Abstract: Students differ from one another in a wide variety of ways. Students have different levels of motivation, different attitudes about learning. Students have different approaches to learning and different intellectual levels. They also have different learning styles, which are characteristic ways of taking in and processing information. The differences may have been classified into four categories under the concepts of cognitive strategy and cognitive style, learning strategy and learning style. Instructors have to take these individual properties of students into account, while deciding the type of instruction and preparing the teaching scenarios. To improve skill development in engineering education, instruction should be designed to meet the learning styles of students. Several learning style models have been developed, but a few of them were been the subject of studies in the engineering education literature. According to the Felder-Silverman model, a student’s learning style may be defined in four dimensions; i) sensing or intuitive, ii) visual or verbal, iii) active or reflective, iv) sequential or global. The Index of Learning Styles (ILS) has been designed as a tool to assess the preferences on this four dimensions. The ILSQ is a questionnaire with forty-four questions. In this study, the ILS is performed in three different courses in the Geomatic Engineering program at the Istanbul Technical University, Department of Geodesy and Photogrammetry. The results are evaluated with student profiles. Teaching techniques used in those courses are overviewed and reconfigured in order the student’s learning styles. Afterwards, the performance of the courses are interpreted with final grades.

Keywords: Learning Styles, Teaching Models, The Index of Learning Styles, ILS, ILSQ

1 Introduction

Students have different levels of motivation, different attitudes about teaching and learning, and different responses to specific classroom environments and instructional practices. The more thoroughly instructors understand the differences, the better chance they have of meeting the diverse learning needs of all of their students. Three categories of diversity that have been shown to have important implications for teaching and learning are differences in students’ learning styles (characteristic ways of taking in and processing information), approaches to learning (surface, deep, and strategic), and intellectual development levels (attitudes about the nature of knowledge and how it should be acquired and evaluated) [1].

Learning styles are “characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment” [2]. Several dozen learning style models have been developed, five of which have been the subject of studies in the engineering education literature. The best known of these models is Jung’s Theory of Psychological Type as operationalized by the Myers-Briggs Type Indicator (MBTI)[3]. Other models that have been applied extensively to engineering are those of Kolb [4], and Felder and Silverman [5]. Two other models that have been used in engineering are those of Herrmann [6], and Dunn and Dunn [7].

This document presents the results of an experimental study relating to the application of learning styles in a higher education undergraduate engineering program and their effects on student success. In this study, the Felder-Solomon Learning Style Questionnaire (ILSQ) was used to measure the learning style preferences of students.

2 Felder-Solomon Learning Style Questionnaire (ILSQ)

In 1988, Richard Felder and Linda Silverman developed a learning model that focuses specifically on aspects of learning styles of engineering students. Three years later, a corresponding psychometric assessment instrument, the Felder-Soloman’s Index of Learning Styles, was developed. The Felder model of learning styles focuses on aspects of learning styles significant in engineering education, and is very popular among engineering educators even though the psychometric instrument associated with the model, the Index of Learning Styles (ILS), has not yet been fully validated. In brief, the model has five dimensions: Processing (Active/Reflective), Perception (Sensing/Intuitive), Input (Visual/Verbal), Understanding (Sequential/Global) and Organization (Inductive/Deductive). Felder recommends the inductive teaching method (i.e. problem-based
learning, discovery-based learning), while the traditional college teaching method is deductive, i.e. starting with fundamentals and proceeding to applications. Thus the last dimension was removed from the ILS, so as not to provide incentives for a continuing use of the traditional deductive instruction [8].

The sensing learners are concrete thinker, practical and oriented toward facts and procedures. In spite of them, the intuitive students are abstract thinker, innovative and oriented toward theories and underlying meanings. The students in the visual category prefer visual representations of presented material, such as pictures, diagrams and flow charts. The verbal students prefer written and spoken explanations. The active students learn by trying things out and enjoy working in groups. But the reflective students learn by thinking things through and prefer working alone or with a single familiar partner. The students in the sequential group enjoy linear thinking process and learn in small incremental steps. The global students like holistic thinking process and learn in large steps [9]. Each of the above stated dimensions has parallels in other learning style models.

The ILSQ is a forty-four item forced-choice instrument developed in 1991 by Richard Felder and Barbara Solomon to assess preferences on the four scales of the Felder-Silverman model. The ILSQ is available at no cost to individuals, to instructors or students on the World Wide Web since 1997 [1], [5], [10]. The questions are designed in four categories: Q1, Q2, Q3 and Q4. Each category has 11 questions. The first category Q1 is about processing, the second category Q2 is the perception. The third group of questions Q3 is the input category and the last is the understanding category. The categories vary in turn of questions. The question #1 begins with the first category; the question #2 belongs to the second category, the question #3 to the third and so on. All questions have double choices as a and b. An answer sheet designed for the ILSQ is presented in Table-1. Such a design simplifies the evaluation. The differences between the sums of the number of choices give the potential learning style. The values of differences must be equal to 1, 3, 5, 7, 9 or 11. If your score is between 1-3, then it can be said that you are fairly well balanced between these learning styles. If your score is between 5-7, it means that you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension. It might be useful that you enhance your skill with the other learning style. At last, if your score is between 9-11, you have a very strong preference for the corresponding dimension and you will be forced in an environment which does not support that preference. It is strongly preferred that you have to be improving the alternate style for yourself.

<table>
<thead>
<tr>
<th>Table-1: ILSQ Answer Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student#:……………Name&amp;Surname:……………..</td>
</tr>
<tr>
<td>Q1 a b Q2 a b Q3 a b Q4 a b</td>
</tr>
<tr>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2 6 7 8</td>
</tr>
<tr>
<td>9 10 11 12</td>
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<tr>
<td>13 14 15 16</td>
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<td>17 18 19 20</td>
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<td>21 22 23 24</td>
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<td>25 26 27 28</td>
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<td>29 30 31 32</td>
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<td>33 34 35 36</td>
</tr>
<tr>
<td>37 38 39 40</td>
</tr>
<tr>
<td>41 42 43 44</td>
</tr>
<tr>
<td>Σ A1 B1 Σ A2 B2 Σ A3 B3 Σ A4 B4</td>
</tr>
</tbody>
</table>

3 Application
In the department of Geodesy and Photogrammetry Engineering at Istanbul Technical University, a quality assurance system (QAS) has been established and performed since 2002. This year was also the date at which the department has gained the Accreditation Board of Engineering and Technology (ABET) accreditation for its undergraduate program until 2011. A quality loop is managed according to the QAS by the department. To enhance the quality of teaching and also to increase the success of the student it is decided to research the learning styles of the students. It is also aimed to determine the correlation between the learning styles and student access. Using this data and results, the teaching methods, the performance of courses are being discussed by the faculty. The contents and scenarios of the lectures are reconstructed under the decisions making after the discussions.

The ILSQ is being applied to students and instructors for several courses in the program. In this study a group of data with 48 applicants is presented. The professor and the assistant of the course are also joined to this application. The differences explained in the above section are calculated for each learning style category. The sums of the rows i.e. the values for each applicant and the sum of the columns i.e. the values for each category are calculated and presented in the last row and column of the tables. An average value is also produced.
for each row dividing the sum into four. A great average value means that the applicant is being on the upper limits of the scale defined from 1 to 11. The results are presented for the instructors and for the students on table-2 and table-3, respectively.

### Table-2: Survey results of instructors

<table>
<thead>
<tr>
<th>Student</th>
<th>Processing</th>
<th>Perception</th>
<th>Input</th>
<th>Understanding</th>
<th>Av</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Reflective</td>
<td>Sensing</td>
<td>Intuitive</td>
<td>Visual</td>
</tr>
<tr>
<td>Arslan</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Erol</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10</td>
<td>7</td>
<td>17</td>
<td>21</td>
<td>14</td>
</tr>
</tbody>
</table>

### Table-3: Survey results of students

<table>
<thead>
<tr>
<th>Student</th>
<th>Processing</th>
<th>Perception</th>
<th>Input</th>
<th>Understanding</th>
<th>Av</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Reflective</td>
<td>Sensing</td>
<td>Intuitive</td>
<td>Visual</td>
</tr>
<tr>
<td>Arslan</td>
<td>4</td>
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<td>11</td>
<td>9</td>
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<tr>
<td>Erol</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10</td>
<td>7</td>
<td>17</td>
<td>21</td>
<td>14</td>
</tr>
</tbody>
</table>

**Grd.**
4 Conclusions

The frequent approach in the department is using a deductive teaching method. The instructors prepare the scenarios of their lectures consistent with the learning styles of their selves. The results of the ILSQ application show that the students who’s learning style overlap with the instructor get high grades. The rows in which the students with higher grades take place are assigned with arrows in table-3. There are several values which don’t agree with this assumption, because the student’s success is under the influences of other more different parameters except learning styles.

Another important result of this application is that the great amounts of our students are active, sensing, visual and global learners. The analysis of the results provides us useful feedbacks. A series of decisions are produced and executed. Accordingly, the faculty began to try and use effective teaching models. The contents and scenarios of the lectures are implemented and active teaching methods are like problem based learning (PBA) with team work put in the practice (for active learners). The instructors tried to give more concrete information with facts, data, real or hypothetical experiments with results and tried to follow an algorithmic method in presenting theoretical material (for sensing learners). They began to visualize the lecture beside the blackboard using data show and similar hardware. They use more pictures, schematics, graphs and sketches before, during and after the presentation of verbal material (for sensing/visual learners). Computer assisted instructions are accumulated. Open-ended problems are given, brainstorming with classmates and exercises are performed that call for analysis and synthesis (for global learners).

It is tried to target all of the students in the class with different learning styles. We are motivating the students to improve their learning style on which they have weaknesses. The instructions are modified to support these efforts. In the last two years, the weighted average grade of total students increased from 2.19 to 2.41. The ILSQ application continues every year with the junior students during the first registration for the department.

References: