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# A Descriptive Study of the Learning Style Profiles of the Engineering Students at the Middle East Technical University (METU)

# Orta Doğu Teknik Üniversitesi (ODTÜ) Mühendislik Öğrencilerinin Öğrenme Stili Profillerine Yönelik Betimsel Bir Çalışma

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*Abstract*

This descriptive study identified engineering students' learning styles and the differences in the learning styles according to sex and department. To determine the differences in the learning styles of engineering students, the Turkish version of the Index of Learning Style (ILS) developed by Felder-Solomon for engineering students was used. The form was administered to 400 engineering students at METU. The differences in learning style preferences according to sex and department factors were assessed via Chi-square tests. The results showed that engineering students are active, sensing, visual and global learners rather than reflective, intuitive, verbal and sequential. The Chi-square results did not indicate any significant results in all of the four learning style dimensions in terms of sex and department.

*Key Words:* Learning style, Index of Learning Style, engineering education.

*Öz*

Tarama türündeki bu çalışmada mühendislik öğrencilerinin öğrenme stilleri ve cinsiyet ve bölümlerine göre öğrenme stillerindeki farklılık incelenmiştir. Mühendislik öğrencilerinin öğrenme stillerini belirlemek için Felder-Soloman tarafından mühendislik öğrencileri için geliştirilen Öğrenme Stilleri Index'i (ÖSI) Türkçe'ye uyarlanmış ve 400 ODTU mühendislik öğrencisi üzerinde uygulanmıştır. Öğrencilerin ÖSI'den elde ettikleri 4 öğrenme stilindeki tercihlerinin cinsiyet ve bölüm faktörlerine göre farklılaşıp farklılaşmadığını belirlemek için ki-kare testi uygulanmıştır. Sonuçlar, mühendislik öğrencilerinin genel olarak aktif, duyusal, görsel, bütünsel öğrenenler olduğunu ortaya koymuştur. Yansıtıcı, sezgisel, sözel ve ardışık öğrenenlerin sayısının ise daha az olduğu görülmüştür. Ki kare sonuçları 4 öğrenme stilinde de cinsiyet ve bölüm bakımından mühendislik öğrencileri arasında anlamlı bir fark olmadığını ortaya koymuştur.

*Anahtar Sözcükler:* Öğrenme Stilleri, Öğrenme Stilleri İndexi, mühendislik eğitimi.

## Introduction

In any educational field, teachers need to have some general knowledge about their learners' profiles. Recently, the individual differences of the learners have been considered by many educators to be a unique and important factor affecting the classroom atmosphere and learning environment. (Dunn&Dunn 1981, Felder& Henriques 1995, Keffe & Ferrel 1990). Both external and internal factors may result in different learning outcomes. External factors such as family, income levels and the effects of society may be counted. On the other hand, the learning style of the learner, his/her personality and differences in perception are some of the internal (individual) factors that may affect learning. Educational authorities have different opinions regarding whether learning styles are developed through activities or whether they are inborn characteristics of human beings.

Issues such as how an individual learns and which paths he/she follows while learning have great

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importance for both learners and instructors. Connet (1983) theorized that each individual is born with certain tendencies towards particular learning styles that are subsequently influenced by culture, personal experiences, maturation and development.

The learning style preferences that every student brings to the classroom setting have a great impact on the efficiency of the teaching that takes place. In other words, a student's way of learning influences the teaching/ learning environment. How much teaching and learning styles should match each other was an argumentative issue among educators at this point. Claxton and Murrell (1987) emphasized the importance of matching teaching and learning styles particularly when working with poorly prepared students and with college students. However, at the university level the validity of "matching" teaching and learning styles as the ultimate goal of the education given there was scrutinized and it was stressed that matching may be inappropriate if the long-term goal of education is developmental (Hunt, 1979; Kolb, 1984).

The great impetus in the learning style conceptualization was given by Jung's theory of psychological types. C. G. Jung's (1927) theory of psychological types attempted to categorize people in terms of their primary modes of psychological functioning. The theory was based on the assumption that there were different functions and attitudes of consciousness. The functions of consciousness refer to the different ways in which the conscious mind can apprehend reality. In his model Jung stressed individual differences in perceiving and judging. Later, Isabel Myers and Katherine Briggs developed the Myers-Briggs Type Indicator (MBTI) in 1977 and consequently formed an association named the Association of Psychological Type (Mc Caulley, 1987). In 1981, Dunn and Dunn developed a learning style model that considered learning styles across five categories: Environmental, Emotional, Sociological, Physiological, and Psychological. Kolb (1984) considered learning as a circular process and claimed that what is important is the student's place in the cycle. Felder and Silverman (1988) combined all these theories and developed their own learning style theory.

There are different learning style descriptions in the literature. Learning styles reflect a person's characteristic style of acquiring and using information in learning or solving problems according to Kolb (1984). Keffe and Ferrell (1990) define learning style as;

> *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. Its 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 (p.59).*

According to Felder & Henriques (1995), learning styles pertain to the manner in which individuals typically acquire, retain and retrieve information. Although the model initially categorized learning styles into five different learning dimensions (Felder and Silvermen, 1988); instruments developed later by Felder and Soloman include only four of the dimensions that the model describes. These dimensions are categorized below:

*Processing Dimension*: This deals with the way information is processed. According to Felder& Silverman (1988) students would prefer to learn information actively or reflectively. Active learners learn best by trying things out and working with others. Reflective learners learn via thinking things through and like working independently.

*Perception Dimension*: In this dimension learners are categorized as sensing and intuitive. This dimension deals with the way information is perceived. Sensing learners are concrete, practical, fact-oriented and favor information arriving through their senses. Intuitive learners are conceptual, innovative, oriented toward theories and favor information that arises internally through memory reflection and imagination.

*Input Dimension*: This dimension deals with the way information is presented. Two sub-dimensions of the dimension are visual and verbal learning preferences. Visual learners prefer learning visually with the help of pictures, diagrams, experiments and demonstrations. On the other hand, verbal learners prefer written or spoken explanations and formula.

*Understanding Dimension*: This deals with understanding. Felder and Silverman (1988) claimed

that learners might prefer sequential learning or global learning while they assimilate knowledge. Sequential learners are linear, orderly, learn in small incremental steps, can solve problems with incomplete understanding but may lack an ability to grasp the big picture. Global learners are holistic, systematic thinkers, prefer to learn in large steps and need to have a general picture.

Knowledge about learning styles can give an instructor a general perspective about students and help him/her to arrange classroom activities according to students' preferences.

There is evidence to support the idea that learning styles often reflect the special needs and learning demands of a profession (Kolb,1984). Harrelson, Dunn, and Martin (2003) stated that "the learning styles of a profession's membership are often linked to the characteristics of that profession" (p.64). In other words people's field of study could influence their learning style preferences and research on the effects of study fields on learning style preferences would be beneficial.

Many researchers have investigated engineering students' learning style preferences in the literature (Stice, 1991; Rosati et all., 1988; Felder, 1995; Lumsdaire, 1995) Most of them studied the matching of teaching styles with learning styles in engineering classrooms. Stice (1991) undertook an investigation to see if matching the instructional style to the students' learning styles increased the conditions of learning among chemical engineering students. The researcher identified students' learning style preferences according to Kolb's Learning Style Inventory (LSI) and arranged courses by taking into consideration the learning style differences. At the end of the study, interviewed students stated that they had learned more easily with the new methods. In addition, the study found that when the students were taught according to their learning style preferences their success increased significantly. Another study conducted by Rosati, Dean and Rodman (1988) aimed to investigate the interaction of learning style and the presentation modes of the instructor in an undergraduate engineering course at West Virginia University. Using the Myers -Brings Type Indicator (MBTI) researchers identified the undergraduate engineering students' learning style preferences and divided them into two groups. Two different instructors whose teaching styles matched the learning style preferences of the groups taught the courses. Both groups were given the same homework problems and they undertook a common one-hour examination at the end of the experimental period. The study found a significant relationship between teaching modes and performance level. Felder (1995) used Felder& Silverman's model to design instruction in a longitudinal study of engineering education. The results of this study suggested that teaching to the full spectrum of learning styles improved students' learning and increased their satisfaction with their instruction, and their self-confidence.

Another important variable that many researchers (Keri,2002, Honigsfeld and Dunn,2003) agreed had an effect on learning style preferences was gender. Keri (2002) conducted a study on the differences in male and female college students' learning style preferences using Canfield's Learning Style Inventory. The researcher reported significant differences between males' and females' preferences in terms of conceptual and applied learning. Female students were reported to be more conceptual learners while males were more applied learners. In addition, Honigsfeld and Dunn (2003) found significant gender differences in 9 of the 22 learning style variables. Their study's overall findings indicated that boys were more kinesthetic and peer oriented than were girls. No studies related to the differences in learning styles according to departments have been found in the literature.

Awareness of learning styles could help both learners and instructors. Hence the purpose of the present study was to identify the learning style preferences of the students in engineering departments and to investigate the differences in learning style preferences according to sex and department, at METU, Turkey.

*Problem*

The present study examined the following questions;

1. What are the dominant learning styles of the engineering students at METU according to Felder's four learning style dimensions?
2. Do the learning styles preferences of the engineering students differ according to department?
3. Do the learning styles of the engineering students differ according to sex?

## Method

The study described the learning style profile of engineering students according to the Felder & Soloman Index of Learning Style (ILS) instrument. The sex and department of the students were independent variables and the learning style preferences of the students were the dependent variables.

*Index of Learning Style*

The Index of Learning Style is a paper-pencil instrument that is designed to measure students' learning styles according to Felder and Silverman'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 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 vice 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 learning styles while the 'b' responses show reflective, intuitive, verbal, global ones.

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

For the purpose of this study, the ILS was translated into Turkish by two experts. Then it was re-translated into English by other two experts in order to ensure that the original and the translated forms of the instrument were consistent. For piloting purposes, the original and Turkish forms of the instrument were administered to 40 engineering students at Gazi University. 20 of the 40 students first took the English form of the inventory and then took the Turkish form, whereas the other 20 took the Turkish form first, then the English form. The answers of these 40 students were evaluated and correlated to check the match between the English and Turkish versions. The following table gives the correlation results for the Turkish and English forms of the instrument.

In order to determine the construct validity and reliability of the instrument, a pilot study was conducted with 120 engineering students at Gazi University. The alpha reliabilities were 0.49, 0.55, 0.53, and 0.30 for active-reflective, sensing-intuitive, visual-verbal, and sequential-global dimensions respectively.

*Participants*

The subjects of the study were almost 30% of the fourth grade (senior) students in all departments of the Faculty of Engineering at METU.

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 (Table 2).

*Procedures*

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

Table 1.
*Correlation Results of the Turkish and English Forms of the ILS*

| *Learning style dimensions* | *N* | *r* | *p* |
|---|---|---|---|
| Pair 1<br>Active-Reflective (e) & Active-Reflective (t) | 40 | .87 | .000 |
| Pair 2<br>Sensing-Intuitive (e) & Sensing-Intuitive (t) | 40 | .79 | .000 |
| Pair 3<br>Visual-Verbal (e) & Visual-Verbal (t) | 40 | .92 | .000 |
| Pair 4<br>Sequential-Global (e) & Sequential-Global (t) | 40 | .76 | .000 |

(e= English version, t= Turkish version)

Table 2.
*Group of Departments in the Study*

| *Categories* | *Department* | *N* | *P* |
|---|---|---|---|
| Group I | Electrical and Electronics Engineering<br>Computer Engineering | 103 | 25.8% |
| Group II | Environmental Engineering<br>Civil Engineering<br>Geological Engineering<br>Mining Engineering<br>Petroleum and Natural Gas Engineering | 125 | 31.2% |
| Group III | Industrial Engineering<br>Mechanical Engineering<br>Metallurgical and Materials Engineering<br>Aeronautical Engineering | 120 | 30% |
| Group IV | Food Engineering<br>Chemical Engineering | 52 | 13% |
| TOTAL | | 400 | 100% |

*Limitations*

The data collection instrument's bipolar characteristic seemed to be the most important limitation of this study. The bipolar characteristics of the questions in the inventory limited the students to the presented two alternatives. The nature of the questionnaire did not allow the sample group to choose different alternatives. Also, the duration of the study was too short to implement a follow-up study.

In learning style studies, conducting longitudinal studies would be more helpful both for instructors and students. However this study would be helpful to define the learning style profile of engineering students.

## Findings

*Learning Styles Preferences of the Engineering Students at METU*

Table 3 shows the percentage of engineering students falling in each learning style sub-dimensions.

The results of the study revealed that students in all engineering departments are highly active, sensing,

Table 3.
*Learning Style Preferences of Engineering Students*

| | | ***Engineering students*** | | | |
|---|---|---|---|---|---|
| | | *n* | *p* | *M* | *N* |
| ***Learning style dimensions*** | | | | | |
| In terms of *processing* | Dominant active | 244 | **61%** | 15.87 | 400<br>100% |
| | Dominant reflective | 156 | 39% | | |
| In terms of *perception* | Dominant sensing | 254 | **63.5%** | 15.66 | 400<br>100% |
| | Dominant intuitive | 146 | 36.5% | | |
| In terms of *Input* | Dominant visual | 366 | **91.5%** | 13.62 | 400<br>100% |
| | Dominant verbal | 34 | 8.5% | | |
| In terms of *Understanding* | Dominant sequential | 168 | 42% | 16.89 | 400 |
| | Dominant global | 232 | **58%** | | 100% |

visual, and global rather than reflective, intuitive, verbal, and sequential.

*Engineering Students' Learning Style Differences According to Department*

To determine if students from different engineering departments have different learning style preferences a Chi-square test for each of the four department groups was conducted. The Chi-square results did not indicate any significant differences among the four departments in terms of all learning style dimensions.

Although the learning style preferences of the students in different departments may have changed slightly, the students' preferences were not significantly different from each other.

*Engineering Students' Learning Style Differences According to Sex*

Chi-square tests were conducted to compare males' and females'learning style preferences in each dimension. It was found that the students' learning style preferences did not differ according to their gender as indicated in some other studies (Ginter et al., 1989).The results are shown in Table 5.

## Conclusion And Discussion

The study indicated that engineering students were dominantly active learners as indicated in the literature (Felder,1996). Felder stated that in a 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 the students' way of processing information to provide them with a suitable learning environment. Habermas (1974) suggested that the relationship between action and reflection moves back and forth. As we reflect upon our actions or practice, we begin to understand the constraints that have an effect on our actions, and based on such understanding we change our practice, we learn from such reflection and grow in our understanding.

In terms of perception dimension the results revealed that engineering students at METU were highly sensing learners rather than intuitive. This result is consisted with the results of several other studies (Mc Caulley,

Table 4.
*Learning Style Preferences of Students in Four Department Groups*

| Learning style dimensions | | Group I | Group II | Group III | Group IV | TOTAL |
|---|---|---|---|---|---|---|
| Processing Dimension | Active | 59<br>57.3% | 75<br>60.0% | 77<br>64.2% | 33<br>63.5% | 244<br>61.0% |
| | Reflective | 44<br>42.7% | 50<br>40.0% | 43<br>35.8% | 19<br>36.5% | 156<br>39.0% |
| $\chi^2$= 1.289, p>.05 | | | | | | |
| Perception Dimension | Sensing | 66<br>64.1% | 83<br>66.4% | 67<br>55.8% | 38<br>73.1% | 254<br>63.5% |
| | Intuitive | 37<br>35.9% | 42<br>33.6% | 53<br>44.2% | 14<br>26.9% | 146<br>36.5% |
| $\chi^2$= 5.569, p>.05 | | | | | | |
| Input Dimension | Visual | 95<br>92.2% | 116<br>92.8% | 106<br>88.3% | 49<br>94.2% | 366<br>91.5% |
| | Verbal | 8<br>7.8% | 9<br>7.2% | 14<br>11.7% | 3<br>5.8% | 34<br>8.5% |
| $\chi^2$= 2.389, p>.05 | | | | | | |
| Understanding Dimension | Sequential | 44<br>42.7% | 58<br>46.4% | 49<br>40.8% | 17<br>32.7% | 168<br>42.0% |
| | Global | 59<br>57.3% | 67<br>53.6% | 71<br>59.2% | 35<br>67.3% | 232<br>58.0% |
| $\chi^2$= 2.932, p>.05 | | | | | | |

Table 5.
*Learning Style Preferences of Male and Female Engineering Students*

| Learning style dimensions | | Male | Female |
|---|---|---|---|
| Processing Dimension | Active | **59.2%** (n=186) | **67.4%** (n=58) |
| | Reflective | 40.8% (n=128) | 32.6% (n=28) |
| $\chi^2$= 1.91, p>.05 | | | |
| Perception Dimension | Sensing | **61.5%** (n=193) | **70.9%** (n=61) |
| | Intuitive | 38.5% (n=121) | 29.1% (n=25) |
| $\chi^2$= 2.61, p>.05 | | | |
| Input Dimension | Visual | **91.7%** (n=288) | **90.7%** (n=78) |
| | Verbal | 8.3% (n=26) | 9.3% (n=8) |
| $\chi^2$= 0.91, p>.05 | | | |

Table 5 (continued)

| | | | |
|---|---|---|---|
| Understanding Dimension | Sequential | 40.4% (n=127) | 47.7% (n=41) |
| | Global | **59.6%** (n=187) | **52.3%** (n=45) |
| $\chi^2$= 1.45, p>.05 | | | |

M.H., 1976; Yokomoto and Ware, 1982; Mc Calley, 1987).

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

As for input preferences, the group revealed their preferences as leaning strongly towards visual learning without sex and department differentiation.

Considering the understanding dimension, METU engineering students were dominantly global learners.

Learning style studies are important especially for their implication in teaching. There are many researches that have examined the effect of learning styles on teaching (Hativa & Birebaum,2000; Haar et all.,2002). Doyle and Rutherfold (1986) claimed that in the learning-teaching environment instructors should consider some critical aspects of learning styles before implementation, such as deciding which dimensions of learner styles to consider important; selecting a method of measuring learning styles; considering the amount of diversity to accommodate and devising alternative instructional situations to accommodate the variations in learning styles that might exist in a classroom.

These studies generally emphasized how important it is for instructors to know about the learning styles of the learners to provide an effective teaching atmosphere. Taking learning style as a unique and individual characteristic of a learner, one should consider its importance for the learning environment. It is clear that learners feel confident in the learning environment where his/her learning style is taken into consideration (Hativa & Birebaum, 2000; Haar et all.,2002, Rosati et all., 1988). Being aware of the learners' learning styles would help instructors in their teaching. Studies on engineering students' presentation preferences are

available in the literature. Hativa and Birebaum (2000) stated that engineering students prefer an instructor who is well organized and presents the subject matter in an organized and systematic way. They also emphasized that activities for improving instruction should concentrate on the effectiveness of presentation, particularly its clarity, interest and organization and on methods for supporting students' learning as employed by the providing instructor. The present study would be helpful for instructors to be aware of the learning style profiles of engineering students and could help them to arrange courses accordingly. The study revealed that METU engineering students are dominantly active, sensing, visual and global learners. Through considering these learning style preferences some specific implementations for each of the learning style dimensions would help instructors in engineering classrooms.

Students who have *active* learning preferences in *processing* knowledge learn by trying things out and working with others. Thus they need active learning environments. Instructors should arrange the learning environments to provide active participation. They should allow time for students to participate. Students having *sensing* preferences in *perception* are concrete and practical in their learning and would like to be oriented toward facts and procedures. They prefer to deal with actual data and facts. Certainly the best activity for sensory students is an actual experience (Montgomery, 1995). Instructors should use demonstrations and concrete materials. Sensory students prefer organized, linear, and structured lectures (Brightman, H. J.,2004). Brightman stated that applications motivate sensory students to learn the material. Applications answer the question that sensory students often ask, 'Why am I learning this material?' In addition, firstly explaining theories or ideas, and then applying them to the original application would be beneficial to their learning. Case studies and actual industrial problems would help sensory learners to learn more easily. Learners having *visual* preferences to *input* presented knowledge prefer visual presentations, pictures, diagrams and memorize by visual association. Instructors should use pictures and diagrams while in the presentation process. Highlighting important points with color would help learners to draw their attention to the topic. *Global* learners try to *understand* holistically the presented knowledge and they are systematic thinkers and want to learn in large leaps. As for global learners, a connection to relevant material from their everyday experiences is important. Instructors should connect their learning topics to their everyday experiences.

College/faculty professors should be aware of students' ideas about effective instruction (Hativa & Birebaum, 2000), the need for variety in their students' learning approaches and of the necessity to accommodate these differences.

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