten hoşlanırım.
   --- fikirler üzerine düşünmekten hoşlanırım.
   --- birşeyler yapmaktan hoşlanırım.

2. En iyi
   --- duygularıma ve önsezilerime güvendiğimde öğrenirim.
   --- dikkatlice dinlediğim ve izlediğimde öğrenirim.
   --- mantıksal düşünmeyi temel aldığımda öğrenirim.
   --- birşeyler elde etmek için çok çalıştığımda öğrenirim.

3. Öğrenirken
   --- güçlü duygu ve tepkilerle dolu olurum.
   --- sessiz ve çekingen olurum.
   --- sonuçları bulmaya yönelirim.
   --- yapılanlardan sorumlu olurum.

4.
   --- Duygularımla öğrenirim.
   --- İzleyerek öğrenirim.
   --- Düşünerek öğrenirim.
   --- Yaparak öğrenirim.

5. --- Yeni deneyimlere açık olurum.
--- Konunun her yönüne bakarım.
--- Analiz etmekten ve onları parçalara ayırmaktan hoşlanırım.
--- Denemekten hoşlanırım.

6. Öğrenirken --- sezgisel biriyim.
--- gözleyen biriyim.
--- mantıklı biriyim.
--- hareketli biriyim.

7. En iyi --- kişisel ilişkilerden öğrenirim.
--- gözlemlerden öğrenirim.
--- akılcı kuramlardan öğrenirim.
--- uygulama ve denemelerden öğrenirim.

8. Öğrenirken --- kişisel olarak o işin bir parçası olurum.
--- işleri yapmak için acele etmem.
--- kuram ve fikirlerden hoşlanırım.
--- çalışmamdaki sonuçları görmekten hoşlanırım.

9. En iyi --- duygularıma dayandığım zaman öğrenirim.
--- gözlemlerime dayandığım zaman öğrenirim.
--- fikirlerime dayandığım zaman öğrenirim.
--- öğrendiklerimi uyguladığım zaman öğrenirim.

10. Öğrenirken --- kabul eden biriyim.
--- çekingen biriym.
--- akılcı biriyim.
--- sorumlu biriyim.

11. Öğrenirken --- katılırım.
--- gözlemekten hoşlanırım.
--- değerlendiririm.
--- aktif olmaktan hoşlanırım.

12. En iyi --- akılcı ve açık fikirli olduğum zaman öğrenirim.
--- dikkatli olduğum zaman öğrenirim.
--- fikirleri analiz ettiğim zaman öğrenirim.
--- pratik olduğum zaman öğrenirim.

APPENDIX C

BIOLOGY ACHIEVEMENT TEST (BAT)

1. Aşağıdaki grafik, insanda uzun süreli açlıkta vücuttaki yağ, protein ve karbonhidrat miktarlarının değişimini göstermektedir.

Bu grafikte, yağ, protein ve karbonhidrat miktarlarının değişimini gösteren eğrileri numaraları aşağıdakilerin hangisinde doğru olarak verilmiştir?

	Yağ	Protein	Karbonhidrat
A)	III	II	I
B)	II	III	I
C)	II	I	III
D)	I	III	II
E)	I	II	III

2. Bir hücrenin bir molekülü pasif taşıma (difüzyon) ile içine <u>alamamasının</u> nedeni aşağıdakilerden hangisi olabilir?

A) Hücrede ATP miktarının az olması
B) Hücrede ilgili enzimin bulunmaması
C) Molekülün hücre içindeki derişiminin az olması
D) Molekülün suda çözünebilir olması
E) Molekülün yapısının büyük olması

3. Bir balık türü, yaşamının,

- I. evresinde bakteriler, su pireleri ve küçük bitkilerle
- II. evresinde eklembacaklılar, salyongozlar ve küçük balıklarla

beslenmektedir.

Bu balık türünün I. ve II. evrelerindeki beslenme biçimlerinin adları aşağıdakilerinin hangisinde doğru olarak verilmiştir?

	I	II
A)	Karışık	Etobur
B)	Karışık	Otobur
C)	Otobur	Etobur
D)	Etobur	Etobur
E)	Otobur	Karışık

4. Aşağıdaki yapılardan hangisinin, karşısındaki olayla ilişkisi <u>yoktur?</u>

A) Ribozom – Protein sentezi
B) Kloroplast – Fotosentez
C) Mitokondri – Fermentasyon
D) Çekirdek – Mitoz bölünme
E) Hücre zarı – Osmoz

5. Aşağıdaki grafik, enzim aracılığıyla gerçekleşen bir reaksiyonun hızındaki değişmeyi göstermektedir.

Hücrede gerçekleşen bu reaksiyonun hızı, t_1 anında aniden sıfıra düşmektedir.

Bu değişmenin nedeni,

I. Substrat (etkilenen madde) miktarı › Enzim miktarı
II. Ortamda bulunan enerji miktarı ‹ Gerekli aktivasyon enerji miktarı
III. Substrat (etkilenen madde) miktarı ‹ Oluşan ürün miktarı

durumlarından hangileri olabilir?

A) Yalnız I
B) Yalnız II
C) Yalnız III
D) I ve II
E) II ve III

6. Doğada, bir besin ve enerji piramidinde bulunan canlılar arasındaki etkileşimle ilgili olarak, aşağıdaki ifadelerden hangisi <u>yanlıştır?</u>

A) Üst basamağa doğru gidildikçe toplam birey sayısı azalır.
B) Bir basamaktaki canlıların tükettikleri enerji toplamı, bir üst basamaktakinden daha fazladır.
C) Alt basamak bireylerinde depo edilen toplam enerji miktarı daha fazladır.
D) Bir basamaktaki türün birey sayısındaki artış, sadece alt basamaktaki enerji kaynağını etkiler.
E) Enerji bir üst basamağa sadece besin yoluyla geçer.

7. Vitaminlerle ilgili bazı özellikler şunlardır:

I. Bazılarının suda, bazılarının yağda çözünmesi
II. Bazılarının heterotrof canlıların vücudunda depolanması
III. Her vitaminin, yanlızca kendine özgü reaksiyonun gerçekleşmesinde rol alması
IV. Heterotrof canlılar tarafından doğrudan sentezlenmesi

Bu özelliklerden hangileri, heterotrof canlılarda, bir vitamin eksikliğiyle ortaya çıkan bozukluğun başka bir vitaminle giderilememesinin nedenidir?

A) Yalnız II
B) Yalnız III
C) I ve II
D) II ve IV
E) III ve IV

8. Canlıların bilimsel olarak adlandırılmasında kullanılan yönteme göre,

I. Capra domesticus
II. Felis domesticus
III. Canis lupus
IV. Felis leo

olarak adlandırılan canlıların cins ve tür adlarına bakarak, hangilerinin birbiriyle diğerlerinden daha yakın akraba olduğu düşünülebilir?

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

9. Aşağıdakilerden hangisi kloroplast ve mitokondride görülen ortak özelliklerden biri değildir?

A) Çift zara sahip olma
B) Bağımsız çoğalabilme
C) Kendine özgü yönetici moleküllere sahip olma
D) ATP sentezleyebilme
E) Suyu ayrıştırabilme

10.

Bir populasyonun birey sayısı, yukarıdaki büyüme eğrisinde görüldüğü gibi, I.zaman aralığında artmış, II. zaman aralığında azalmıştır.

Aşağıdakilerin hangisinde verilenler, birey sayısında iki zaman aralığında görülen bu değişmeleri doğrudan sağlayabilecek nedenler arasındadır?

	I. zaman aralığında	II. zaman aralığında
A)	Avcı sayısının artması	Populasyon dışına göçün azalması
B)	Populasyon dışına göçün artması	Avcı hayvan sayısının azalması
C)	Avcı hayvan sayısının artması	Hastalıkların azalması
D)	Doğum oranının artması	Besin miktarının azalması
E)	Hastalıkların artması	Besin rekabetinin azalması

11. 'Bitkilerde nişastanın yıkımını sağlayan enzimler vardır.' hipotezini doğrulamak için düzenlenen deneyde, bitki özütünün, aşağıdaki karışımlardan hangisinin bulunduğu tüpe konması gerekir?

A) Nişasta + Monosakkarit ayıracı
B) Nişasta yıkan enzim + Monosakkarit ayıracı
C) Nişasta ayıracı + Nişasta yıkan enzim
D) Monosakkarit + Nişasta yıkan enzim
E) Monosakkarit + Monosakkarit ayıracı

12. Bir enzimin hücrede sentezinin başlamasından dışarıya salgılanmasına kadar gerçekleşen olaylarda, aşağıdaki yapı ve organellerden hangisinin doğrudan işlevi yoktur?

A) Ribozom
B) Endoplazmik retikulum
C) Hücre zarı
D) Lizozom
E) Golgi aygıtı

13. Hücrelerinde,

I. Polimerleri sindirebilme
II. Temel amino asitleri sentezleyebilme
III. Kromatitleri sentromerle bağlı tutabilme
IV. Polisakkarit sentezleyebilme

özelliklerinden hangileri, çok hücreli bitki ve hayvanların <u>ortak</u> özellikleridir?

A) Yalnız I
B) Yalnız II
C) II veIII
D) I, II ve IV
E) I, III ve IV

14. K, L, M ve N bakteri türleri bir petri kabındaki besi ortamında gelişmeye bırakılmış, bir süre sonra bu kaba belirli aralıklarla ve gittikçe artan dozlarda (I.doz ‹ II. doz ‹ III. doz) bir antibiyotik uygulanmıştır. Her dozun uygulanmasından sonra canlı kalan birey sayıları tabloda verilmiştir.

Bu deneyin sonuçları ile ilgili aşağıdaki yorumlardan hangisi <u>yanlıştır?</u>

A) M türü, bu antibiyotiğe N türünden daha dirençlidir.
B) L türü, bu antibiyotiğe M ve N kadar dirençli değildir.
C) K ve L türlerinin bu antibiyotiğe dirençleri aynıdır.
D) K türü, bu antibiyotiğe en az dirençlidir.
E) M türü, bu antibiyotiğe en dirençlidir.

15. Doğanın korunmasıyla ilgili aşağıdaki önlemlerden hangisi <u>en dar</u> kapsamlıdır?

A) Ormanların sürekliliğinin korunması
B) Zehirli fabrika atıklarının arıtılması
C) Tarım ilaçları kullanımının en aza indirilmesi
D) Bir tür hayvanın avlanmasının yasaklanması
E) Arıtılmamış atıkların denizlere atılmasının yasaklanması

16. Kara yaşamına uyum yapan hayvanların hepsinde, aşağıdaki özelliklerden hangisi, <u>her zaman bulunmak zorundadır?</u>

A) Vücut ısısını koruyucu önlemler alma
B) İç döllenme yapma
C) Akciğerlerle solunum yapma
D) Yumurtaları çevre koşullarına karşı korunmuş olma
E) Gelişmiş bir iç iskelete sahip olma

17. Aşağıdakilerden hangisi, hücrelerde birim zamanda üretilen ATP miktarı ile <u>doğrudan</u> ilişkili <u>değildir?</u>

A) Lizozom B) Sıcaklık C) Mitokondri D) Glikoz E) Enzim

18.

I. İnorganik elementlerden organik molekül sentezleyebilme
II Kendine özgü molekülleri sentezleyebilme
III. Yapılarındaki karmaşık organik molekülleri temel organik yapıtaşlarına ayırabilme

Yukarıdakilerinden hangileri ototrof ve heteretrof canlıların ortak özelliklerindendir?

A) Yalnız I
B) Yalnız II
C) Yalnız III
D) I ve II
E) II ve III

19. Saf su dolu kabın içine bir bağırsak parçası daldırılıyor. Bağırsak parçasının içinde M maddesi ile M maddesini parçalayan bir enzim bulunuyor. Bir gün sonra kaptaki su inceleniyor ve içinde sadece X maddesi bulunduğu belirleniyor.

Bu gözlemlere dayanarak aşağıdakilerden hangisi <u>söylenemez?</u>

A) X maddesi M enzimi ile parçalanır.
B) M maddesi bağırsak içinde yıkılır.
C) X maddesi M maddesinin yapı taşıdır.
D) X maddesi bağırsak duvarını geçme özelliği taşır.
E) M maddesinin molekül yapısı X maddesininkinden büyüktür.

20. Bir karınca türü, ihtiyacı olan şekerli maddeleri, yuvasına getirdiği yaprak bitinden sağlar; buna karşılık onları düşmanlarından korur.

Bu karınca türü ile yaprak bitinin yaşama şekli aşağıdakilerden hangisine bir örnektir?

A) Saprofitizm
B) Ototrofizm
C) Kommensalizm
D) Parazitizm
E) Mutualizm