A DESCRIPTIVE STUDY ON LEARNING STYLE PREFERENCES OF THE ENGINEERING STUDENTS AT METU

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ABSTRACT

A DESCRIPTIVE STUDY ON LEARNING STYLES OF THE ENGINEERING STUDENTS AT METU

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The purpose of the study is to find out preferred learning styles of the engineering students at METU. It is also aimed to search whether learning style preferences differ according to sex and department variables. Additionally the study tried to find out if engineering students' CGPA (Cumulative Grade Point Average) differ according to their learning style preferences. The instrument, Index of Learning Style (ILS), which was developed especially for engineering students, was administrated to 400 engineering students from 13 different departments at METU. Out of 1447 senior engineering students, using stratified random sampling method 400 students were selected as a sample. Chi-square and t tests were used in the analysis process. Also mean and standard deviations were calculated for each of the eight learning style dimensions. The result of the study indicated that most of the engineering students have preference toward visual learning being independent of sex or department variables. Also, the number of students who are dominantly sensing and active learners were more than intuitive and reflective ones. As for CGPA score difference according to learning style preferences, t test did not indicate any significant result. In other words, learning style preferences did not influence CGPA scores. In conclusion, the study had important implications for engineering education. Possible teaching methods and strategies for each learning style were tabulated in the conclusion section. Study suggested that instructors should use appropriate teaching methods and strategies for general learning style profile of their classroom.

Key Words: Engineering Students' Learning Styles, Felder& Silverman's Index of Learning Styles, Teaching Aids and Activities.

ÖZ

ODTÜ MÜHENDİSLİK ÖĞRENCİLERİNİN ÖĞRENME STİLLERİNE YÖNELİK BETİMLEYİCİ BİR ÇALIŞMA

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Bu çalışmanın amacı, ODTÜ mühendislik öğrencilerinin tercih ettikleri öğrenme stillerini belirlemektir. Çalışma, öğrenme stillerinin cinsiyet ve bölüm değişkenlerine göre farklılık gösterip göstermediğini de belirlemeyi amaçlamıştır. Ayrıca, bu çalışma öğrencilerin öğrenme stillerine göre başarı düzeylerinde değişiklik olup olmadığını saptamayı hedeflemiştir. Felder ve Silverman tarafından özellikle mühendislik öğrencileri için geliştirilmiş olan Öğrenme Stilleri Aracı, ODTÜ'de 13 mühendislik bölümündeki 400 öğrenciye uygulanmıştır. 1447 son sınıf mühendislik öğrencisi arasından 400'ü oranlı küme örnekleme yöntemi ile seçilmiştir. Verilerin analizinde kay-kare ve t test kullanılmış, ayrıca ortalama ve standart sapma hesaplamaları yapılmıştır. Yapılan çalışma sonuçları göstermiştir ki, ODTÜ mühendislik öğrencileri bölüm ya da cinsiyet ayrımı olmaksızın çoğunlukla görsel öğrenenlerdir. Somut ve aktif öğrenmeyi tercih edenlerin sayısının soyut ve yansıtıcı öğrenmeyi tercih edenlere göre fazla olduğu görülmüştür. Ayrıca sonuçlar öğrencilerin başarı düzeylerinin onların öğrenme stillerinden etkilenmediğini göstermiştir. Sonuç olarak, çalışma mühendislik eğitimi açısından önemli uygulamalara yer vermiştir. Her bir öğrenme stiline uygun

olası öğretim metot ve stratejileri sonuç bölümünde tablolaştırılmıştır. Öğreticilerin, sınıflarındaki öğrencilerin genel öğrenme stili profiline uygun öğretim yöntem ve stratejileri kullanmaları önerilmiştir.

Anahtar Kelimeler: Mühendislik Öğrencilerinin Öğrenme Stilleri, Felder ve Silverman'ın Öğrenme Stilleri İndexi, Öğretim Araçları ve Faaliyetleri.

To My Family,

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INTRODUCTION

1.1. Background to the Study

Over the last century our knowledge about the education has gone through many changes. Educating people having different background and experience in the same classroom settings has a crucial importance among the educators nowadays. The external or internal effects can cause background differentiation. As the external factors family, income level, society can be counted. On the other hand, learning style of the learner, personality, perception differences are the individual factors that affect the learning.

Learning involves two ways based on how learners perceive and how the information is processed (Fardouly, 1998). These ways influence learners with respect to their choice of learning (Richards and Lochart, 1996). Felder mentions way of understanding and input preferences additional to these two ways (Felder, 1996). That is; learners' perception of learning, their preference to get sensory information, their way of understanding, and their information processing are valued in their learning styles. "Learning style is a gestalt combining internal and external operations derived from the individual's neurobiology, personality and development, and reflected in learner behavior" (Keefe and Ferrell 1990, p. 16) Litsinger and Osif (1993) describes learning style as " the different ways in which children and adults think and learn (p. 73)." A learning style consists of a distinctive and observable behavior that provides clues about each individual, and knowledge about learning style helps the learners to improve their power of learning (Aşkar and Akkoyunlu, 1993). Students' learning style profile in any field can provide sound information about students in the field as long as valid data gathered from the students.

Before considering learning style and its dimensions we should think about learning and teaching as one of the most important components of any learning process. Davis et al. (1994) defines learning as an active process of translating new knowledge, insights, and skills into behavior. Significantly learning only takes place when individuals accept responsibility for their own learning, and actively seek to develop themselves. As Knowles (1972) says, the learner has to take the initiative and be proactive in any learning process. Individuals, therefore, need to develop an attitude of "ownership" towards learning, and any training program must seek to enhance this feeling of responsibility within the student (Knowles,1972, p.286).

Learning is not associated with the increase in knowledge and its subsequent recall; instead it is related to the understanding of fundamental principles and concepts which can be applied to both familiar and unfamiliar situations in the real world (Hargreaves,1996, p.1).

Information of learning style is essential especially for university education, because students at university level are expected to gain self-study habits to accomplish the requirements of the courses. Knowledge of learning style is very useful for:

- University students who need more knowledge about their own learning process to guide their own learning.
- Instructors who should have an opinion about their students to lead them for effective learning.

Shroeder (1996) points out that the "typical" student learning style profile is changing on campuses today and there is a much greater variation in the range of learning style preferences to be considered. Therefore, it would be wise to understand what learning style preferences are, and how to address them when preparing instructional material for adults. Faculty should be teaching to a sufficient diversity of student learning styles to encourage innovation in their fields.

Today engineering is one of the important fields among higher education institutions. The Accreditation Board of Engineering and Technology (ABET) defines engineering as " the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind " (Wright, P.H., 1989, p.23). Considering this definition we would say that engineering is a field that comprises various qualifications in it. Reaching all these qualifications require both technical and theoretical studies in the field. Studies on teaching and learning would be considered as theoretical studies in which learning style studies should be included.

Broun, Darwing, and Asimov (1979) report that learning efficiency depends on at least three factors;

- Material to be learned,
- The psychological readiness of the learner,
- Learning strategies.

While meaningfulness of the material and psychological readiness of the learner have effect on efficient learning, usage of learning strategy (Broun et al. 1979) and also knowledge of learning style is another important component of efficient learning.

Learning efficiency would be considered a crucial topic especially for education at university level. At university level, students are expected to gain technical ability and theoretical knowledge of their study fields. The difference between higher education and compulsory education has been explained that higher education aims at giving specific knowledge about subject area, while compulsory education provides student with fundamental knowledge of life (Etkili Öğretim Semineri, 2001 ODTU). Regarding this citation university education requires more specialized skills to complete it. These skills differ according to subject area and study field. Felder, Rugarcia, Woods, and Stice (2000) claim there are six essential skills required in engineering fields as;

- Lifelong learning skills,
- Problem solving, critical thinking and creative thinking skills,
- Interpersonal and teamwork skills,
- Self-assessment skills,
- Integrative and global thinking skills,
- Change management skills.

Although Felder et al. states these skills are specific for engineers, they are expectable for other fields as well.

Felder (1996) states the objective of education as helping students build their skills in both their preferred and less preferred methods of learning. Learning style models that categorize these modes provide good frameworks for designing instruction with the desired breadth. Besides the learning styles of the students, the teachers in the classroom settings and their style of teaching is another factor to be considered. Teaching style can be seen as the way that a teacher handles a learning task (David et al.,1980). Fisher and Fisher (1979) define teaching style as "a pervasive way of approaching the learners that might be consistent with several methods of teacher."

When the general profile of higher education in Turkey is scrutinized, it is obvious that educational system of Turkey is under the heavy pressure of the high rate of population increase. The annual population growth is close to 1 million in absolute numbers. This high rate of increase naturally affects the age structure of the population in favor of the youth. According to human development report of 1998, Turkey's median age is still under 25 on average. According to State Planning Organization's report (1998) almost 1/3 of the population is in school age, excluding the pre-school group. Hence, 6% of the total population is 4-6 age group, 10.2% is 7-11, and 8,2% is 18-21. Student enrollment rating is 10.1% for pre-school education, 99.7% for compulsory elementary education, 64% for secondary education in which 22.2% is for vocational high school and 41.8% for general high school. As for higher education total enrollment ratio is 37.3% including 28.3% formal education and 9.3% open education.

Giving a sufficient and effective education to all these students requires enough capacity in terms of both human resources and physical infrastructure. The number of public universities in Turkey increased sharply in 1992. Since the physical and academic environment had not been prepared, this increase did not bring about a parallelism in the growth in the numbers of student and also risked the quality of higher education. Hence, higher education should be concerned with not only enhancing learning in a specific situation, but should also constitute a catalyst for further self-initiated development of the individual, above and beyond the contents and aim of a particular course.

As one of the reputable university, Middle East Technical University (METU) have great importance in scientific studies in Turkey. Especially in the field of engineering, university has important place among Turkish universities. The success of the faculty lies behind both the student profile in which most students range from the first proportional percentages in the distribution of university entrance examination and successful teaching staff whose quality has been approved by Accreditation Board of Engineering and Technology (ABET). Because of the students and the teaching staff, the improvement of the university in both technical and educational perspectives has always been promoted.

The basic philosophy of the Faculty of Engineering at Middle East Technical University (METU) is "to deliver a sound engineering education at both undergraduate and graduate levels for the purpose of providing the graduate students with a background which will enable them to carry out high quality engineering work." Looking at this mission statement we can easily say that the main purpose of the engineering faculty is to lead students to improvement in both their professional and academic studies. This purpose requires knowledge about students' and teachers' nature before all other necessities.

One of the problems of higher education would be considered as practice in teaching and learning in Turkey. The diverse student profiles lead faculty to concern more about students' learning and teaching. Learning style is a concept that can be important in this movement, not only in informing teaching practices but also in showing students to their preferences. Information about learning style can help faculty become more sensitive to the differences students bringing into the classroom. (Claxton and Murrell, 1987)

Students' and instructors' academic success and quality need supportive studies in higher education institutions. As an important component of learning, learning style of the students needs to be taken into consideration by instructors and curriculum developers in higher education level. Knowledge of learning style helps instructors to shape their courses.

Debates on how much learning and teaching styles should match with each other have a long history. The match or mismatch between the way that professors teach and the way that students learn may have important ramifications for levels of satisfaction with a given school, and with the retention of both students and teachers. When education level is taken into consideration, learners' styles have great importance at any level. Learning styles can be considered as guides in designing learning experiences.

Claxton and Murrel (1987) emphasize the importance of matching between teaching and learning style particularly for working with poorly prepared students and with new college students. But at the university level, the validity of "matching" teaching and learning styles as the ultimate goal of education is scrutinized and stressed that matching may be inappropriate if the long-term goal of education is developmental (Confield, 1978; Hunt, 1971; Kolb, 1984). In some cases, mismatches between the teacher's teaching style and the student's learning style can be valuable because this mismatch forces students to stretch or "style-flex" as they are forced to use their non-preferred learning modes (Campbell, 1991,p.358). Opinions about matching/ mismatching change among educators, while some of them stated that the match between teaching and learning style required for effective learning, others say mismatch is more effective than match. The table below shows some of them;

Table 1.1

Opinions About Learning and Teaching Style Matches

Learning Is More Effective Where There Is a Match	Learning Is More Effective Where There Is a Mismatch
Di Stefano (1970)	Gehlman (1951)
Koran et al (1971)	Glass (1967)
Grieve and Davis (1971)	Coop and Brown (1971)
James (1973)	Anderson (1972)
Carpenter et al (1976)	Nelson (1972)
Mc Cleod and Adams (1977)	Montgomery (1972)
Witkin (1977)	Thornell (1974)
Hudak (1985)	Gorton (1975)
Canino and Cockerill (1988)	Kolb (1985)

(Adopted from Witkin et al, 1977 and Hayes and Allinson, 1996)

Besides the debate on the match mismatch issues between learning and teaching style, it is the fact that faculty should give importance on learning preferences of the students in the process. Defining the learning styles of the students would help faculty to be aware of general profile of students.

1.2. Purpose of the Study

The purpose of the study is to assess learning style preferences of the students in engineering departments at Middle East Technical University (METU). The two main research questions in the study are;

1. What are the dominant learning styles of the engineering students according to Felder's four learning dimensions?

2. Do learning style preferences differ according to sex, engineering departments and CGPA?

1.3. Significance of the Study

It is apparent that each person differs in class. Every person has his own ways to learn. These differences affect both the learner and the teacher involving teaching learning process. Teachers and learners sometimes are not aware of the teaching learning differences, although it is crucial to know in class. Learning/teaching differences appear as learning/teaching style in class and they considerably influence classroom atmosphere. Awareness of the learning style can help instructors to be more sensitive toward the individual differences in the class. As it is mentioned before there are disagreements among educators about the necessity of match or mismatch between learning and teaching styles. Beyond all arguments it is the fact that both styles affect the classroom interaction and the success of the students in class.

Every student has tendency to learn by definite way, and we can add variety to our teaching activities, design our course considering different learning preferences and improve the success of the students by knowing their learning styles. Engineering at professional level consists of the essence in creating and doing things on one's own responsibility, and development of this capacity is the fundamental aim of engineering education. Hence, how students presently learn in an engineering department is a necessary prerequisite for any proposed modifications to teaching methodologies.

There are many studies on foreign engineering students' and instructors' learning and teaching styles. This study is unique in that the learning styles of Turkish engineering students are considered here. It is beneficial to see engineering students' learning style preferences to adopt courses according to the preferences of the students. Moreover, this study is supposed to be helpful for the students in engineering departments to know their preferred learning style.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter presents development of learning style, the learning style models, and review of related studies on learning styles both in the world and in Turkey.

2.1. Development of Learning Style

Before 1940, research on learning style was concerned with relationship between memory and oral or visual teaching methods. Most early researchers were occupied with finding the one perceptual mode that would best increase learning or retention. The consideration of learning style has widened since 1960s to include selection strategies (scanning an focusing), open/ closed mindedness, memory or retention styles, risk taking vs. cautiousness, and sensory modality preferences (kinesthetic, tactual, visual, and auditory). The term learning style began to appear in the learning literature in the 1970s.

In 1974 a study of 40 people revealed interesting results about people' learning styles (Gregorc, 1982). Gregorc's study showed that learning style patterns could be learned or adopted to some degree. He mentioned four peculiar driving forces to learning as space, time, mental processing, and relationships. The space qualities dealt with concrete space and abstract space. Time refers to order structures as sequential and random. Mental processing occurred through deduction and induction. Finally, relationships would be more individual or as a group relations. The sample group in Gregorc's study showed significant preferences toward one type of space, time, processing, and relationship more than other (Gregorc, 1984). This finding leaded learning style studies toward bipolar dimensional perspectives. Bipolar characteristics of learning style theories are criticized as, no doubt the partitioning of thinking into two types involves something of an over-simplification but possibly a useful one (Nickerson, Perkins, and Smith, 1985, p.23). Among the terms used to describe one type are analytic, deductive, rigorous, constrained, convergent, formal and critical. Representative terms used to describe the other type are synthetic, inductive, expansive, unconstrained, divergent, informal, diffuse and creative." (Nickerson et al., 1985)

Grigorenko and Sternberg (1995) claims there are three distinct approaches in the style conceptualization that are centered on cognition, personality, and activity. Cognition-centered approach (1940-1970) focused upon individual differences in cognition and personality, resulting in the identification and description of several styles, abilities, and dimensions of cognitive processing. The personality-centered approach dates from the 1970s and involves the study of styles in relation to other individual personality characteristics. The activity-centered approach or learning-centered approach, focus on styles in relation to various activities, settings, and environments.

The great impetus was taken in the learning style conceptualization by Jung's theory of psychological types. C. G. Jung's (1971) theory of psychological types attempts to categorize people in terms of their primary modes of psychological functioning. The theory is based on the assumption that there are different functions and attitudes of consciousness. The functions of consciousness refer to the different ways in which the conscious mind can apprehend reality. According to Jung, these are (a) Sensation, (b) Intuition, (c) Thinking, (d) Feeling. Jung arranges these four functions into two pairs of opposites. Firstyly, there are two perceiving (or non-rational) functions of Sensation and Intuition. Secondly, there are two judging (or, rational) functions of Thinking and Feeling. In 1981, Dunn and Dunn developed learning style model that consider learning style across five categories: Environmental, Emotional, Sociological, Physiological, and Psychological. Kolb (1984) considered the learning as a circular process and claimed what is important is student's place in the cycle. Felder and Silverman (1988) combined all these theories and developed their own learning style theory.

Cornett (1983) theorized that each individual is born with certain tendencies toward particular learning styles that are subsequently influenced by culture, personal experiences, maturation, and development. Learning style also have been referred to as an individual typical way of reacting to and utilizing stimuli in the context of learning (Claxton and Ralston, 1978).

Velmunt (1996) describes the concept of a learning style in four aspects: processing strategies, regulation strategies, mental models of learning and learning orientations. Processing strategies are thinking activities students use to process information. Regulation strategies (metacognitive) are activities students use to monitor, to plan and to control the processing strategies. Mental models of learning are conceptions and misconceptions students have about learning process. Learning orientations are personal aims, intentions, expectations, doubts, etc. Entwistle and Ramsden (1983) define learning style as the general tendency to adapt a particular strategy. In addition, they state that it may be helpful to view styles as being more a characteristic of the individual, and approaches as being more obviously affected by the context of studying.

The terms learning strategy and learning styles are often confused with each other. As cognitive variables, learning strategy and learning style differ in their level of usage in learning stages. Learning strategies should be considered as the methods and tactics to learn a topic while learning styles refer to broader term than methods or tactic. According to Felder and Henriques (1995), learning styles pertain to the manners in which individuals typically acquire, retain, and retrieve information. Boilley, Onwuegbuzie, Daley (2000) shows the difference as; whereas learning styles represent unintentional, or automatic individual characteristics, learning strategies are action chosen by students that are intended to facilitate learning. Thus, the difference between learning styles and learning strategies is the level of intentionally (Sposky, 1989).

2.2. Learning Style Models

At least 32 commercially published instruments are being used by researchers and educators to assess the different dimensions of learning style. The instruments vary in length, format, and complexity. Some require special training to administer and interpret, whereas others can be given by following a few simple directions. Some instruments measure just one dimension of style, whereas others measure two or three. The main models that try to define learning style of the learners can be categorized as follows;

Myers-Briggs Type Indicator (MBTI):

Briggs and Myers began working on an instrument in 1942 that was capable of measuring Jung's psychological types (Myers and Myers, 1980). Myers' and Briggs' research led them to believe that a fourth dimension which related to one's judgment and perception needed to be added to Jung's three dimensions (perception, judgment, and introversion/ extraversion). The Myers- Briggs Type Indicator (MBTI) uses a judgment/perception dimension and defines the four learning style dimensions as follows;

Preference for	Affect a Person's choice
Extraversion or Introversion …..	to focus the dominant favorite process on the outer world or on the world of ideas
Sensing or Intuition……………..	to use one kind of perception instead of the other when either could be used.
Thinking or Feeling……………..	to use one kind of judgment instead of the other when either could be used.
Judgment or Perception…………	to use the judging or the perceptive attitude for dealing with the outer world.

(Myers, 1981, p.9).

The four dimensions of the MBTI are compiled to form an individual composite consisting of four preferences. There are sixteen possible "people types". A comprehensive discussion of all sixteen people types as identified by the MBTI is beyond the scope of this research.

MBTI was developed by Isabel Briggs Myers and Katherine Cooks Briggs, the inventory is based on Carl Jung's concept of archetypes (McCaulley et al., 1987; Myers and Myers, 1980). It is a self-reporting instrument, which offers a forced-choice format between equally valuable alternatives. Used for identifying personality types in order to improve communication and open the possibilities for learning.

Kolb/ Mc Carthy Learning Cycle :

A significant impetus in the development of the Colb/ Mc Carthy learning cycle model was Kolb's observation of the distress encountered by many students whose learning styles mismatch to their disciplinary majors (Kolb,1981). An underlying assumption of the model is that all learning entails a cycle of four learning models, but each individual is likely to feel most comfortable in one of the four modes of the cycle based on her/his preference along two dimensions: Perception (Abstract/ Concrete) and Processing (Active/ Reflective).

Kolb's learning cycle is useful for conceptualizing how people learn and for developing courses and training programs (Claxton and Murrel , 1987). Kolb showed that learning styles could be seen on a continuum running from concrete experience to active experimentation.

Concrete Experience (CE): being involved in a new experience,

Reflective Observation(RO): watching others or developing observations about own experience,

Abstract Conceptualization(AC): creating theories to explain observations, *Active Experimentation(AE):* using theories to solve problems make decision.

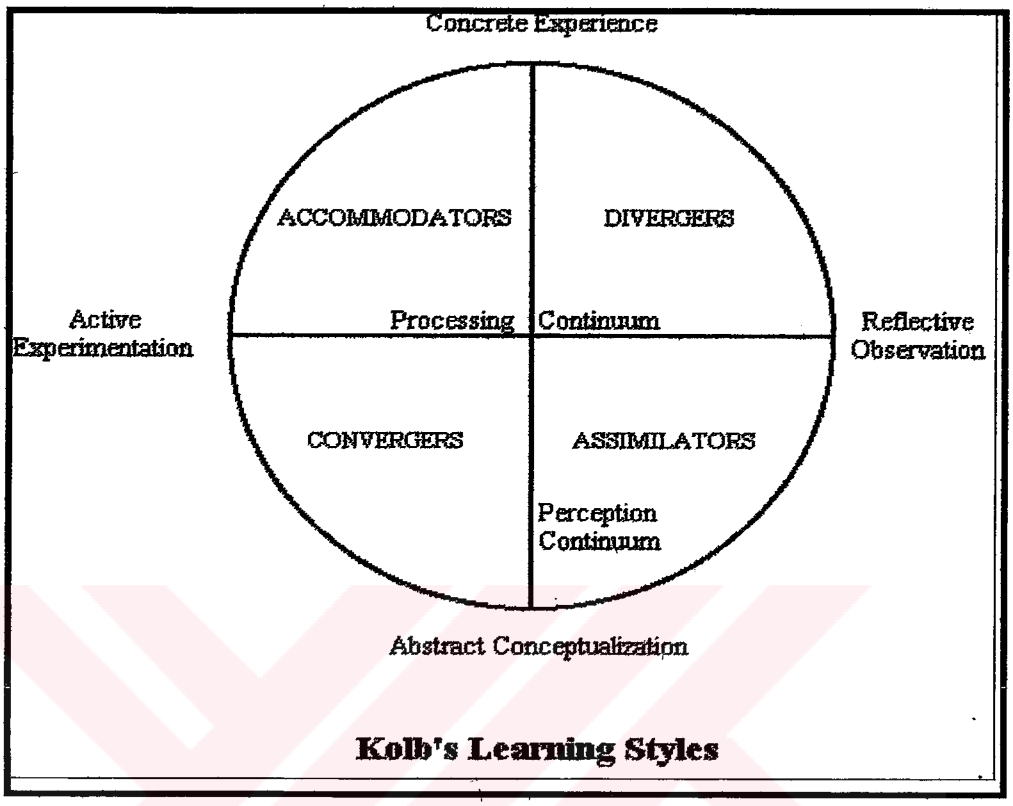

Figure 2.1. *Kolb's Learning Style Model*

Raschick, Maypole, and Day (1998) state students who use converger style are best at finding practical uses for theories and ideas, with strength in problem-solving, decision-making, defining problems and deductive reasoning. Assimilators are best at understanding a wide range of information and putting into a concise, logical form, with strength in planning, creating models, defining problems, and developing theories. Divergers are creative, good at generating alternatives, recognize problems, and understand people. Accomodators adopt well to immediate circumstances, learn primarily from "hands on" experience, get things done, take risks, and tend to act on feelings rather than on logical analysis.

Westman (1993) stated that learning styles are content-specific and thus are influenced by the content area studied. According to Hargreaves (1996), the converger learning style is most appropriate for a practicing engineering career, and the assimilator learning style matches the scientific, research side of the profession.

Grassa- Riechmen Student Learning Style:

A careful study of student approaches to learning led Grasha and Reichmann (1974) to develop a set of student learner types that indicate the likely attitudes; habits and strategies students will take toward their work. It focuses on how students interact with teachers and colleagues with respect to their learning process. It is therefore more categorization of social indicators rather than of cognitive styles or developmental stages.

Grasha and Reichmann considered learning style under the following sub-dimensions,

a. Competitive vs. Collaborative;

Competitive: Students who learn material in order to *perform* better than others in the class.

Collaborative: Typical of students who feel they can learn by sharing ideas and talents.

b. Avoidant vs. Participant;

Avoidant: Describes students who are not enthusiastic about learning content and attending class.

Participant: Try to be good citizens in class. Enjoy going to class and taking part in as much of the course activities as possible.

c. Dependent vs. Independent;

Dependent: Show little intellectual curiosity and learn only what is required.

Independent: Students who like to think of themselves and are confident in their learning abilities.

Dunn and Dunn Learning Style Model:

Their model addresses 21 unique elements that effect learning. Those 21 elements are classified into environmental, emotional, sociological, physiological and psychological variables. According to Dunn and Dunn (1995) learning style is made up of five elements:

Environmental preferences include preferences for sound, light, temperature, and design. Emotions refer to the preferences toward academic productivity—motivation (self-motivated or motivated by others), structure (internal or external need from others), persistence (working continuously on one task or a repeated start-stop approach while working on more than one task at a time), and responsibility (conforming or nonconforming). Sociological preferences refer to the preference for learning alone, in a pair, with peers as part of a team, with an authoritative or collegial adult, or in varied ways rather than routines. Physiological characteristics—auditory, visual, tactual, and/or kinesthetic perceptual preferences, time-of-day energy levels, intake (drinking or snaking), and mobility versus passively needs.

Herrmann Brain Dominance Instrument (HBDI):

This method classifies students in terms of their relative preferences for thinking in four different modes based on the task-specialized functioning of the physical brain (Felder,1996). The four modes or quadrants in this classification scheme are;

Quadrant A (left brain, cerebral). Logical, analytical, quantitative, factual, critical;

Quadrant B (left brain, limbic). Sequential, organized, planned, detailed, structured;

Quadrant C (right brain, limbic). Emotional, interpersonal, sensory, kinesthetic, symbolic;

Quadrant D (right brain, cerebral). Visual, holistic, innovative.

Index of Learning Style ILS (Felder and Silverman Learning Stlyle Model:

The Felder- Silverman learning Style Model has some features of the other instruments and classifies the learners as sensing or intuitive, visual or verbal, inductive or deductive, active or reflective, sequential or global. Felder(1996) classifies learners into the following types;

Sensing (concrete, practical, fact-oriented) or *intuitive* (innovative, theory-oriented); *Visual* (prefer learning visually with the help of pictures, diagrams or flowcharts) or *verbal* (prefer written or spoken presentation of material); *Inductive* (who like learning special details first and then proceed to the general notions) or deductive (who prefer learning general concepts first and then proceed to the specific); Active (learn best by trying things out and working with others) or *reflective* (learn via thinking things through and like working independently); *Sequential* (like to learn gradually, step by step) or *global* (need to have a general picture; they prefer learning in large steps). Felder – Silverman's Index of Learning Style (ILS) is developed specially for assessing learning styles of engineering students.

2.3. Research on Learning Style

Researches on learning style were presented as research in the world and in Turkey.

2.3.1. Research in the World

Educationalists examined learning style's effect on learning and teaching in many studies. Nelson at al. (1993) investigated the relationship between learning styles and

GPA among college students. They found that students who were involved in a learning style workshop had higher GPAs than students who were not involved in such a workshop. In their workshop they followed the steps; (1) completing a learning style instrument, (2) developing a background in individual learning styles, (3) becoming aware of strategies, study tips to accommodate individual styles.

Bailey et al. (2000) examined the relationship between learning styles and academic achievement using PEPS (Dunn et al 1991). They found that higher achievers in foreign language classes tend to like informal classroom designs and prefer not to receive information via the kinesthetic mode.

To assess the students' learning style and their academic performance at university level, Ross, Drydale, and Schulz (2001) conducted a longitudinal study in computer application courses. Using Gregorc style delineator, learning style information from a sample of 974 students were collected over a four-year period from 1993 to 1997. Results of this study showed that learning styles played a significant role in determining student success in introductory computer courses. The researcher found that of all learning style groups, those who were dominant in Abstract Random had difficulty when faced with the task of learning from the computer. In contrast, dominant Abstract Sequential, Concrete Sequential and Concrete Random students all increased from pretest to posttest with dominant Abstract Sequential learners outperforming all other learning style groups.

In the early 1990s, Edward Lumsdaine studied on colledge students and faculty members using the Hermann Brain Dominance Instrument (HBDI). They found that many engineering students and professors were left-brain thinkers namely, logical, analytical, verbal, and sequential (Lumsdaine, 1995). Engineering professors on the average were strongly Quadrant A dominant and would like their students to be that way as well according to Lumsdaine Edward and Monica (1995). Also Felder (1996) stated that 20 to 40 % of the engineering students have strong preferences for C (Emotional, interpersonal, sensory, kinesthetic, symbolic) and D (Visual, holistic, innovative) quadrant thinking.

ILS, developed by Felder and Silverman (1988), was used to assess the learning style preferences of engineering faculty members and first- year and fourth-year engineering students at University of Western Ontario by Peter Rosati (1999). Rosati found that faculty members were significantly more reflective, intuitive, and sequential than the students. The result suggests that professors could improve engineering instruction by increasing the use of methods that orient toward active learners, sensing learners, and global learners.

At North California University Felder (1995) used Felder and Silverman's model to design the instruction in a longitudinal study of engineering education. He taught five sequential chemical engineering courses in a way that would appeal to a range of learning styles. Throughout the application, the researcher used realistic examples of engineering process to illustrate basic principles and stressed active learning experiences in class. The results of his study suggest that teaching to the full spectrum of learning styles improves students' learning, satisfaction with their instruction, and self-confidence.

Additional to the learning style studies, there are studies that investigated the instructors and their teaching styles at university level. Dall' Alba (1991) interviewed 20 university teachers across four disciplines to determine their conceptions of teaching. She described seven different conceptions: (1) presenting information, (2) transmitting information from teacher to student, (3) illustrating the application of theory to practice, (4) developing the capacity in students to be experts, (5) developing concepts and principles through interaction with students, (6) exploring ways of understanding from particular perspectives, and (7) bringing about conceptual change in students.

Ginter, Brown, Scalise, and Ripley (1989) investigated whether learning styles of students differed in terms of age, sex, and understanding in a university setting. The study involving in 35.000 university students revealed significant relationships between learning style preferences and age. They used James and Galbraith's types of learning style classification and found that individuals who indicated print or a split preference tended to be older than those selecting a visual preference. Additionally, study did not indicate any significant result with respect to class standing and sex.

Coker (1995) administrated the Kolb's Learning Style Inventory (ILS) to 23 athletes, and asked them to complete instrument first focusing on classroom learning, then on learning in their sport. He found significant difference between the cognitive and motor settings for the feeling and thinking modalities. In other words, study have showed that feeling and thinking learning modalities shift depending on the setting.

Valle et al. (1986) investigated the active and passive learners' mobility preference and recognition levels. This study was conducted on approximately 1.500 students in high school. The Learning Style Inventory (LSI) have been used to collect data in the study. They found that students' performance yielded significantly higher scores when the students' mobility preferences and learning environment were matched rather than when preference and environment were mismatched. The results of their study also revealed insignificant correlation between sex and active/reflective preferences. In other words, the preference youngsters reported (active or reflective), their gender (male or female), and the environment (active or passive) do not appear to have caused the interaction.

An experimental study was conducted by Rosati, Dean, and Rodman (1988) to investigate interaction of learning style and the presentation modes in an undergraduate engineering course at West Virginia University. The researchers administrated the Myers- Brings Type Indicator (MBTI) to the 31 students in the course and assigned them according to their scores on the sensing and intuitive dimension. One group was taught by an INFJ (Introvert, Sensor, Feeler, Judger) instructor in a theoretical intuitive style manner. The other group was taught by an ISTJ (Introvert, Sensor, Thinker, Judger) instructor in a step-by-step algorithmic "sensing type" treatment. Both groups were given the same homework problems and they wrote a common one-hour examination at the end of the experimental period. Researchers designed a questionnaire to determine how the students in each treatment felt about their instructional mode. They found significant relationships between teaching modes and performance level. Students receiving detailed, algorithmic instruction performed substantially better on sensing oriented questions. In addition they found significant interaction between personality type and instructional mode.

Stice (1991) made an investigation to see if matching instructional style with students' learning style increase the conditions of leaning among chemical engineering students. The subjects of the study were 38 chemical engineering students. Firstly, researcher has defined learning styles of the students using Kolb's learning style model. According to study result 19 of the students in the subject group were assimilator, 16 of them were diverger, 2 of them were accommodator, and 1 of them were converger. During a semester researcher arranged courses according to their learning style preferences and at the end students were interviewed about the courses. Students stated that they learned easier with the new methods. Also study found that when the students were taught according to their learning style preferences their success increased significantly.

Considerable research has been conducted regarding the relationship between students' learning styles and academic performance (Witkin, 1973; Gregorc, 1979; Guild and Garger, 1985; Claxton and Murrell, 1987; Schroeder, 1996). These studies concluded that when learning styles were considered in the teaching-learning process, student achievement was enhanced. Schroeder acknowledged that accommodating the variations in learning styles could improve curricula, the teaching-learning process, and ultimately the retention of students in higher education.

2.3.2. Research in Turkey

There are a few studies that investigated learning styles and its effect on learning at university level in Turkey. Various models were used to assess the learning style preference of the students in these studies.

Çekiç (1991) made an investigation to see if matching between students' learning style and teacher's teaching style effects the academic achievement of the students. To conduct this study, he used ELT classrooms as experimental and control groups. After identifying students' and teachers' perceptual learning/ teaching styles, students whose perceptual learning style matched their teachers' teaching styles were placed in the experimental groups, and students with unmatched learning styles were placed in control groups. A matched pairs t-test was performed in order to compare the gain scores of the groups, obtained by means of pre and posttests. In the study, researcher used pretest-posttest control group design to determine whether similarities in learning/ teaching styles had any impact on academic achievement of the subjects. The analysis of the data did not indicate any statistically significant relationship. Also study result revealed significant relationships between sex and visuality. That is, female students are more visual than the male ones.

The cognitive learning style is one of the three major categories of student learning styles. The other two categories of student learning styles are: affective and physiological styles (Hunt, 1979). Behçetoğulları (1992) investigated the relationship between cognitive style (field dependence/ independence) of the learner and second language acquisition. The purpose of this study was to determine whether field independent students achieve higher scores on test when taught grammar lessons with a deductive approach and field independent students achieve higher scores when taught with an inductive approach. The author hypothesized that the field dependent students will achieve higher scores on multiple choice test and close test than the field independent students. Also she hypothesized that field independent students perform better than field dependent students on the multiple choice test, and field dependent students will perform better than the field independent students on close test. 40 students (20 field independent, 20 field dependent) were selected from Bilkent University School of English Language (BUSEL). The students were given GEFT (Group Embedded Figures Test) to define their dominant cognitive style (field dependent vs. field independent). Also multiple choice test and close test were used to assess grammar performance of the sample group. Research results did not verify the hypothesis. Also, the study showed that field independent learners have an advantage over field dependent learners on a multiple-choice test.

Ekici (2001) investigated whether biology courses at high school level are taught according to students' learning style preferences or not. She observed 30 biology classrooms at high school level during their classroom activities and lab courses. The subject of the study was 30 biology teachers selected from 8 different schools from different regions of Ankara. As a data collection instruments observation and interview forms, developed by the researcher, have been used. Students' learning style preferences have been identified according to Gregorc's learning style model. Teachers' use of different teaching activity have been investigated according to their graduated faculty and according to their involvement of in-service training programs before the implementation. Researcher did not find any significant difference among biology teachers according to their graduated faculty. Also, she did not find significant difference between the teacher group who have been involved in-service training programs and the others who have not involved in such a programs in terms of using appropriate teaching activity for different learning styles in biology courses.

Demirbaş (2001) examined the learning styles' effect on students' performance in the Department of Interior Architecture at Istanbul Technical University (ITU). The author hypothesized that different courses in the curriculum require different learning styles or in other words, the performance scores of students having different learning styles may vary according to content of the course. He used the Kolb's experimental learning cycle to assess the performance scores of the architecture students in a studio design course. In the design process, stages, which require different learning processes, were devised for controlling the effects of different learning styles on the performance of students. It was found that, different learning styles affected the performance of students in different stages of a design problem through the studio process. The results showed that in different stages different learning styles became successful. For example, in stage 2 the most successful learners were the assimilating ones. The results of the study suggest that there is a relation between learning style types and different stages of design education. Author, also concluded that through design education process there is a shift from learning by experiencing (CE) and learning by doing (AE) to learning by reflecting (RO) and learning by thinking (AC).

Research on learning style preferences of Turkish students made by Dizdar (1993) showed interesting results about graduate and undergraduate students' learning preferences at Istanbul Technical University (ITU). She assessed the learning style preferences of the undergraduate and graduate students who were enrolled in English preparatory classes at Istanbul Technical University (ITU). Learning style questionnaire which was developed especially for English language learners was used as an instrument in the study. The study was carried on 152 (90 undergraduate, 62 graduate) intensive English preparatory students out of 1180 at Istanbul Technical University (ITU). The results showed that no ITU prep students was communicative learners. Moreover, 50,7% of all the participants were concrete learners, and 13.3% were analytical. In short, the major learning style preference of Istanbul Technical University (ITU) students was concrete learning style.

In summary, most of the learning style studies were in the context of foreign language learning in Turkey. When the general profile of the learning style studies is undermined in the world, it is obvious that there are various studies in this field. Using different instruments and methods researchers investigated learning style preferences of the learners. Many research results showed that individual learning differences affect the classroom environment heavily in all educational levels.

CHAPTER 3

METHOD

This chapter is devoted to overall design, research questions, hypothesis, sample, instruments, data collection procedures, and data analysis.

3.1. Overall Design of the Study

The main purpose of this study was to investigate the learning styles of the students in engineering departments at METU.

This research is a descriptive study. According to Isaac and Michael (1981, p.46) descriptive research is used " to describe systematically the facts and characteristic of a given population or area of interest, factually and accurately". The design of this study portrayed the state of fourth grade engineering students' learning style preferences at METU. Study composed of two distinct parts. First the context of this study was established through a comprehensive review of literature on development of learning style, learning style models, and researches made in Turkey and in the world. Secondly, to describe the learning styles of engineering students at METU, this study utilized stratified random sampling, Index of Learning Style Questionnaire, mean and percentages, Pearson's Chi-Square, and crosstab analysis.

3.2. Operational Definitions

The following operational definitions were accepted in this study by their intended meaning in the context of their cited references;

Learning Style: " The composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interact with, and responds to the learning environment. It is demonstrated in that pattern of behavior and performance by which an individual approaches educational experiences. It is basis lies in the structure of neural organization and personality which both molds and is molded by human development and the learning experiences of home, school, and society." (Keffe and Ferrell, 1990, p.59).

Learning Strategy: " A learning strategy is a complete plan one formulates for accomplishing a learning goal, and a learning tactic is any individual processing technique one uses in service of the plan. That is a learning strategy is the application of one or more specific tactics to a learning problem" (Derry, S.J., 1989, p.5).

Engineering: " The profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind " (Wright, P.H., 1989, p.23)

Engineering Education: A formal education that provides fundamental engineering knowledge for a learner group during a four-years period.

3.3. Research Questions

In this study there are 4 main and 12 sub questions.

1- What are the dominant learning styles of the engineering students at METU according to Felder's four learning style dimensions?

2- Do learning styles differ according to department?

2.1. Do the students in four group of departments differ from each other in terms of process dimension?

2.2. Do the students in four group of departments differ from each other in terms of perception dimension?

2.3. Do the students in four group of departments differ from each other in terms of input dimension?

2.4. Do the students in four group of departments differ from each other in terms of understanding dimension?

3. Do learning styles of the engineering students differ according to sex?

3.1. Do male and female students differ from each other in terms of process dimension?

3.2. Do male and female students differ from each other in terms of perception dimension?

3.3. Do male and female students differ from each other in terms of input dimension?

3.4. Do male and female students differ from each other in terms of understanding dimension?

4. Do the engineering students' CGPA scores differ according to their learning style preferences?

4.1. Do the engineering students' CGPA scores significantly differ according to their preferences for process dimension (active or reflective)?

4.2. Do the engineering students' CGPA scores significantly differ according to their preferences for perception dimension (sensing or intuitive)?

4.3. Do the engineering students' CGPA scores significantly differ according to their preferences for input dimension (visual or verbal)?

4.4. Do the engineering students' CGPA scores significantly differ according to their preferences for understanding dimension (sequential or global)?

3.4. Hypothesis

The following hypotheses were developed from the research questions and the review of related literature.

1. Learning style preferences of engineering students are not different depending on their department.
    1.1. Engineering students' preferences for process dimension are not significantly different from each other according to department variable.
    1.2. Engineering students' preferences for perception dimension are not significantly different from each other according to department variable.
    1.3. Engineering students' preferences for input dimension are not significantly different from each other according to department variable.
    1.4. Engineering students' preferences for understanding dimension are not significantly different from each other according to department variable.

2. Learning style preferences of engineering students are not different depending on their sex.
    2.1. Engineering students' preferences for process dimension are not significantly different from each other according to sex variable.
    2.2. Engineering students' preferences for perception dimension are not significantly different from each other according to sex variable.
    2.3. Engineering students' preferences for input dimension are not significantly different from each other according to sex variable.
    2.4. Engineering students' preferences for understanding dimension are not significantly different from each other according to sex variable.

3. Students' CGPA scores do not differ according to their learning style preferences.
    3.1. CGPA scores of the students do not significantly differ according to process dimension preferences.

3.2.CGPA scores of the students do not significantly differ according to perception dimension preferences.

3.3. CGPA scores of the students do not significantly differ according to input dimension preferences.

3.4.CGPA scores of the students do not significantly differ according to understanding dimension preferences.

3.5. Description of Variables

For second and third research questions, department and sex were the independent variable and dependent variables were Felder's four learning style dimensions, namely processing (active vs. reflective), perception (sensing vs. intuitive), input (visual vs. verbal), and understanding (sequential vs. global). Cumulative GPA score was dependent and independent variables were learning style dimensions for fourth research question and its sub-questions. Sex and department were categorical, and CGPA was continuous variable.

3.6. Subjects of the Study

The subjects of the study was the fourth grade (senior) students in all departments of Faculty of Engineering at METU in 2001-2002 academic year. Using stratified random sampling 400 students out of 1447 senior engineering students were selected from all engineering department which are; Aeronautical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical and Electronics Engineering, Environmental Engineering, Food Engineering, Geological Engineering, Industrial Engineering, Mechanical Engineering, Metallurgical and Materials Engineering, Mining Engineering, Petroleum and Natural Gas Engineering.

Number of fourth grade students, number of subjects and subject group by gender are shown in Table 3.1. Nearly 30% of the subjects were selected from all engineering departments.

As Table 3.1 displays, Electrical and Electronics Engineering students form the largest group of respondents (17.5 %). Civil Engineering students follow them as the second largest group (16.5%). Mechanical Engineering students represented 14.3% of the total sample. Other departments' percentages in the sample group are less than 10%.

Table 3.1
Distribution of Subjects According to Department and Gender

Department	Total Number of Seniors	N (~30%)	Male	Female	P	Cumulative Percent
Industrial Eng.	103	27	19	8	6.8	6.8
Geological Eng.	51	22	15	7	5.5	12.3
Mining Eng.	38	14	10	4	3.5	15.8
Computer Eng.	119	33	23	10	8.3	24
Petroleum and Natural Gas Eng.	38	8	8	0	2.0	26
Environmental Eng.	76	15	9	6	3.8	29.8
Food Eng.	63	26	14	12	6.5	36.3
Chemical Eng.	106	26	16	10	6.5	42.8
Mechanical Eng.	232	57	51	6	14.3	57
Electrical and Electronics Eng.	240	70	62	8	17.5	74.5
Civil Eng.	222	66	57	9	16.5	91
Metallurgical and Materials Eng.	94	27	23	4	6.8	97.8
Aeronautical Eng.	65	9	7	2	2.3	100
Total	1447	400	314	86	100.0	

Due to the small number of students in some departments, the departments were grouped according to the common must courses on engineering offered in each department. (see appendix C).

Table 3.2
Engineering Departments Grouped According to Must Courses Offered

Categories	Departments	N	P
Group I	Electrical and Electronics Engineering	103	25.8%
	Computer Engineering		
Group II	Environmental Engineering		
	Civil Engineering	125	31.2%
	Geological Engineering		
	Mining Engineering		
	Petroleum and Natural Gas Engineering		
Group III	Industrial Engineering		
	Mechanical Engineering	120	30%
	Metallurgical and Materials Engineering		
	Aeronautical Engineering		
Group IV	Food Engineering	52	13%
	Chemical Engineering		
Total		400	100%

3.7. Data Collection Instrument

In this study, Index of Learning Style designed by Felder and Silverman was employed. ILS is an instrument, which was developed from the learning styles model of Richard Felder and Linda Silverman (Felder and Silverman, 1988). In their learning style model Felder and Silverman (1988) presents four learning style dimensions as; processing dimension (active/reflective), perception dimension (sensing/intuitive), input dimension (visual/verbal) and understanding dimension (sequential/global). ILS (Index of Learning Style) developed especially for assessing the learning style preferences of engineering students by its authors.

Index of learning style is a paper- pencil instrument that is designed to measure students' learning styles according to Felder's four learning style dimensions (active-reflective, sensing-intuitive, visual-verbal, sequential-global).

The ILS consists of 44 two-part ('a' and 'b') items, designed to provide scores on the four hypothesized bipolar scales. Total scale scores are computed by summing the scores on the 'a' parts of relevant questions/ items and subtracting the sum of the relevant 'b' parts (or vise versa if the 'b' total is greater than the 'a' total). Each question has two options and the "a" responses represent active, sensing, visual, sequential learner while the "b" shows reflective, intuitive, verbal, global ones. Distribution of the items according to the related characteristics are shown in Table 3.3

Table 3.3
Distribution of the ILS Items According to the Related Characteristics

Learning Style Categories		Related Items
1	Active	1a, 5a, 9a, 13a, 17a, 21a, 25a, 29a, 33a, 37a, 41a
2	Reflective	1b, 5b, 9b, 13b, 17b, 21b, 25b, 29b, 33b, 37b, 41b
3	Sensing	2a, 6a, 10a, 14a, 18a, 22a, 26a, 30a, 34a, 38a, 42a
4	Intuitive	2b, 6b, 10b, 14b, 18b, 22b, 26b, 30b, 34b, 38b, 42b
5	Visual	3a, 7a, 11a, 15a, 19a, 23a, 27a, 31a, 35a, 39a, 43a
6	Verbal	3b, 7b, 11b, 15b, 19b, 23b, 27b, 31b, 35b, 39b, 43b
7	Sequential	4a, 8a, 12a, 16a, 20a, 24a, 28a, 32a, 36a, 40a, 44a
8	Global	4b, 8b, 12b, 16b, 20b, 24b, 28b, 32b, 36b, 40b, 44b

According to Felder and Silverman (1988), ILS is designed to tap four bipolar scales related to preferences for learning style.

To find mean scores for each of four learning style dimension "a" responses were coded as 1 and "b" responses coded as 2 and total scores were found for each of four learning style dimension. The mean scores ranges 11 from 22. The means between 11 and 16 represent active, sensing, visual, and sequential learners. On the other hand, the mean scores between 17 and 22 represent reflective, intuitive, verbal, and global learners.

Turkish form of ILS was prepared during the academic year 2001-2002 by the researcher and four English Literacy experts. At first, instrument was translated into Turkish form by two experts. Then it was re-translated into English by other two experts in order to reassure that the original and the translated forms of the instrument are consistent. The researcher analyzed all translations and in the final phase, a final version of the Turkish form of ILS was formed under the supervision of an educational expert from METU. Pilot study was conducted at Gazi University in the engineering departments, where students take 30% of their courses in English. In order to adapt ILS into Turkish, each item was examined in terms of its cultural bias. At the end of translation process, Turkish form of ILS was designed to employ in this study.

3.7.2. Pilot Study

To determine the construct validity and reliability of the instrument, a pilot study was conducted with 120 engineering students at Gazi University. All of 120 students were given the Turkish form of the inventory to complete. However, 40 students, whose English proficiency at an advanced level, were asked to complete Turkish and English forms in different sequence. At first, 20 of the students out of 40 took the English form of the inventory and then took the Turkish form. Meanwhile, the other 20 took the Turkish form. The answers of these 40 students were evaluated and correlated to check the match between the English and Turkish versions.

The results of the 40 students, who have taken both Turkish and English forms of the inventory, were used to compute correlation between these two forms. The significance of the correlation results (p = 0.05) indicated that there is a strong correlation between Turkish and English forms of the inventory. Furthermore, these results pointed out that the translation of the inventory is reliable enough to employ it. Both versions produced consisted scores and they were understood similarly with the same students.

Table 3.4
Pearson Correlations Between the Factors of English and Turkish versions of ILS

	n	r	p
Pair 1			
Active-Reflective (e)& Active-Reflective (t)	40	.87	.000
Pair 2			
Sensing Intuitive (e) & Sensing-Intuitive (t)	40	.79	.000
Pair3			
Visual-Verbal(e) & Visual-Verbal (t)	40	.92	.000
Pair 4			
Sequential-Global (e) & Sequential-Global (t)	40	.76	.000

(e= English version., t= Turkish version)

Table 3.5. summarizes the alpha reliability of English and Turkish ILS for each dimension.

Table 3.5
Alpha Reliability of Turkish and English Versions of the ILS

	English ILS	Turkish ILS
Dimension	Alpha Reliability Coefficients	Alpha Reliability Coefficients
Active-Reflective	.4323	.4998
Sensing-Intuitive	.6376	.7201
Visual-Verbal	.4907	.5172
Sequential-Global	.3604	.2324

To check the construct validity evidence for the instrument, the following steps were carried out;

- A principle component analysis was conducted so as to discover common factors underlying the set of items
- Following the component analysis, an oblique rotation was carried out.

The factor loading for each dimension was as follows

Table 3.6
Factor Loading of Each Learning Style Dimension

Dimension	Percentage of total variance explained
Active-Reflective	6.42
Sensing-Intuitive	5.18
Visual-Verbal	4.30
Sequential-Global	3.49

As can be seen from the factor loading of the instrument, the sequential-global (understanding) dimension of the instrument has the weakest percentage among all four bipolar dimensions. This indicates that sequential and global related items are not good enough to assess students' preferences for the way of the understanding dimension. However, for the sake of not changing the originality of the instrument, the questions in this dimension were not altered.

Table 3.7 shows the reliability coefficients of items in each dimension, for the sample group, calculated by using SPSS 10.0 for windows.

Table 3.7
Alpha Reliability of Each Learning Style Dimension

Dimension	Alpha Reliability
Active-Reflective	.4935
Sensing-Intuitive	.5518
Visual-Verbal	.5302
Sequential-Global	.2989

In this table, the weakest dimension is the sequential-global one, just as in the table 3.6 titled as Factor Loading of Each Learning Style Dimension.

Champhell (1991) states four important points to be considered before choosing any learning style instrument. These are; (a) cost of the instruments, (b) time required to administer, (c) ease of interpretation, (d) validity.

ILS is suitable instrument because;

- It takes 15 minutes to complete,
- It was developed especially for engineering students,
- Interpretation of the instrument is easy,
- It is a pencil-paper instrument, which is easy to accommodate.

3.8. Data Collection Procedures

The final form of the ILS was distributed to 440 engineering students and 400 forms were returned.

In Food Engineering, Chemical Engineering, Mechanical Eng., Petroleum and Natural Gas Eng., Geological Eng., ILS were given to the department secretaries and they distributed them to the randomly selected senior students and collected forms. In departments like Electrical and Electronics Eng., Computer Eng., Civil Eng., the researcher distributed and collected the forms. In the Mining Eng., Industrial Eng. departments, the researcher joined the senior students' classes to collect data with the help of the instructors. In departments of Metallurgical and Materials Eng. and Aeronautical Eng. the Head of the Departments helped researcher to distribute and collect the forms in their own courses.

3.9. Analysis of the Data

The primary purpose of the study was to describe general learning style preferences of engineering students at METU.

For the first main question, percentages and means were calculated. For the second and third research questions and their sub-questions, chi-square were calculated and their percentages were presented in terms of crosstabs. For the fourth question, in order to examine if students having different learning style preferences differ from each other in terms of CGPA independent t test was conducted for each of four learning style dimensions. The grouping variable for t test were learning style dimensions namely, processing, perception, input, understanding. Each of these dimensions includes two options in it. Dependent variable was CGPA. Since the CGPA was continues variable and the independent variables are in two categories, t test was used to answer fourth research questions and its sub-questions.

Data obtained in the study was analyzed using SPSS packaged program (Green, Salkind, Akey, 2000).

3.10. Limitations of the Study

The scope of the study was limited to the fourth grade students in engineering departments in 2001-2002 spring semester.

Another limitation of the study was related to instrument used. Bipolar characteristics of the questions in the inventory limit the students in presented two alternatives.

The study was descriptive in a sense and qualitative studies are needed to gather deeper information in relation to learning style studies.

CHAPTER 4

RESULTS

In this chapter, the data obtained from the sample using Index of Learning Style (ILS) is presented. Initially, students' dominant learning style preferences are displayed and discussed. Next, learning style preferences were analyzed in terms of CGPA, sex, and department variables.

4.1. Learning Style Preferences of Engineering Students

What are the dominant learning styles of the engineering students at METU according to Felder's four learning style dimensions?

We examined students in the sample group in terms of Felder's four learning style dimensions. Felder considers learning in terms of process (active vs. reflective), perception (sensing vs. intuitive), input (visual vs. verbal), and understanding (sequential vs. global).

Total number of students' ILS scores were calculated for each learning style dimension. To calculate mean score of the groups, sub-dimensions were coded as 1 and 2. In other words, mean score value between 11 and 16 represents active, sensing, visual, sequential learning preferences, while the mean score value between 17 and 22 indicates reflective, intuitive, verbal, and global learning preferences. Mean values range from 11 to 22 for each learning style dimension.

Table 4.1.

Engineering Students' Distribution of Learning Styles According to Felder's Four Learning Style Dimensions

ENGINEERING DEPARTMENTS					
		n	P	M	N
In terms of processing (Active versus Reflective)	Dominant Active	244	61%	15.87	400 100%
	Dominant Reflective	156	39%		
In terms of perception	Dominant Sensing	254	63.5%	15.66	400
(Sensing versus Intuitive)	Dominant Intuitive	146	36.5%		100%
In terms of input	Dominant Visual	366	91.5%	13.62	400
(Visual versus Verbal)	Dominant Verbal	34	8.5%		100%
In terms of understanding	Dominant Sequential	168	42%	16.89	400
(Sequential versus Global)	Dominant Global	232	58%		100%

The results of the study have revealed that students in all engineering departments are heavily active, sensing, visual, and global rather than reflective, intuitive, verbal, and sequential (Table 4.1).

4.2. Results Related to Process Dimension of Learning Style

The first dimension of learning in Felder and Silverman's learning style theory is the processing dimension. It examines students' learning style to see whether they are active participants or reflective thinkers in their learning process.

In the present study it was hypothesized that engineering students' preferences for process dimension were not significantly different from each other according to department and sex variables. Also, the study claimed that students' CGPA scores did not differ according to their preferences on process dimension.

The process dimension related research questions are as follows;

- Do the students in four group of departments differ from each other in terms of process dimension?
- Do male and female students differ from each other in terms of process dimension?

The research question related to CGPA and process dimension was,

- Do the engineering students' CGPA scores significantly differ according to their preferences for process dimension (active or reflective)?

For department and sex related questions chi-square were carried out. As for CGPA variable t test was conducted.

4.2.1. Result Related to Department and Process Dimension Preferences

Do the students in four group of departments differ from each other in terms of process dimension?

Processing preferences of the students in four group of engineering departments, are shown in Table 4.2. The results showed that students in all groups are active learners. In terms of reflective learning the first group; Electrical and Electronics Engineering and Computer Engineering, have the highest percentages (42.7%). On the other hand, the students in the third group are heavily active learners (64.2%) rather than reflective.

Table 4.2
Processing Preferences of the Engineering Students According to Department

			Processing Dimension		
			Active	Reflective	Total
Departments	Group I	n	59	44	103
		%	57.3%	42.7%	100%
	Group II	n	75	50	125
		%	60.0%	40.0%	100%
	Group III	n	77	43	120
		%	64.2%	35.8%	100%
	Group IV	n	33	19	52
		%	63.5%	36.5%	100%
	Total	N	244	156	400
		%	61%	39%	100%

$\chi^2 = 1.29$ SD=3 p=.73

Chi-square result did not indicate any significant difference among four group of departments in terms of processing dimension (χ^2 (3)= 1.289, p=.73). In other words, there isn't any significant relationship between department and processing dimension of the learning style. Students' preferences for active or reflective learning do not change depending on their departments.

4.2.2. Result Related to Sex and Process Dimension Preferences

Do male and female students differ from each other in terms of process dimension?

To see if students' process dimension preferences are changing depending on their sex, chi-square test was conducted and presented in terms of crosstab.

Table 4.3
Processing Preferences of the Engineering Students According to Sex

		Process Dimension		
		Active	Reflective	Total
Male	n	186	128	314
	%	59.2%	40.8%	100%
Female	n	58	28	86
	%	67.4%	32.6%	100%
Total	N	244	156	400
	%	61.0%	39.0%	100%

χ^2= 1.91 SD=1 p=.17

The result indicated that both male (59.2 %) and female (67.4%) students are active learners rather than reflective in terms of process dimension of learning style. The distribution of active versus reflective learning is normally distributed among male students. As for reflective preferences male students have higher percentage (40.8%) than females (32.6%). When the Table 4.3 is examined one can easily see that active learning preferences ratio are very high among female learners comparing the males. However, the difference is not significant at statistical level. In short, most of the students are active learners and there isn't any significant difference in terms of sex factor (χ^2 (1)= 1.911, p= 17).

4.2.3. Result Related to CGPA and Process Dimension

CGPA scores of engineering students do not show any significant difference according to process preferences ($t_{(398)}$=1.44, p= .34). Although reflective learners' mean score (M=2.82) was higher than active ones (M=2.74), this difference was not significant at 0.05 level. This result would be interpreted as CGPA score does not affected by preferences of process dimension. In other words, students' preferences toward active or reflective learning did not influence their CGPA scores.

Table 4.4

t Test Results of Engineering Students' CGPA Scores According to Process Dimension

Process Dimension	N	M	SD	df	t	p
Active	244	2.74	.55	398	1.44	.34
Reflective	156	2.82	.58			

4.3. Results Related to Perception Dimension of Learning Style

Perception dimension includes sensing learners (concrete, practical, oriented toward facts) and intuitive learners (conceptual, innovative, oriented toward theories and meanings). The study hypothesized that engineering students' preferences for perception dimension are not significantly different from each other according to department and sex variables. Also the study claimed that engineering students' CGPA scores do not differ according to their perception preferences. In relation to the effect of sex and department variables on perception dimension, the following research questions were asked;

- Do the students in four group of departments differ from each other in terms of perception dimension?
- Do male and female students differ from each other in terms of perception dimension?

To test the hypothesis on students' CGPA difference on perception preferences the following research question was asked;

- Do the engineering students' CGPA scores significantly differ according to their preferences for perception dimension (sensing or intuitive)?

4.3.1. Result Related to Department and Perception Dimension

Do the students in four group of departments differ from each other in terms of perception dimension?

To examine the departments' effect on perception dimension chi-square test was conducted and not any significant result were found between department and perception (χ^2= 5.57, p= .14).

Table 4.5
Perception Preferences of the Engineering Students According to Department

			Perception Dimension		
			Sensing	Intuitive	Total
Departments	Group I	n	66	37	103
		%	64.1%	35.9%	100%
	Group II	n	83	42	125
		%	66.4%	33.6%	100%
	Group III	n	67	53	120
		%	55.8%	44.2%	100%
	Group IV	n	38	14	52
		%	73.1%	26.9%	100%
	Total	N	254	146	400
		%	63.5%	36.5%	100%

χ^2 = 5.57 SD= 3 p= .14

When the crosstab (Table 4.5) is examined one can easily see that engineering students are heavily sensing learners (63.5%) rather than intuitive (36.5%) in general. In other words, their dominant learning preference for perception was sensing learning, which emphasizes the concrete learning environment rather than the intuition. However, when it is examined in terms of departments, 44.2% of the students in the third group were intuitive learners, while this ratio decreased up to 26.9% for students in the fourth group (see Table 4.5). Most of the students in the fourth group of departments (Chemical Eng., Food Eng.) are sensing learners (sensors) in their perception of the knowledge.

4.3.2. Result Related to Sex and Perception Dimension

Regarding the sex variable it is obvious that most of the sample group, without any difference between males and females, have a tendency towards sensing learning preference, just as the department variable.

Table 4.6

Perception Preferences of the Engineering Students According to Sex

		Perception Dimension		
		Sensing	Intuitive	Total
Male	n	193	121	314
	%	61.5%	38.5%	100%
Female	n	61	25	86
	%	70.9%	29.1%	100%
Total	N	254	146	400
	%	63.5%	36.5%	100%

χ^2=2.61 SD=1 p=.11

Chi-square result indicated that sex is not a significant factor for determining the perception of the students (χ^2 = 2.61, p= .11). In other words, male and female students are not different from each other in terms of perception preferences, and both of them prefer sensing learning and concrete materials to theories.

4.3.3. Result Related to CGPA and Perception Dimension

CGPA scores of engineering students do not show significant difference according to perception preferences ($t_{(398)}$=.388, p= .92). CGPA mean scores of sensing (M=2.76) and intuitive (M=2.79) are not significantly different from each other. This result would be interpreted as CGPA scores of the students were not affected by perception dimension. In other words, students' preference toward sensing or intuitive learning did not influence their CGPA scores significantly.

Table 4.7
t Test Results of Engineering Students' CGPA Scores According to Perception Dimension

Perception Dimension	N	M	SD	df	t	p
Sensing	254	2.76	.56	398	.388	.92
Intuitive	146	2.79	.56			

4.4. Results Related to Input Dimension of Learning Style

The third dimension is input dimension. This investigates whether sensory information most effectively perceived by visual images (pictures, diagrams, graphs, demonstrations) or verbal materials (sounds, written and spoken words and formulas). The study hypothesized that engineering students' preferences for input dimension are significantly different according to department and sex variables. Also study hypothesized that CGPA scores of engineering students are significantly different considering input dimension of learning style.

To test the sex and department variables' effect on learning style preferences, conducted research questions are as follows;

- Do the students in four group of departments differ from each other in terms of input dimension?
- Do male and female students differ from each other in terms of input dimension?

In relation to the CGPA hypothesis the following research question was presented;

- Do the CGPA scores of engineering students significantly differ according to input preferences dimension (sensing or intuitive)?

For department and sex related questions chi-square tests were performed, and for CGPA independent t test was conducted using SPSS.

4.4.1.Department and Input Dimension

Do Students in four group of departments differ from each other in terms of input dimension?

Table 4.8

Input Preferences of the Engineering Students According to Department

			Input Dimension		
			Visual	Verbal	Total
Departments	Group I	n	95	8	103
		%	92.2%	7.8%	100%
	Group II	n	116	9	125
		%	92.8%	7.2%	100%
	Group III	n	106	14	120
		%	88.3%	11.7%	100%
	Group IV	n	49	3	52
		%	94.2%	5.8%	100%
	Total	N	366	34	400
		%	91.5%	8.5%	100%

χ^2=2.39 SD=3 p=.50

The results indicated that most of the engineering students are visual learners (91.5%). Majority of the students in the fourth group stated their preference toward visual learning (94.2%). As can be seen from the Table 4.8 department is not a determinant factor for input preferences.

4.4.2. Sex and Input Dimension

As for sex variable input dimension does not show any significant difference (χ^2= 0.91, p=.76). For both males and females visual learning preferences are dominant among engineering students. This means male and female students' preferences to get sensory information not differ.

Table 4.9

Input Preferences of the Engineering Students According to Sex

		Input Dimension		
		Visual	Verbal	Total
Male	n	288	26	314
	%	91.7%	8.3%	100%
Female	n	78	8	86
	%	90.7%	9.3%	100%
Total	N	366	34	400
	%	91.5%	8.5%	100%

χ^2= 0.91 SD=1 p=.76

4.4.3. CGPA and Input Dimension

CGPA scores of engineering students do not show significant difference according to input preferences ($t_{(398)}$=.98, p= .28). Although visual learners' mean score (M=2.74) was higher than verbal ones (M=2.68), this difference was not significant. This result would be interpreted as CGPA scores of the students were not affected by preferences for input dimension. In other words, students' preferences toward visual or verbal learning did not influence their CGPA scores.

Table 4.10
t Test Results of Engineering Students' CGPA Scores According to Input Dimension

Input Dimension	N	M	SD	df	t	p
Visual	366	2.74	.55	398	.98	.28
Verbal	34	2.68	.62			

4.5.Results Related to Understanding Dimension of Learning Style

The fourth dimension of learning is understanding in Felder and Silverman's learning style theory. This dimension searches whether students progress sequentially or globally toward understanding. Sequential learners progress information in small incremental steps while globals prefer large jumps (Felder, 1993). The study hypothesized that engineering students' preferences for understanding dimension are not significantly different from each other according to department and sex variables. Also, the study claimed that engineering students' CGPA scores did not differ according to their understanding preferences. In relation to the effect of sex and department variables on understanding dimension, the following research questions were asked;

- Do the students in four group of departments differ from each other in terms of understanding dimension?
- Do male and female students differ from each other in terms of understanding dimension?

To test the hypothesis on students' CGPA difference regarding understanding preferences the following research question was asked;

- Do the engineering students' CGPA scores significantly differ according to their preference for understanding dimension (sequential or global)?

4.5.1. Department and Understanding Dimension

Do the students in four group of departments differ from each other in terms of understanding dimension?

Engineering students stated their preference toward global learning (58%) rather than sequential (42%) with respect to understanding dimension . The students in the fourth group of departments have the highest percentage (67.3%) in global learning, while the students in the second group of departments have the highest perçentage in sequential learning (46.4%).

Table 4.11
Understanding Preferences of the Engineering Students According to Department

			Understanding Dimension		
			Sequential	Global	Total
Departments	Group I	n	44	59	103
		%	42.7%	57.3%	100%
	Group II	n	58	67	125
		%	46.4%	53.6%	100%
	Group III	n	49	71	120
		%	40.8%	59.2%	100%
	Group IV	n	17	35	52
		%	32.7%	67.3%	100%
	Total	N	168	232	400
		%	42.0%	58.0%	100%

χ^2=2.93 SD=3 p=.40

According to chi-square result, it is revealed that engineering students in different departments do not differ significantly from each other in terms of understanding dimension (χ^2 (3)=2.93, p= .40).

4.5.2. Sex and Understanding Dimension

Do male and female students differ from each other in terms of understanding dimension?

As for understanding dimension chi-square test did not indicate any significant result (χ^2= 1.45, p= .23). That is to say, sex variable is not a significant factor in terms of understanding dimension of learning style.

Table 4.12

Understanding Preferences of the Engineering Students According to Sex

		Understanding Dimension		
		Sequential	Global	Total
Male	n	127	187	314
	%	40.4%	59.6%	100%
Female	n	41	45	86
	%	47.7%	52.3%	100%
Total	N	168	232	400
	%	42.0%	58.0%	100%

χ^2= 1.45 SD=1 p= .23

4.5.3. CGPA and Understanding Dimension

CGPA scores of engineering students do not significantly differ according to understanding preferences ($t_{(398)}$=.10, p= .21). The CGPA mean scores of sequential learners (M=2.78) and global learners (M=2.77) were nearly the same. In other words, CGPA was not affected by understanding way as globally or sequentially. This result would be interpreted as; CGPA scores do not affected by preferences for understanding.

Table 4.13

t Test Results of Engineering Students' CGPA Scores According to Understanding Dimension

Understanding Dimension	N	M	SD	df	t	p
Sequential	168	2.78	.5766	398	.10	.21
Global	232	2.77	.5459			

CHAPTER 5

CONCLUSION AND IMPLICATIONS

5.1. Conclusions and Interpretations of the Findings

The focus of this study was on learning style preferences of the engineering students at METU. In order to find out which ways of learning were heavily used by engineering students, 400 students from 13 different engineering departments were selected using stratified random sampling. Results were analyzed according to Felder and Silverman's (1988) four dimensions of learning style. One of these dimensions was process dimension, which includes active and reflective learning in it. The second one was perception dimension, which categorizes students as sensing learners and intuitive learners. The third one was input dimension, in which visual and verbal learners are placed. The last one was understanding dimension, which grouped students' understanding way as sequential or global.

The study indicated that engineering students are dominantly active learners as indicated in the literature (Felder, 1996) Felder states in learning environment nobody can be purely active or reflective. Learning a topic requires both active participation and reflective thinking (Felder, 1996). What we are trying to find out is which side of the learning process is more heavily used by engineering students. It would be considered important to learn students' way of process information to provide them suitable learning environment. Habermas (1974) suggests that the relationship between action and reflection moves back and forth. As we reflect upon our action or practice, we begin to understand the constraints that have an effect on our action, and based on such understanding we change our practice, we learn from such reflection and grow in our understanding.

The second dimension of learning in the Felder and Silverman's theory is perception. Perception refers to the ways that we process information or become aware of the world around us (Felder, 1996). The study confirmed the learning style related researches' finding about sensing/intuitive dimension and revealed that engineering students at METU are heavily sensing learners rather than intuitive (Mc Caulley, M.H., 1976; Yokomoto and Ware, 1982; Mc Calley, 1987).

Sensing and intuition characterizes the perceptive function, or how one becomes aware of, or perceives, the world. The sensing person learns toward working with known facts rather than looking for possibilities and relationships, as the intuitive person often prefers to do. Students can perceive information through using their senses (sensing learners) or through memory, reflection, and imagination (intuitive learners) (Felder, 1993).

Mc Caulley (1987) points out, sensing and intuitive learners approach problems from opposite directions. She states "in fields with relatively equal numbers of sensing and intuitive students, such as engineering, the faculty have more of a challenge maintaining student interest than in fields, such as counseling, where students and faculty are more similar"(p.47)

The difference between sensing and intuitive learners are explained by Bargor and Hoover (1986) as " the intuitive tends to perceive information holistically, often losing the sight of details in favor of seeing a world of possible meanings. Intuitives may appear to be imaginative, creative or theoretical in their interest when at their best. They may also be seen as impatient, imprecise, or careless with details. Sensing as à preferred way of perceiving information describes those who tend to deal realistically, observantly and precisely with tasks. The sensing type is able to deal well with complicated situations, or with speculative situations which require seeing the world of possibilities" (Bargor and Hoover, 1986, p.57).

When the sample group examined in terms of perception preferences, intuitive learning preferences are more among the students in the third group of departments, Industrial Engineering, Mechanical Engineering, Metallurgical and Materials Engineering, Aeronautical Engineering, than students in the fourth group, Food Engineering and Chemical Engineering. In other words, number of students having intuitive learning preferences is much more among the third group than fourth group. This result is very interesting considering the type of courses being taken in the departments. Some of the departments in the third group require more reflection (e.g. Industrial Engineering) in their courses and the students in this department may affect the mean scores of the third group with respect to intuitive learning.

The third dimension is input dimension, which categorizes learners as visual and verbal. This dimension investigates whether learners are visual or verbal in their learning environment. According to Gardner's Multiple Intelligence Theory (1988) visual learners,

- learn by seeing and observing. Recognized faces, objects, shapes, colors, details, and scenes,
- perceives and produces mental imaginary, thinks in pictures, and visualize detail. Uses visual images as an aid in recalling information,
- decodes graphs, charts, maps, and diagrams. Learns with graphic presentation or through visual media,
- sees things in different ways.

Considering input dimension all engineering student indicated their preferences toward visual learning.

The fourth and the last dimension is understanding which categorizes learners as sequential or global learners.

In order to find students' dominant learning style preferences percentage tables were prepared for each of four learning style dimensions. Later, crosstab with chi-square test was carried out to see the effect of sex, and department variables on style preferences. To determine if CGPA scores differ according to learning style dimensions t test was conducted.

In terms of department, the results revealed that the students in the fourth group (Food Eng. and Chemical Eng.) are more active, sensing, and visual than the students in other three groups involving different engineering departments. In other words, they need more concrete materials, real examples, in their learning environment and they prefer active participation to the process.

Although learning style preferences of the students in different departments may change slightly, students' preferences are not significantly different from each other according to four group of departments. In other words, our first hypothesis were approved.

In terms of process dimension, all students reflected their preference toward active learning without sex, department difference. Also t test result revealed that, active and reflective students' CGPA scores are not different. T test results did not indicate any significant difference for all bipolar group of the learning style dimensions. Thus, our third hypothesis, which claims students' CGPA scores do not differ according to their learning style preferences were approved.

The result indicated that all of the engineering students are active learners in their process of knowledge. However, the number of students who have reflective preferences toward processing is very high among male students comparing females.

However, differences between the four group of departments were not significant. Our second main hypothesis, which claims there is not any significant difference among male and female engineering student groups in terms of learning style preferences, was approved. Findings of the study support the literature in terms of sex difference and learning style preferences (Ginter et al., 1989). The study found that students' learning style preferences are not different depending on their gender.

The main conclusion drawn from this study is that there is not any significant difference between sex, department, CGPA and four learning style dimensions.

In conclusion, all of our null hypotheses were approved. In other words, study revealed that learning style preferences of the engineering students are not different from each other depending on department variable. Also, male and female engineering students' learning style preferences are not significantly different. As for learning style preferences' influence on CGPA, the t test result did not indicate any significant result. In other words, engineering students' CGPA scores are not different from each other depending on their learning style preferences.

5.2. Implication for Teaching

Learners approach learning in different ways. The research into learning styles and preferences has taken the attention of prominent researches in this area (Kolb,1989). This is because, in contrast with the traditional methods where the teacher was the main figure, teaching has started to be strongly depending on the learning thinking that the learners are responsible for the learning process (see appendix D).

For effective teaching, it is essential for instructors to have ideas about how their students learn. By examining their students the teachers may find ways of being effective in their teaching processes. Awareness of the learning style would provide better educational experiences for students and may help instructors understand why some students are successful while others are not.

As it is known at the beginning of all educational processes there are three main questions to be answered as;

1. *What* student wants to know / or should know?

2. *How* student learn/ or should learn?

3. *Why* student learn/ or should learn?

These three questions are essential to planning any curriculum. Instructors make decisions as they plan their courses. While they are doing this, they think of the content and procedure of the course. In other words, they consider what to teach and how to teach it. "How to teach" part is mostly related to the students as well as the assumptions of the teacher.

Although the first question was more emphasized in the past, the other two have importance as much as the first one for the entire educational process. In some fields as engineering, instructors give much more importance to "what" of the curriculum than the other two. The reason for this emphasis can be caused by syllables to be completed by the end of the semester.

Felder at all(2000) states the components of engineering education as (1) knowledge (*what*), (2)skills (*how*), (3)attitudes(*why*). While the knowledge that engineering students should gain increases day-by-day, skills for gathering these knowledge become important point for engineering education.

Pratt(1997) emphasizes the importance of subject matter being taught in terms of teaching as;

> "When one looks only at the technical aspects of teaching, it matters little whether one is teaching English literature, medicine, or engineering" (p.28)

He emphasizes the importance of what, how, why of the topic rather than technical ways to present it. He states;

"Unless we understand *what* a person is trying to accomplish (intentions) and *why* they think that it is justifying (beliefs) we are very likely to misunderstand their actions (*how*)" (p.30)

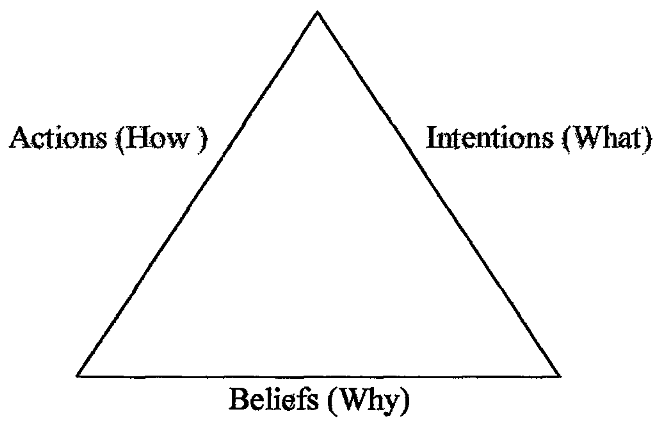

Figure 2. *Interacting Aspects of Conceptions of Teaching (Pratt, p.25)*

Teaching strategies and methods should shift from surface features to deeper structures, should answer "why" as well as "how". Without this crucial shift in approach, teaching will continue to be seen as a relatively mechanistic activity.

One of the important points in teaching is presentation of subject matter. Just having knowledge about the topic would be insufficient for good teaching in most cases.

There are many ways to deliver information to the students having different learning style preferences. For example, for active-sensing-visual-global learners, case study can be used as a teaching method. This method provides problems from actual industrial experience while requires much more effort than other methods. According to Bolz and Dean (1968) requirements of case study method are;

- Selection of problems from actual industrial experience
- Preparation and documentation of the steps
- Proper presentation of the problem (not the solution)

- Requirement that the student as individuals or teams first attack the problem
- Presentation of the actual solution
- Evaluation of the students' solutions in light of those actual used.

Felder criticizes teaching delivery ways as " ...most labs involve primarily mechanical exercises that illustrate only a minor subset of the concepts presented in the lecture and seldom provide significant insights or skill development. Sensing, visual, active and global learners thus rarely get their educational needs met in science courses" (Felder,1993).

The following table illustrates some suitable teaching strategies, methods, and materials to cope with students having different learning style preferences in their learning process

Table 5.1

Four Learning Styles and Teaching Methods and Strategies for Them

	Learning Styles	Teaching Strategies, Methods and Materials
Processing	1. Active Learners - Learn by trying things out, working with others.	These students need active learning environments. Thus teacher would arrange learning environments to provide active participation and would allow time for student participation. One-minute papers, brief group problem solving exercises (see appendix E) would help instructors to involve students in learning process more actively.
	2. Reflective Learners - Learn by thinking things through, working alone.	These students need thinking process to acquire the given instruction. Therefore, the instructors should give chance to reflection by allowing time to show reflection, giving chance to criticize studied topic etc.

(table continues)

Table 5.1. (continued)

Perception	1. Sensing learners - Concrete - practical - oriented toward facts and procedures	Specifically planned tasks associated with some appropriate materials are prescribed (Task oriented). Demonstrations and examples would be used as teaching strategy. Case studies; selection of problems from actual industrial experience, preparation and documentation of the steps, presentation of the problem, giving time students to show their solutions in the light of those actually used.
	2. Intuitive Learners - Conceptual - Innovative - oriented toward theories and meanings	A task structure is provided by the teacher with the students given options according to their interest (Child oriented) Inspirational Literature method, and programmed learning materials would help the learner .

(table continues)

Table 5.1. (continued)

	1. Visual Learners - Prefer visual presentations, pictures, diagrams, and flow charts. Some characteristics are; - observant especially of environmental details, - memorize by visual association, - may forget verbal instructions, - good, fast readers, - make doodles during conversations, - sometimes can't find the right words.	These learners tend to process information better when it is supplied in the form of pictures, diagrams, graphs and so on. Using pictures, sketches, and diagrams while presentation process will help the learner. Highlighting with color help learners to draw their attention to the topic. Chalkboard, posters, and bulletin boards, magazines and manuals; programmed learning materials,; drawings, pictures, graphs and diagrams, films, filmstrips, transparencies. Visual outlines are some of the materials used
Input	2. Verbal Learners - prefer written and spoken explanations some characteristics are; - learn by listening, - speak in rhythmic patterns, - easily distracted by noise, - move their lips and say the words as they read, - enjoy reading aloud, - good at repeating music, - better at telling than writing down.	Verbal learners learn best by listening to conversations or presentations and like to take notes. Teacher would give time to take notes while they present their topic. Written assignments to provide written evaluations. Discussion method and story telling would be effective methods for verbal learners.

(table continues)

Table 5.1. (continued)

Understanding	1. Sequential Learners - linear, orderly, - learn in small, incremental steps.	Discovery approach can be used. New concepts and procedures can be taught by logical explanation and analytical exploration. The class atmosphere can be businesslike and the room can be functional, work oriented. Role of the teacher is that of guide. Problem-solving should be modeled. The class atmosphere should be relax and friendly, without tension or pressure. The room should be comfortable and attractive. The teacher should make a consistent effort to strengthen personal relationships with students, and recognition of achievement should include the teacher expressing personal pleasure.
	2. Global Learners - holistic, system thinkers, - learn in large leaps.	Connections with relevant material from students' everyday experiences are important.

(Adopted from, Behçetoğulları, 1992; Champbell, 1996; Felder, 1996; Felder, R.M. and Silverman, L.K., 1988; Litzinger M. E., Osif B., 1993).

Teaching ways and methods have great importance on effective learning in higher education like all other educational levels. Although self-study and students' efforts to learning have more effect on learning than teaching way at university level, they are the teachers who lead students to get self-study habits. In other words, teachers' knowledge of teaching methods and strategies is essential in all educational level as well as university level. However, most of the instructors teach their topic without getting any training on education. Having just the knowledge about subject matter couldn't be enough for good and effective teaching. Bornheimer, Burns, and Dumke (1973) separated teaching into two facets –the simulation of thinking and the transmission of knowledge. The former one can be achieved with good knowledge of the subject matter, but the later facet can only be achieved with good knowledge of teaching learning process including learning styles. Knowledge of learning style is important for both learners and instructors in educational process.

Learning style awareness is important for learners to;

- get self-knowledge
- arrange learning process,
- develop self-study ways.

Learning style knowledge helps instructors to;

- have information about students in the class,
- arrange teaching atmosphere,
- regulate their own teaching styles

Teachers can only control their own actions. They can suggest, guide and direct students, but they cannot make students learn and act in specific ways (Hyman and Rosoff, 1986, p.40)

Learning problems could be minimized and the quality of education significantly enhanced if instructors modified their teaching styles to accommodate the learning styles of all the students in their classes.

5.3. Implications for Further Research

In this study the learning style preferences of the students were examined without focusing on any specific program, course, or instructional method. Taking this study into account further studies can focus on the effect of a program, a course, an instructional method designed regarding the results. Besides them other further studies can deal with teaching style and the match between the teaching style and learning style in general or in specific cases.

In terms of ILS the validity and reliability studies can be conducted especially on the Turkish version of it.

As the study mainly designed as the descriptive study, it focuses on statistical analysis of the inventory. In other words, this is a quantitative study, however for further researches qualitative studies focusing on general or specific cases can be conducted.

Furthermore, longitudinal studies can be conducted to find out whether there is any change in learning style preferences in a long period, and if any what the causes of this change are.

Finally, studies dealing with the relationship between the type of the course, e.g. does the course mainly consist of cognitive or kinesthetic skills, and the learning styles can be carried out. That is the learning preferences of the students can be searched in different types of courses in order to see whether there is any change according to course type.

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APPENDIX A

INDEX OF LEARNING STYLES

DIRECTIONS: *Circle "a" or "b" to indicate your answer to every question. Please choose only one answer for each question.*
If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1) I understand something better after I
   a- try it out.
   b- think it through.

2) I would rather be considered
   a- realistic
   b- innovative

3) When I think about what I did yesterday, I am most likely to get
   a- a picture
   b- words

4) Generally,
   a- I understand the details about a subject but I have difficulty understanding the whole.
   b- I understand the whole but I have difficulty understanding the details.

5) While I am learning something new I ,
   a- talk about it.
   b- think about it.

6) If I were a teacher, I would rather teach a course
   a- that deals wit facts and real life situations.
   b- that deals with ideas and theories.

7) I prefer the get new information in
   a- pictures, diagrams, graphs, or maps.
   b- written directions or verbal information.

8) Once I understand
   a- all the parts, I understand the whole thing.

b- the whole thing, I see how the parts fit.

9) In a study group working on difficult material, ı am more likely to
   a- join actively and contribute ideas.
   b- sit down and listen.

10) I find it easier
   a- to learn facts.
   b- to learn concepts.

11) In a book with lots of pictures and chart, I am more likely to
   a- look over the pictures and charts carefully.
   b- focus on the written text.

12) When I solve math problems
   a- I usually work my way to the solutions one step at a time.
   b- I often just see the solutions but then have to struggle to figure out the steps to get to them.

13) In classes, I have taken
   a- I have usually gotten to know many of the students.
   b- I have rarely gotten to know many of the students.

14) In reading nonfiction, I prefer
   a- something that teaches me new facts or tells me how to d something.
   b- something that gives me new ideas to thing about.

15) I like teachers
   a- who use a lot of diagrams.
   b- who spend a lot of time explaining.

16) When I am analyzing a story or a novel
   a- I think of the incidents and try to put them together to figure out the themes.
   b- I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17) When I start a homework problem, I am more likely to
   a- start working on the solution immediately.
   b- try to fully understand the problem firs.

18) I prefer the idea of
   a- certainty.
   b- theory.

19) I remember best
   a- what I see.
   b- what I hear.

20) It is more important to me that an instructor
  a- lay out the material in clear sequential steps.
  b- give me an overall picture and relate the material to other subjects.

21) I prefer the study
  a- in a group work.
  b- alone.

22) I am more likely to be considered
  a- careful about the details of my work.
  b- creative about how to do my work.

23) When I get instructions to a new place, I prefer
  a- a map.
  b- written directions.

24) I learn
  a- at a fairly regular pace. If I study hard, I' II get it.
  b- in fits and starts. I' II be totally confused and then suddenly it all "clicks".

25) I would rather first
  a- try thing out.
  b- think about how I'm going to do it.

26) When I am reading for enjoyment, I like writers who
  a- express clearly what they mean.
  b- say things in creative, interesting way.

27) When I see a diagram or sketch in class, ı am most likely to remember
  a- a picture.
  b- what the instructor said about it.

28) When considering a body of information, I am more likely to
  a- focus on details and miss the big picture.
  b- try to understand the big picture before getting into the details.

29) I more easily remember
  a- something I have done.
  b- something I have thought a lot about.

30) When I have to perform a task
  a- master one way of doing it.
  b- come up with new ways of doing it.

31) When someone is showing me data, I prefer

a- charts or graphs.
b- texts summarizing the results.

32) When writing a paper, I am more likely to
a- work on (think about or write) the beginning of the paper and progress forward.
b- work on (think about or write) different parts of the paper and then order them.

33) When I have to work on a group project, I first want to
a- have "group brainstorming" where everyone contributes ideas.
b- brainstorm individually and then come together as a group to compare ideas.

34) I consider it higher praise to call someone
a- sensible.
b- imaginative.

35) When I meet people at a party, I am more likely to remember
a- what they looked like.
b- what they said about themselves.

36) When I am learning a new subject, I prefer to
a- stay focused on that subject, learning as much about it as I can.
b- try to make connections between that subject and related subjects.

37) I am more likely to be considered
a- outgoing.
b- reserved.

38) I prefer courses that emphasize
a- concrete material (facts, data).
b- abstract material (concepts, theories).

39) For entertainment, I would rather
a- watch television.
b- read a book.

40) Some teachers starts their lectures with an outline of what they will cover. Such outlines are
a- somewhat helpful to me.
b- very helpful to me.

41) The idea of doing homework in groups, with one grade for the entire group,
a- appeals to me.
b- does not appeal to me.

42) When I am doing long calculations,

a- I tend to repeat all my steps and check my work carefully.
b- I find checking my work tiresome and have to force myself to do it.

43) I tend to picture places I have been
   a- easily an fairly accurately.
   b- With difficulty and without much detail.

44) When solving problems in a group, I would be more likely to
   a- think of the steps in the solution process.
   b- think of possible consequences or applications of the solution in a wide range of areas.

APPENDIX B

ÖĞRENME STİLLERİ İNDEX'İ

YÖNERGE: *Bu çalışma ODTU mühendislik fakültesinde okuyan öğrencilerin genelde nasıl öğrendiklerini betimlemek amacıyla yapılmaktadır. Aracın 1. bölümünde kişisel bilgiler, 2. bölümünde ise öğrenme stillerini betimlemeye yönelik bilgiler yer almaktadır. Lütfen her bölümdeki soruları dikkatlice okuyunuz ve cevaplayınız.*

BÖLÜM I:

1. Bölümünüz:________________________________
2. Sınıfınız:_______
3. Yaşınız: _______
4. Genel Not Ortalamanız (GPA):_______
5. Cinsiyetiniz: Kız ☐ Erkek ☐

BÖLÜM II:

YÖNERGE:Aşağıdaki soruları cevaplamak için "a" ya da "b" seçeneklerinden birini daire içine alınız. Lütfen her bir soru için sadece bir cevap veriniz.
Eğer iki seçenek de size uygunsa en çok uygun olanını seçiniz.

1) Bir şeyi ....sonra daha iyi anlarım.
   a- yaptıktan
   b- detaylı düşündükten

2) Daha çok ....olarak görülmek isterim.
   a- gerçekçi
   b- yaratıcı

3) Dün ne yaptığımı düşündüğümde,aklıma
   a- bir resim gelir.
   b- kelimeler gelir.

4) Genellikle...............................kafamda belirsizlikler kalır.

a- bir konuyla ilgili ayrıntıları anlarım ama bütünü hakkında
b- bütünü anlarım ama detayları konusunda

5) Yeni bir şey öğrenirken, o konu hakkında
a- konuşurum.
b- düşünürüm.

6) Bir öğretmen olsaydım,
a- gerçekleri ve gerçek yaşamda karşılaşabileceğimiz durumları öğretmek isterdim
b- düşünceleri ve teorileri öğretmek isterdim

7) Yeni bilgileri ....edinmeyi tercih ederim.
a- resimler,diyagramlar, grafikler, ya da haritalardan
b- yazılı ifadelerden ve sözel bilgilerden

8) Eğer,
a- parçaları anlarsam bütünü de anlarım.
b- bütünü anlarsam, parçaların nasıl birleştiğini de anlarım.

9) Zor bir konu üzerinde çalışan bir grupta, grup üyesi olarak genellikle
a- aktif olarak katılır, fikirler üretirim.
b- sadece oturur ve dinlerim.

10) ....öğrenmeyi daha kolay bulurum.
a- Olguları (facts)
b- Kavramları

11) İçinde bir çok resim ve grafik olan bir kitapta, daha çok,
a- resim ve tabloları dikkatlice incelerim.
b- yazılı metinin üzerinde dururum.

12) Matematik problemlerini çözerken,
a- genellikle problemin çözümünü kendi yöntemlerimi kullanarak adım adım çözerim.
b- çözümü çoğu kez hemen görsem de çözüme ulaşmak için gerekli adımları bulmak için uğraşmam gerekir.

13) Ders aldığım sınıflarda,
a- öğrencilerin çoğunu genellikle tanırım.
b- tanışık olduğum öğrenci sayısı nadirdir.

14) Düz yazıları(makale vb.)/bilimsel yazıları okurken......................tercih ederim.
a- yeni olguları öğreten ya da bir şeyin nasıl yapılacağını anlatanları
b- bana üzerinde düşünebileceğim yeni fikirler verenleri

15) Derste.................öğretmenlerden hoşlanırım.

a- diyagramlar, şekiller, şemalar kullanan
b- zamanının çoğunu konu hakkında açıklama yaparak geçiren

16) Bir hikayeyi ya da romanı analiz ederken,
a- olayları düşünür, temaları çıkarmak için onları birleştirmeye çalışırım.
b- okumayı bitirdiğimde temaları anlamış olurum ve bu temaları örneklendiren olayları bulmak için geri dönmem gerekir.

17) Bir ev ödevine başladığım zaman , çoğunlukla
a- hemen çözüm üzerinde çalışmaya başlarım.
b- ilk önce problemi tam olarak anlamaya çalışırım.

18) .... tercih ederim.
a- Kesinliği
b- Teoriyi

19) ....daha iyi hatırlarım.
a- Gördüğümü
b- Duyduğumu

20) Bana göre bir öğretmenin.................daha önemlidir.
a- materyali belirgin düzenli bir sırayla sunması
b- bütünü göstermesi ve materyali diğer konularla bağdaştırması

21) ....çalışmayı tercih ederim.
a- Grup içinde
b- Yalnız

22) Daha çok.....................olarak düşünülebilirim.
a- işimin detayları konusunda dikkatli
b- işimi nasıl yapmam konusunda yaratıcı

23) Bana bir yer tarif edilirken tercihim,
a- bir haritadır.
b- yazılı talimattır.

24) Yeni bir konuyu öğrenirken,
a- oldukça düzenli bir hızda öğrenirim. Eğer çalışırsam başarırım.
b- düzensiz olarak öğrenirim. Tamamen kafam karışır ve sonra aniden her şey yerine oturur.

25) Bir şeyi öncelikle,
a- denemeyi tercih ederim.
b- nasıl yapacağımı düşünmeyi tercih ederim.

26) Kendi zevkim için okuduğumda,.........................yazarlardan hoşlanırım.
a- anlatmak istediklerini net olarak ifade eden

b- düşüncelerini yaratıcı ve ilginç yollarla anlatan

27) Sınıfta bir diyagram ya da taslak görürsem, çoğunlukla
   a- resmi hatırlarım.
   b- öğretmenin konuyla ilgili söylediklerini hatırlarım.

28) Bir bilginin bütünü düşünüldüğünde, çoğunlukla
   a- detaylara odaklanır büyük resmi kaçırırım.
   b- detaylara geçmeden önce büyük resmi anlamaya çalışırım.

29) ....daha kolay hatırlarım.
   a- Yaptığım bir şeyi
   b- Uzerinde çok düşündüğüm bir şeyi

30) Bir görev yerine getirmem gerektiğinde,.......................tercih ederim.
   a- o işi yapma yollarından birinde uzmanlaşmayı
   b- o işi yapmak için farklı yollar bulmayı

31) Birisi bana veri gösterirken tercihim,
   a- şema ve grafiklerdir.
   b- sonuçları özetleyen bir metindir.

32) Bir yazı (makale) yazarken, daha çok
   a- yazının başlangıcında üzerinde çalışır(düşünür yada yazar) sonra ilerlerim.
   b- yazının farklı kısımları üzerinde durur (düşünür ya da yazar) ve sonra bunları düzenlerim.

33) Bir grup projesi üzerinde çalışmak durumundaysam, öncelikle
   a- herkesin kendi fikriyle katkıda bulunduğu bir "beyin fırtınası" yapmak isterim.
   b- bireysel fikirlerimi oluşturmayı ve sonra grupla fikirlerimi karşılaştırmayı isterim.

34) Birisinin.......................olarak nitelendirilmesini büyük bir övgü olarak görürüm.
   a- mantıklı, anlayışlı
   b- hayal gücü kuvvetli

35) Bir partide tanıştığım insanlar hakkında aklımda daha çok
   a- fiziksel özellikleri kalır .
   b- kendileri hakkında söyledikleri şeyler kalır.

36) Yeni bir konu öğrenirken,
   a- konuya odaklanmış olarak kalır, konuyla ilgili öğrenebildiğim kadar çok şey öğrenirim.
   b- o konu ve ilgili konular arasında bağlantılar kurmaya çalışırım.

37) Daha çok..................olarak nitelendirilebilirim.
   a- dışa dönük
   b- içe dönük

38) ....üzerinde duran dersleri tercih ederim.
- a- somut materyaller (olgular, veriler)
- b- soyut materyaller (kavramlar, teoriler)

39) Eğlenmek için genellikle,
- a- televizyon izlerim.
- b- kitap okurum.

40) Bazı öğretmenler derslerine işleyecekleri konuların ana hatlarını belirterek başlarlar. Bu taslaklar bana,
- a- pek yardımcı olmaz.
- b- çok yardımcı olur.

41) Tüm gruba tek bir notun verildiği grup ödevi yapma fikri bana
- a- cazip gelir.
- b- pek cazip gelmez.

42) Uzun hesaplamalar yaparken,
- a- tüm aşamaları tekrar etme ve işimi dikkatle yapma eğilimindeyimdir.
- b- yaptığım işi kontrol etmeyi yorucu bulurum ve bunu yapmak için kendimi zorlarım.

43) Gittiğim/gördüğüm yerleri......................gözümde canlandırabilirim.
- a- kolaylıkla ve oldukça düzgün
- b- güçlükle ve çok ayrıntıya girmeden

44) Bir grubun üyesi olarak, grup içinde problem çözerken çoğunlukla,
- a- çözüm sürecindeki aşamaları düşünürüm.
- b- çözümün olası sonuçları veya uygulamalarını kapsamlı bir şekilde düşünürüm.

APPENDIX C

Common Must Courses Among Engineering Departments

	1.EE	*2. CENG*	*3.IE*	*4. ENVE*	*5. CE*	*6. ME*	*7. METE*	*8. AEE*	*9. GEOE*	*10. MINE*	*11. PETE*	*12. FDE*	*13. CHE*
1. EE		7				1	1						
2. CENG	10												
3.IE	2	3				5	3						
4.ENVE		1			11								1
5.CE		3							3				
6.ME	2	1					4						
7.METE		1				1							
8.AEE	1	3				6	1						
9.GEOE	2				3					1			
10.MINE		1				2			4				
11.PETE	1	4				1			4				3
12.FDE		3	1			1							7
13.CHE		1				1	1						

APPENDIX D

A Comparison of Instruction-focused and Learning-focused Design for Higher Education

Focus on Instruction	Focus on Learning
• Curriculum goals are established which guide the performance of the instructional staff	• A statement of learning outcomes tells what the learner will be able to know and do. This statement serves as a guide to the learner and the instructional staff.
• Subject matter is presented by the teacher and the text book. Students are responsible for completing assignment and taking tests.	• A variety of learning resource, situations and learning arrangements are available, including self-directed and guide learning, tutorial, team learning, and the use of technology.
• A group of students sits in a class and respond to the instructional program. The teacher is the actor on the instructional scene.	• Learners are involved directly and intensively as actors on the learning stage. The teacher manages the learning environment.
• Members of a class undergo the same experience qualitatively (same kind of instruction) and quantitatively (same amount of time)	• Learners are provided a variety of learning experiences from which to select. Time spent on a learning task vary with individual learners.
• The achievement of students is measured by pre-arranged schedule of tests.	• The achievement of learners is assessed and if needed adjustments are made until they master the learning task.

APPENDIX E

Sample Minute Paper Questions

1. What was the most important thing that you learned today?
2. What questions are upper most in your mind?

Sample problem-Solving Activity in Engineering

1. Divide the students into groups of not more than six.
2. Ask them to develop together a step-by-step outline of how they actually solve problems
3. Give them a problem that is relatively simple to state.
4. Tell tem to use their outline to attack the problem together for one hour.
5. Have groups trade tapes and listen to another group's work. (Did they follow their outline, did they agree on the problem, was there organization, was it effective, did one person built on another's ideas, did people listen to each other, etc. Each behaviors should be noted)
6. Have each group listen to its own tape in the same fashion.
7. Ask each group to evaluate its own behaviors by classifying them as "desirable", "undesirable", "don't know"
8. Instruct each group to devise a problem-solving procedure that will encourage the desirable behaviors and discourage the undesirables. The "don't knows" should be experimented with.
9. Finally, give the students a second problem and ask them to recycle steps 4-7. The procedure is repeated until the groups have developed a procedure that is both helpful capable of being

(Adopted from Wankat, P.C., Oreovicz, F.S. ,1993)

APPENDIX F

Student Numbers and Enrollment Ratios (1996-1997)

Composition of the Population at School Age (1998 Estimate)	
Age Group	% of Total Population
4-6	6.0
7-11	10.2
12-14	6.2
15-17	6.3
18-21	8.2

Source: State Planning Organization,1998 Program, Ankara,1997 p.33

Student Numbers and Enrollment Ratios (1996-1997)		
Students		Enrollment Ratio (%)
Pre-school Education	22.900	8.8
Compulsory Elementary Education	9.463.000	88.5
Secondary-Education	2.225.000	54.7
General High Schools	1.252.000	30.8
Vocational-Technical High Schools	973.000	23.9

Higher-Education	1.213.165	23.2
Formal Education	749.970	4.3
Open Education	463.195	8.9

Source: State Planning Organization, 1998 Program, Ankara, 1997 p.27