THINKING AND LEARNING PREFERENCES FOR
A SAMPLE OF ENGINEERING STUDENTS AT
THE UNITED ARAB EMIRATES UNIVERSITY

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This paper presents the results of a statistical analysis carried out to measure the preferred thinking and learning styles for a sample of engineering students at the United Arab Emirates University. The study is based on the Herrmann brain model for thinking preferences and Solomon-Felder index of learning styles for learning preferences. The students sample used in the study consists of four different groups whose size ranges from 22 to 60 students for each group. The first group belongs to students just entering the university who are studying at the University General Requirement Unit. The students of the second group are selected from the first year engineering students who are taking courses in the College Requirement Unit. Junior engineering students who are in their third year form the third group. The fourth group belongs to engineering students in their final year. The results of this study indicates that the United Arab Emirates University engineering students generally prefer, in their learning styles, the active more than the reflective; the sensing more than the intuitive; the visual more than the verbal; and the sequential more than the global. It is also clear that the students prefer, in their thinking style, C and B more than A and D. The study finds that efforts need to be established to strengthen the D thinking modality that is referred to the innovation and creativity through strengthening the global, reflective and intuitive learning styles for the engineering students at the United Arab Emirates University.

1. INTRODUCTION

It has long been scientifically established that individuals think and behave with different styles. Each person thinks and behaves in preferred ways that are unique to that individual. These dominant thinking styles are the results of the native personality interacting with family, education, work, and social environments[1,2]. People’s approaches to problem solving, creativity, and communicating with others are characterized by their thinking preferences[3-5]. For example, one person may carefully analyze a situation before making a rational, logical decision based on the available data. Another may see the same situation in a broader context and look for several alternatives. One person will use a very detailed, cautious, step-by-step procedure. Another has a need to talk the problem over with people and will solve the problem intuitively.

Thought processes have been studied since ancient history. Several models have been proposed on how the human brain works. One of the well-known models is the Herrmann model[6-10], which divides the brain into a four quadrant brain dominance model. These quadrants are located in the left and right hemispheres (left and right brain). The left cerebral hemisphere [Quadrant A] in Herrmann’s model is associated with logical, analytical, and quantitative thinking. The left limbic system [Quadrant B] is associated with sequential, organized, and detailed thinking. The right cerebral hemisphere [Quadrant D] is associated with visual, intuitive, and innovative thinking. The right limbic system [Quadrant C] is associated with emotional, sensory, and interpersonal thinking.

Student preferences in the reception and processing the information formulate the preferred learning style for a student. There are a number of models, assessment tools and methodologies designed to test the learning styles[11-14]. In Engineering and Science Education two instruments have been widely recognized: Kolb’s Learning Style Inventory (LSI) [14] and Soloman-Felder Index of Learning Styles (ILS)[13-15]. In the ILS model students’ learning style is characterized according to the ways they:
1. Input the information as visual and verbal. A visual learner remembers best what he can see; a verbal learner remembers much of what they hear.
2. Organize of information as sensor and intuitor. A sensor learner gathers information through senses while intuitor learners involve indirect perception by ways of unconscious, imagination and hunches.
3. Process of information as active and reflective. An active learner needs to be doing something in the external world with the information while the reflective learner involves examining and manipulating the information introspectively.

4. Understand of information as sequential and global. A sequential learner uses an ordered sequence for the information while the global learner needs to see the whole information before digesting the details.

It should be noted that the level of understanding of students in a class depends, to a large extent, on the correspondence between the instructor teaching style and the students learning styles. It is well known that any discrepancy between the instructor and student styles may lead to the failure of the whole educational process[11,12]. This paper presents the results of the statistical analysis of an engineering students sample by using Herrmann and Felder models to measure, respectively, the students’ thinking and learning styles.

2. HERMANN MODEL FOR THINKING STYLES

Thinking preferences may change due to significant life changes or by training. There is no right or wrong modality of thinking preference; however, understanding one preference allows for initiation of training for other thinking preferences and possible improvement in communication, leadership, management, problem solving and decision making among other interpersonal quality improvements.

Herrmann whole brain model is applied in this study to measure the preferred thinking styles among the students of each of the considered groups of students[9,10]. The instrument used in measuring the thinking preferences consists of 13 questions each has four choices representing the thinking styles A, B, C, and D. In the space to the right of each choice, the students are required to write the numbers 4, 3, 2, or 1, where a 4 indicates most likely and 1 indicates least likely. Each number must be used only once for each question.

The instrument also contains four other questions where each has a list of items representing possible answers. The number of statements in each list ranges from 11 to 14. The first question is associated with thinking style A; the second question is associated with thinking style B; the third question is associated with thinking style C; the fourth question is associated with thinking style D. The students are asked to check the number of items in each list that they enjoy doing. This number is multiplied by four and added to the corresponding numbers of the first thirteen questions mentioned above. The result would give a numerical measure of the corresponding thinking style.

3. SOLOMON-FELDER MODEL FOR LEARNING STYLES

Student preferences in the reception and processing the information formulate the preferred learning style for a student. The compatibility between the instructor delivery style and the student learning style partially contributes to the percentage of the learning a student attains in a class. A mismatch between the instructor teaching style and the student style may lead to a failure in the learning process[11-13]. There are a number of models, assessment tools and methodologies designed to test the learning styles[12]. In Engineering and Science Education two instruments have been widely recognized: Kolb’s Learning Style Inventory (LSI)[14] and Soloman-Felder Index of Learning Styles (ILS)[15]. The styles assessment tool is an opinion survey. In this study, the ILS assessment tool was used. It consists of 44 multiple-choice questions. The instrument is conveniently available on the internet[15]. The ILS model classifies students according to where they fit on a number of scales pertaining to the ways they receive and process information. The ILS model classifies learners along four dimensions; namely, 1) Active-Reflective, based on Kolb model for processing information, 2) Sensor-Intuitive, based on Jung’s theory of psychological types, 3) Visual-Verbal, and 4) Sequential-Global. The last two dimensions are based of dimensions of other models[11]. The number of the possible different learning styles according to the ILS model is (2^8=16).

3.1 Dimensions of Learning Styles

In this study, the ILS assessment tool was utilized[15]. This tool is based on responding to 44 multiple-choice questions designed to classify a respondent’s learning style along four dimensions active-reflective, sensing-intuitive, visual-verbal and sequential-global dimensions.

Active-Reflective

This dimension deals with the processing of the perceived information. Active experimentation learner prefers to experiment with, discuss, test and explain the perceived information. Active learners prefer group work. Active learners tend to be experimentalists. Reflective observation learner prefers to examine and manipulate the information introspectively. Reflective learners prefer independent work. Reflective learners tend to be theoreticians. Active learning style is closely related with the C and D thinking styles, while reflective learning style is closely related with the A thinking style.

Sensor-Intuitive

This dimension deals with the perception and organization of information. Sensing involves observing, gathering data through senses, intuition involves indirect perception through speculation, imagination and guessing. Sensor learners prefer facts,
data and experimentation, solving problems using standard methods, memorizing facts. Intuitors learners prefer principles and theories, challenging new concepts, innovation and dislike repetition. Sensor learning style is closely related with B thinking style, while intuitive learning style is closely related with the D thinking style.

Visual-Verbal
This dimension deals with the input of information. Visual learners prefer information presented in pictures, diagrams, movies, demonstrations and charts. Verbal learners prefer information said to them. They prefer verbal discussion and presentation more than that presented by other input modalities.

Sequential-Global
This dimension deals with the understanding of the information. Sequential learners prefer an ordered progression in presenting the material while global learners like to see the whole scheme of the presentation in order to comprehend the information. Sequential learning styles are closely related to the B thinking style while the global learning style is closely related to the D thinking style.

4. STUDENT SAMPLE
The data for this research has been collected from four different groups of students from the United Arab Emirates University where the size of each group varies from 22 to 62 students. The first group (52 for thinking styles and 22 for learning styles) belongs to the students studying at the University General Requirement Unit (UGRU); where students spend their first year at the university after coming from high school. The second group (59 for thinking styles and 62 for learning styles) belongs to the engineering students studying their first year after UGRU at the College Requirement Unit (CRU). The students of the third group (49 for thinking styles and 56 for learning styles) belong to those studying at the College of Engineering at the intermediate (junior) level; where one to two years remain before graduation. The fourth group (37 for thinking styles and 50 for learning styles) belongs to the engineering students studying their final year at the College of Engineering and who are taking their graduation project. It should be noted that all the students sampled hold the United Arab Emirates nationality and with equal ratio of males and females.

5. THINKING STYLES
The instrument to measure the thinking preferences among the sampled students was distributed to students in each of the considered groups. The student input was collected and statistically processed. Scores of 59 or higher on any thinking modalities (A, B, C or D) indicate a peak or preference of that mode of thinking.

Scores of 49 or below indicate a valley or relatively low preference for that thinking style. It is possible to have no peaks or valleys, yielding a relative flat profile that may indicate versatility in thinking styles and an ability to adapt one’s thinking style to a given situation. The peak or valley for each group is converted to a percentage to compare the different thinking styles.

Figure 1 shows the results for all students of the four groups. The average measure of each of the four thinking styles (A, B, C, and D) is given in the figure. It can be noticed that, on average, the preferred thinking style is style B; which means that the students have the tendency to do things in a detailed, organized and sequential fashion. It can also be seen that the D is the least preferred thinking mode for the sampled students; which means that the student do not like to think in an intuitive and innovative way.

Table 1. Thinking styles peaks for all students

<table>
<thead>
<tr>
<th>Thinking Style</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaks</td>
<td>23</td>
<td>40</td>
<td>57</td>
<td>41</td>
</tr>
<tr>
<td>Peaks %</td>
<td>12</td>
<td>20</td>
<td>29</td>
<td>21</td>
</tr>
</tbody>
</table>

Table 1 shows a large discrepancy in the percentage of the peaks of the different thinking styles. One can observe that a high percentage of students have a peak in thinking style B and a relatively small percentage in style D – which agrees with the results of Figure 1.
Table 2 gives a comparison between the peaks of thinking styles for the considered four groups of students as well as the whole student sample. We would like to iterate that the group number represents the educational level of the students in that group. For example, group 3 represents students in their junior year. The results of the table shows that all the groups, except group 4 (senior students), prefer thinking style B. Moreover, it can be seen from the table that most of the students of all groups do not prefer the intuitive and innovative thinking (style D).

To compare between the preferred thinking styles of male and female students, Table 3 is constructed. The table gives the peaks of the thinking styles for males and females separately. One can observed that there is a remarkable difference between the thinking styles depending on students’ gender. While the males do not prefer the intuitive and innovative style (style D), a large percentage of female students prefer this style. The table also shows that the female students do not prefer thinking in an analytic and logical way (style A).

Table 2. Thinking styles peaks for each group

<table>
<thead>
<tr>
<th>Thinking Style</th>
<th>All students</th>
<th>Group 4</th>
<th>Group 3</th>
<th>Group 2</th>
<th>Group 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>21</td>
<td>46</td>
<td>18</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>29</td>
<td>43</td>
<td>27</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>C</td>
<td>20</td>
<td>38</td>
<td>10</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>D</td>
<td>12</td>
<td>24</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 3. Thinking style peaks for males and females

<table>
<thead>
<tr>
<th>Thinking style</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Females</td>
</tr>
<tr>
<td>A</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>19</td>
</tr>
<tr>
<td>C</td>
<td>16</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
</tr>
</tbody>
</table>

To study the effect of university education on the changes that could happen on the thinking styles of students, Figure 2 includes the progress of the peaks of the different thinking styles with the group number (year of study). It can be observed that style B remains the preferred style throughout the years in the university except for group 4. The effect of university education on group 4 is remarkable as the students of this group tend to prefer thinking style A (the analytic and logical style). The table also shows that, generally speaking, the percentage of the peaks of all styles is increasing over the years of university education with a noticeable increase for group 4 which is the largely affected by university education.

6. LEARNING STYLES

The instrument’s questions were downloaded from the internet. The questions were translated to Arabic. Both the English and Arabic versions of the instrument were distributed to students at the United Arab Emirates University with clear instructions on how to fill the forms. The forms were collected and responder’s choices were fed into the internet form and the results were then used in the analysis. The validity and reliability of the ILS has been established across multiple domains [11,16].

The dominant learning styles for the four groups and the whole sample was analyzed statistically, the error in the statistics analysis assumes 5% error. Figure 3 shows the dominant learning style for the whole student population participated in this study. The results show that the students are preferring the active over reflective, sensing over intuitive, visual over verbal and sequential over global. The data also shows that the majority of students are in the moderate range for each of the domains.

Figure 4 shows the distribution of the four dimensions of learning styles for all students participated in the study. For each dimension, the distribution is shown from strong (9-11) to moderate (5-7) to weak (1-3) scale. The negative notion is used to present the whole domain on the same figure as was used in [16]. The negative scale is indicated for the first modality in each domain. For example in Figure 4-a,
the negative is indicating a predominant active domain. Figure 4-a shows that majority of students are balanced active-reflective learners. There is however a small skew toward active learning style over reflective learning style. Figure 4-b shows that students are preferring sensor learning style over intuitive learning style. The skew in the preference is clearly toward moderate scale in the sensor scale. Figure 4-c shows that students’ preference is skewed toward visual over verbal. The majority of students are predominantly visual. Figure 4-d shows that students are predominantly sequential.

Table 4 shows the dominant learning style percentages of the UAEU students sampled in this study compared with other learning styles of students in other institutions\(^{[11,16]}\). The data for the UAEU students suggest similar trend in the students’ preferences toward active-reflective, sequential-global learning styles as those of students in international institutions. However the UAEU students have shown a more predominant preference toward sensor and visual learning styles over those of students in other institutions\(^{[11,12,16]}\). It is interesting to note that, the UAEU students maintain the sensor and visual preference over students at AUS who are studying in the same country but at different institutions.

A comparative analysis of the learning styles of students at the different years of study was conducted. Figure 5 shows the comparison on all learning dimensions for the sample at different stages in their learning careers at the College of Engineering. For the Active-Reflective dimension, an overall balanced distribution is found for all groups. In the sensor-intuitive dimension the skewing toward sensor is observed after the entry level year. The skewness is about the same for the 1st, junior and senior years. The skewness toward visual over verbal is also observed for all years, however a stronger preference towards visual is observed for the junior and senior years.

Skewness toward the sequential learning style is also observed. More towards the global learning style is observed for the junior and senior students but that did not change the overall preference towards sequential learning style.

A comparison between the male and female students in the first year learning preferences was conducted. Figure 6 shows that male students prefer active modality more than female students which coincide with the obtained results in the thinking style as shown in Table 3. It can be observed that male and female students have similar preferences in the sensing-intuitive and visual–verbal styles. It is also shown that male students have more preference towards sequential style than female students.

<table>
<thead>
<tr>
<th>Institution/Country</th>
<th>Active</th>
<th>Sensor</th>
<th>Visual</th>
<th>Sequential</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Arab Emirates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University/UAE</td>
<td>62</td>
<td>82</td>
<td>85</td>
<td>72</td>
</tr>
<tr>
<td>All</td>
<td>59</td>
<td>77</td>
<td>82</td>
<td>77</td>
</tr>
<tr>
<td>UGRU</td>
<td>69</td>
<td>82</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>1st year</td>
<td>63</td>
<td>82</td>
<td>93</td>
<td>73</td>
</tr>
<tr>
<td>Senior</td>
<td>56</td>
<td>84</td>
<td>92</td>
<td>70</td>
</tr>
<tr>
<td>American University of Sharjah/UAE</td>
<td>51</td>
<td>64</td>
<td>79</td>
<td>71</td>
</tr>
<tr>
<td>U of Minnesota Duluth/USA</td>
<td>46</td>
<td>65</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>Ryerson/Canada</td>
<td>53</td>
<td>66</td>
<td>86</td>
<td>72</td>
</tr>
<tr>
<td>University of Sao</td>
<td>57</td>
<td>68</td>
<td>80</td>
<td>51</td>
</tr>
<tr>
<td>Sao Paulo/E Brazil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Kingston/UK</td>
<td>51</td>
<td>64</td>
<td>79</td>
<td>71</td>
</tr>
</tbody>
</table>

Figure 4. Students learning styles at UAEU
Figure 5. Comparison of learning styles for all years of study.

Figure 6. Comparison between male and female learning preferences.
7. COMPARISON BETWEEN LEARNING AND THINKING STYLES

The results of this research clearly indicate that the students at the UAEU have preference towards active, sensor, visual and sequential learning styles over reflective, intuitive, verbal and global learning styles. Also, we have found that the students have B, C and A dominant thinking styles over D thinking style. It should be noted that active, visual and verbal learning styles are related to C thinking style. Sensor and sequential learning style is related to B thinking style, reflective learning style is related to A thinking style, intuitive and global learning style is related to D thinking style. It is concluded, therefore, that both the thinking style and the learning style analysis presented in this article confirm that UAEU students prefer C and B thinking styles over D and A.

In most educational practices, the material is presented in sequential fashion. Its progression is controlled by the time allocated for each topic. Global learners who make most of the multidisciplinary researchers and inventors are not encouraged to strengthen their preference learning and thinking domain in a typical educational setting. Strengthening, the intuitive, verbal and global learning style is, thus, needed for the UAEU students.

8. CONCLUSIONS

The whole brain model and the Index of Learning Style were tested on a sample of engineering students at the United Arab Emirates University. The results of the study conclude that the sampled students prefer the active, sensing, visual and sequential learning styles. Also it is shown that the sampled student population prefers the B and C thinking styles more than the A and D styles. The obtained results for the thinking style and learning styles are matching. The preference towards the sequential thinking and learning styles may be influenced by the instruction methods utilized in most higher education institutes. The need to strengthen the intuitive, verbal and global learning styles is demonstrated in the results.

REFERENCES