

Application of Group Technology to Medical Student's Learning Style Trend

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Abstract

This study aims at grouping post-graduate physician's learners into clusters based on their preferred learning style in order to develop a suitable teaching methodology to be used during their career. Felder and Silverman Index Learning Style, ILS is used to find physician's learning styles preferences; then group them into clusters based on such similarity using multivariate statistical analysis. Group Technology concept is used to group the physicians into clusters as the realization that many problems are similar and by grouping similar problems; single solution can be found to a set of problems. Using Felder and Silverman Index Learning Style in conjunction with using group technology concept; will give physicians instructors a good idea about their physicians' student's learning preferences as groups rather than as individuals. Other conclusion can be inferred from this approach; is to check for outlier learners' students' physicians and deal with them accordingly.

The current study shows that physicians tend to learn by three major learning styles, namely; Visual learners, sensing learners and sequential learners. Hence the suitable teaching approach is to present the content using presentations and other visual means sequentially.

Keywords: Group Technology, Clustering, Learning Style. Kolb

INTRODUCTION

In medical education; the pre-clinical years are taught using didactic approach were lectures are given to large groups of students. While during the clinical years; bedside and round bedside apprenticeship model is used and continues into graduate medical education where the cornerstone of residence education is the theme of education. Teaching is a crucial part of medical profession. Physicians teach colleagues, medical students and residents on daily basis. Barrow (1966)^[1] suggested that medical students are interested in teaching by using surveys showing that medical students saw residents as teachers. Medical schools start to

realize the importance of preparing medical students to teach during their medical career .Moseley et al. 2002; Nestel & Kidd 2002; Haber et al. 2006; Blatt & Greenberg 2007; Dandavino et al. 2007; Pasquinelli & Greenberg 2008; Andreatta et al. 2009) while half of medical schools in United States of America are using some sort of students as teachers in their curriculum [8](Soriano et al. 2010).

Heywood (2000) finds that linking learning style to teaching strategy gains positive factors to improve students' knowledge in subject matter. In this study; Felder and Silverman (1988) Index Learning Style, ILS is used to identify medical professionals learning styles, then using suitable teaching style to teach them. A study conducted by Jack et al in 2010 involving medical students, residence and faculty members shows that there is significant difference between residence and faculty in both teaching and learning preferences. Residence as teachers can use the results of this study to enhance their teaching strategies once they know the learning styles of their students and apply the corresponding teaching approach.

This study aims at enhancing the teaching methodologies used by medical professionals by utilizing the concept of an engineering philosophy called Group Technology, GT,(Abdelhadi ,2010). GT is a methodology that identifies common similarities among attributes of set of objects and clustering them accordingly into cells. By realizing that many problems are similar, and by grouping similar problems together; single solution can be found to a group of problems.

Previous researches have been conducted using teaching style based on teacher's ranks, course level, gender, academic discipline. This study deals with investigating the learning style of physicians by groupings them in groups of learners into clusters based on their common learning style and then selecting the suitable teaching style to maximize the teachings goals.

LEARNING STYLES AND TEACHING STYLES

Several learning styles have been subject to investigations by educators throughout the years. Myers-Briggs Based Type Indicator, MBTI was used in the 1980's and 1970's in engineering campuses; this indicator has strong learning style implications (Pittenger, 1993). Other learning models used as learning style are Dunn and Dunn (McCaulley, 1976), Kolb (Stick, 1987) and Felder and Silverman. It is worth mentioning here that; the concept of learning style is accepted as heuristic approach rather than a solid indication since it was not validated scientifically. Grasha (1996) described six learning styles and they have been used extensively in social sciences. The described learner styles were divided into the following categories: Competitive; they learn by competing with other students, Collaborative; they learn by sharing concept and ideas with other students, Avoidant; they are uninterested by what is happening in the classroom and they believe they can lean by their own, Participant; always they try to participate in the classroom activities by asking questions or try to answer questions, Dependent; always they need to be guided in order to understand the subject matter and Independent; they always like to take the matter in their hands and think independently.

While, the following teaching style are developed based on behaviors of which the faculty members displayed in the classroom. Grasha divided the teaching styles into the following categories: Expert; who transmit and convey information, Formal Authority; who define and sets acceptable standards, Personal Model; who use illustrations to deliver his messages, Facilitator; who teaches by asking questions and interact with the learners and Delegator; who teaches by encouraging students to think independently. Grasha (1996) developed the following scheme table shows the matching between the learning style and teaching style:

Table 1

| <u>Primary Learning Styles</u> | <u>Primary Teaching Styles</u> |
|---------------------------------------|--|
| Dependent/Participant/Competitive | Expert/Formal Authority |
| Participant/Dependent/Competitive | Personal Model/Expert/Formal Authority |
| Independent/Collaborative/Participant | Delegator/Facilitator/Expert |
| Collaborative/Participant/Independent | Facilitator/Personal Model/Expert |

Vaughn and Baker (2008) used Grasha learning style to investigate the pairing of teaching and learning styles in medical environment and came up with conclusion that pairing teaching style with learning style should be considered

when pairing preceptors with residents. Felder and Silverman (1988) developed learning style based on answering the following questions: What type of information does the student preferentially perceive: Sensory or intuitive, the type of information is most effectively perceived: visual or verbal, How students prefer to process the information: actively or reflectively and How does the student characteristically progress toward understanding the issue on hand: sequentially or globally. Based on the learning style student prefers a suitable teaching style was developed to facilitate the processing of the information delivered, for example; what type of information is emphasized by instructor; concrete or abstract, how the presentation is organized by the instructor; inductively were phenomena leading to principals or deductively were principals leading to phenomena. Table 2 represents the dimensions of learning style as it relates to teaching style based on Felder and Silverman classifications and the suitable teaching approach used by the instructors:

Table 2:

| <u>Learning Style</u> | <u>Teaching Style</u> | <u>Teaching Approach</u> |
|-----------------------|-----------------------|--------------------------|
| Sensory | Concrete style | Content |
| Intuitive | Abstract | |
| Visual | visual | Presentation |
| Auditory | Verbal | |
| Inductive | Inductive | Organization |
| Deductive | Deductive | |
| Active | Active | Student Participation |
| Reflective | Passive | |
| Sequential | Sequential | Perspective |
| Global | Global | |

For example; Felder and Silverman (1988) categorized people by the way they receive the information into three categories; by sight (visual), by sound (auditory) and by taste, touch and smell (kinesthetic). Hence, the visual learners can remember best by seeing things such as diagram and charts.

This research will use Felder and Silverman (1988) approach to classify the learning style of physicians in order to use the suitable teaching approach. Group technology concept will be used to achieve this aim.

Group Technology:

It is a methodology that identifies and exploits the common similarities among the attributes of a set of objects and clusters them into cells (Abdelhadi, et. al 2015) Cellular manufacturing is an application of group technology to manufacturing. In cellular manufacturing, machines, usually dissimilar in function, are grouped into a cell. Such cells should be ideally responsible for the processing of a group of

parts called part-family (parts with similar processing requirements). The idea is to process a family of components through a dedicated cell, thereby gaining the advantages of mass production without the problem of batching.

Clustering Algorithms Based on Similarity Coefficients

Large numbers of similarity coefficients have been proposed throughout the years. Among the algorithms used to identify and form part-family associated with the machine cell formation is clustering algorithms based on similarity coefficient method, which is used to find the similarity between parts/machines, then group them into part-families/machine cells. Pairwise similarity coefficients between machines/parts are calculated using specific similarity coefficient formulas. These similarities are then organized into a matrix called the similarity coefficient matrix. This matrix is used as an input to one of the clustering algorithms, such as single linkage clustering (SLINK) to form part-families/machine cells (Abdelhadi et.al. 2015) where the input can be distance or similarities between pair of objects. Groups are developed by merging the nearest neighbors due to heights similarities between them. It works as follows;

- Find the smallest distance/similarities in $D = d_{ik}$
- Merge the corresponding objects, U and V to get the cluster UV
- The distance/similarities between UV and any other cluster, Q is computed by

$$d_{UVQ} = \min(d_{UQ}, d_{VQ})$$

The values d_{UQ} and d_{VQ} are the distance/similarity between the clusters U and Q and V and Q respectively.

- The result will be graphically shown in form of tree diagram (*dendrogram*)

The tree diagram representing machine cells/part-families at different levels of similarity is created using the similarity coefficient matrix. The concept of group technology in conjunction with clustering algorithms is used to create virtual cells of student physicians based on their learning style.

Current Practice

A literature search revealed that learning style preferences have been investigated using descriptive statistical analysis such as frequencies and percentages of the targeted populations. The studies showed the preferences of the targeted student's populations individually. The index of learning style, ILS is 44 questions to assess preferences on four sets of responses. ILS is available at the World Wide Web free of charges to individuals who like to assess their own preferences. Paterson (1999), in his study showed that; of the 83 undergraduate engineering students who completed the ILS in a study conducted at Michigan Technological

University, 56 percent were classified as active (ACT) learners (44 percent were reflective learners, REF), 63 percent were sensing (SEN) learners (37 percent intuitive learners, INT), 74 percent were visual (VIS) learners (26 percent verbal, VRB), and 53 percent were sequential (SEQ) learners (47 percent global).

This paper will use multivariate statistical analysis to group physicians into clusters based on the similarity between their learning styles regardless of tendency of the learning styles the majority of students belong to, then a suitable teaching style is used according to Felder and Silverman classification shown earlier.

Data Collections:

Study participants were physicians selected from private hospitals located in the eastern part of the kingdom of Saudi Arabia. They were from different age group, ethnicity background and specialty. Participants were given the link to answer the questions of the ILS, the reason behind the study were explained to the participants and the science behind the data collection and the importance of learning style and its connection to the teaching style were explained. Consent was signed by all participants including the principal investigator which show the confidentiality of the data and no personal information will be used such as participant's names. Figure (1) shows a sample of a result of one of participant in the study. If the participant

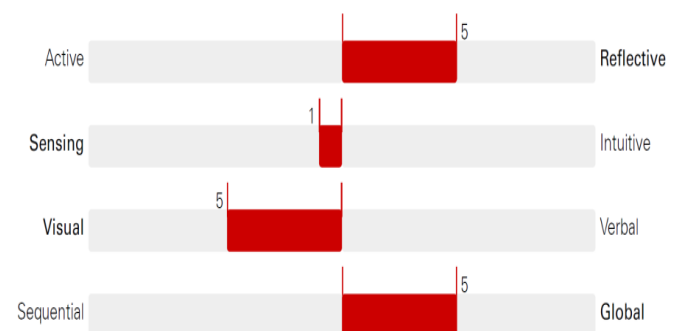


Figure 1

scores between 1-3; he/she fairly is well balanced in the two dimensions, if he/she scores 5-7; the participant has moderate preference toward that criteria and if the score is between 9-11 they have very strong preference toward that dimension in the scale. Table 3 shows the results obtained from 18 participants using ILS questionnaire located in the world wide web, Felder and Silverman, 1988).

Table 3

| Participant Number | Active ACT | Reflective REF | Sensing SEN | Intuitive INT | Visual VIS | Verbal VER | Sequential SEQ | Global GLO |
|--------------------|------------|----------------|-------------|---------------|------------|------------|----------------|------------|
| 1 | 0 | 5 | 1 | 0 | 5 | 0 | 0 | 5 |
| 2 | 0 | 1 | 5 | 0 | 7 | 0 | 0 | 5 |
| 3 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 1 |
| 4 | 3 | 0 | 3 | 0 | 3 | 0 | 1 | 0 |
| 5 | 0 | 5 | 1 | 0 | 3 | 0 | 1 | 0 |
| 6 | 3 | 0 | 0 | 1 | 7 | 0 | 5 | 0 |
| 7 | 5 | 0 | 7 | 0 | 5 | 0 | 5 | 0 |
| 8 | 3 | 0 | 5 | 0 | 7 | 0 | 5 | 0 |
| 9 | 0 | 3 | 5 | 0 | 7 | 0 | 1 | 0 |
| 10 | 0 | 1 | 5 | 0 | 3 | 0 | 0 | 1 |
| 11 | 9 | 0 | 3 | 0 | 11 | 0 | 0 | 1 |
| 12 | 0 | 1 | 5 | 0 | 1 | 0 | 0 | 3 |
| 13 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 14 | 0 | 5 | 0 | 5 | 9 | 0 | 3 | 0 |
| 15 | 5 | 0 | 7 | 0 | 9 | 0 | 0 | 7 |
| 16 | 0 | 1 | 5 | 0 | 5 | 0 | 3 | 0 |
| 17 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 |
| 18 | 0 | 1 | 3 | 0 | 7 | 0 | 1 | 0 |
| Total | 33 | 23 | 62 | 6 | 97 | 1 | 28 | 24 |

Data analysis of using complete linkage clustering:

Mini-tab software is used to develop clusters of physicians under study based on their learning styles using complete linkage clustering; the results are shown in Table 4. Step 1; physician # 17 joins physician #16 at 89.7% common similarity of their learning style, step 2 shows that physician #9 joins physician # 9 at a common level of their learning style similarity at a level equal to 79.5%, and so on. Figure (2) shows a Dendrogram of the developed clusters. It is clear that the Dendrogram can be divided into distinct groups; for example, physicians 1 and 5 are having same learning style with 60% communality, while physicians; 3,4,13,10 and 12 can be grouped together in one cluster with 63% common learning styles. It is obvious that the majority of physicians are belonging to two distinct groups as seen in Figure (4); group 1 consists of 6,7,8,9,18,16 and 17 while group 2 consists of 3,4,13,10.

Table 4:

| Step | Similarity Level | Clusters joined | |
|------|------------------|-----------------|----|
| 1 | 89.74 | 16 | 17 |
| 2 | 79.48 | 9 | 18 |
| 3 | 79.48 | 10 | 12 |
| 4 | 77.05 | 3 | 4 |
| 5 | 74.86 | 7 | 8 |
| 6 | 72.95 | 9 | 16 |
| 7 | 71.91 | 3 | 13 |
| 8 | 63.37 | 3 | 10 |
| 9 | 60.26 | 1 | 5 |
| 10 | 58.97 | 7 | 9 |
| 11 | 55.27 | 2 | 15 |
| 12 | 52.53 | 6 | 7 |
| 13 | 50.02 | 3 | 6 |
| 14 | 44.27 | 1 | 3 |
| 15 | 35.77 | 1 | 2 |
| 16 | 27.79 | 1 | 14 |
| 17 | 19.35 | 1 | 11 |

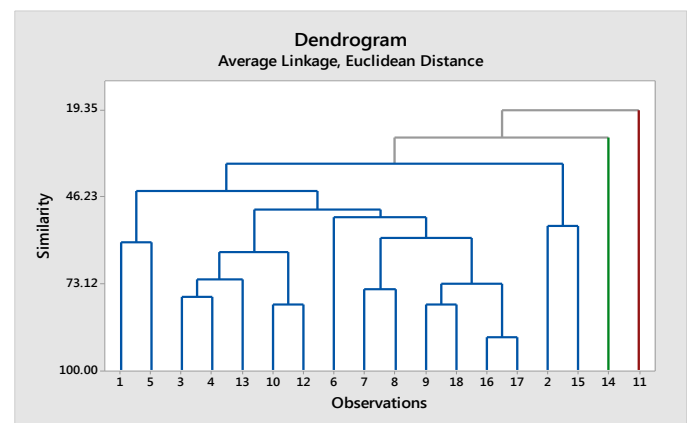


Figure 4:

Table 5 shows the learning style first cluster of physicians, while Table 6 represents the learning style of the second cluster.

Table 5:

| Participant Number | Active ACT | Reflective REF | Sensing SEN | Intuitive INT | Visual VIS | Verbal VER | Sequential SEQ | Global GLO |
|--------------------|------------|----------------|-------------|---------------|------------|------------|----------------|------------|
| 3 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 1 |
| 4 | 3 | 0 | 3 | 0 | 3 | 0 | 1 | 0 |
| 10 | 0 | 1 | 5 | 0 | 3 | 0 | 0 | 1 |
| 12 | 0 | 1 | 5 | 0 | 1 | 0 | 0 | 3 |

Table 6

| Number | ACT | REF | SEN | INT | VIS | VER | SEQ | GLO |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| 7 | 5 | 0 | 7 | 0 | 5 | 0 | 5 | 0 |
| 8 | 3 | 0 | 5 | 0 | 7 | 0 | 5 | 0 |
| 9 | 0 | 3 | 5 | 0 | 7 | 0 | 1 | 0 |
| 16 | 0 | 1 | 5 | 0 | 5 | 0 | 3 | 0 |
| 17 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 |
| 18 | 0 | 1 | 3 | 0 | 7 | 0 | 1 | 0 |

Table 6, shows the highest number of physicians in one cluster indicates that the participants have moderate preferences toward sensing, visual and sequential learning style. While Table 5 indicates that the participants also have moderate tendency toward sensing and visual learning style but with less tendency. Table 3 in conjunction with the dendrogram indicate that physician number 11 has different learning style on his own.

Based on some descriptive statistical analysis using Table 3; the following data were developed:

Table 7

| Learning Style | Mean | Median |
|----------------|--------|--------|
| ACT | 1.833 | 0.500 |
| REF | 1.278 | 0.500 |
| SEN | 3.444 | 4.000 |
| INT | 0.333 | 0.000 |
| VIS | 5.389 | 5.000 |
| VRB | 0.0556 | 0.000 |
| SEQ | 1.556 | 1.000 |
| GLO | 1.333 | 0.000 |

The highest median value of the learning style is 5.0 which belongs to visual learners with mean equal to 5.389 followed by sensing learners at 4.0 and a mean equal to 3.444, then the sequential learners at 1 and mean equal to 1.556 and a median of 0.5 for active learners with mean equal to 1.833. This indicates that the surveyed physicians prefer visual, sensing and sequential as their learning style.

DISCUSSION AND RESULTS

According to Felder and Silverman; Sensing learners can observe the world through their senses; they like facts, data and experimentations. They also like solving problems by standard approach and they do not like surprises; they are patient with details. They have problems with timed tests because they are slow in translating symbols which leads them to read the question several times before answering. Visual learners remember best when they see things such as diagrams, flow charts, films and demonstrations. The sequential learners tend to learn things by reasoning through presenting the material to them partially or superficially and on a steady progression. Felder and Silverman use the following techniques to be used as teaching approach to the sensing learners: 1- Provide them with concrete information such as actual facts and data. 2- Use problem solving approach. 3- Provide sensing patterns to the learners such as surrounding observations. 4- Present applications. 5- Assign exercises based on basic methods. While for visual learners, they suggested using the following teaching approach: 1- Use pictures, graphs and simple sketches to present the concept. 2- Show films and provide demonstrations. For the sequential learners whom represent the third highest category of physicians' learners under study, the following approach can be used to teach them: the traditional formal education which is based on presenting the material on a steady pace starting from basic material going up the ladder with material difficulty without jumping to conclusions.

Conclusion and future research:

This study classified the physicians' learners into three major classifications using a well-known learning and teaching styles called Felder and Silverman learning style. The results show that physician learners are classified into: Visual learners, sensing learners and sequential learners. Based on this classification, the instructor can use specific teaching approach to convey the materials to the learning physicians. The sample size of this study was limited to 18 physicians which opens the door to expand the study to much larger sample size. The learning style results of this study may be due to experience gained by the physicians during their learning career which force them to adapt to this type of learning style (visual, sensing and sequential), hence more study needed to enforce the conclusion with larger sample size.

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