



Toward A Mathematical Model of Teaching and Learning (M²TL)

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Abstract

The current paper falls in line with the contemporary effort aiming towards developing teaching and learning processes. It is a trial to take attention to simulate applied sciences which are using mathematical models to explain related problems and phenomena. This paper may be the first step towards constructing a mathematical model which helps teachers and educators to avoid using their point of views and control all variables and parameters in teaching and learning system such as: students, teachers, physical environment, curriculum, media, ...etc. As an example, the paper refers to a student as a variable by measuring learning styles quantitatively using the Index of Learning Styles which is formulated by Felder and Silverman since 1988. Graphs which is consider as a tool of any mathematical model will be used to express to the responses of participants.

1. Introduction

The mathematical model is a description of a system using mathematical language. Mathematical models are used in natural sciences, engineering applications, and social sciences (economics, psychology, political sciences). So, it's important for the educators to have a model to control and adjust all elements and factors related to teaching and learning system, as so as the physicists when they control the elements of gases or fluids systems. This model may be try to reduce the gap between the theoretical aspects and practical procedures.

As it Known, Teaching and Learning (TL) system is dynamic, continuous, and probabilistic, so these characteristics make it possible to construct such a mathematical model. There are many internal and external variables (parameters) that affected on the TL process such as: students(s), teachers(t), curriculum(c), physical environment(p), media(m), ...etc. So we can express to the TL as a function of these variables as in the equation

$$TL \sim f(s, t, c, p, m, \dots)$$

To construct a mathematical model, it is necessary to start analyzing the system and making assumptions, then choosing mathematical equations from the literature or data exploration. After solving equations analytically or numerically, the step is testing the model by testing the assumptions and model structure, then using the model to form predictions and decisions [1][2].

Constructing a mathematical model of the whole of TL system is ambitious but very difficult. The researchers in this field are going to need data to fit all the free parameters in the model, which is going to be very tough. So, it is better to start small with a very specific type of TL parameters. This paper is the first step in a grand project, it aims to introduce the student as a variable, who is consider the most important variables in TL system by measuring learning styles using the index of learning styles instrument, which is closer to be a mathematical model than the other related instruments and questionnaires.

2. Measuring Learning Styles of the Students

2.1 Literature Review

Students differ in the ways that they prefer to collect, absorb, address, manipulate and use data. That ways are called Learning Styles (LS), which are different in spite of similarity in age, race, culture and religion. Related studies show that the differences in learning styles between students is due to (60%) biological factors, (20%) cultural factors and (20%) environmental factors. Also, most of studies consider Learning styles not only abilities to manipulate information, but they are a human behavior helps students to discover their own methods in learning, and teachers to apply the most suitable methods in teaching inside and outside the school [7].



Naturally, there are many models of different learning styles in education. The most widely used are David Kolb's Experiential Learning Model and Learning Style Inventory, Neil Fleming's VAK/VARK model, Dunn and Dunn Model, and Felder–Solmon Index of Learning Styles. Although, these models and are differ in their dimensions and categories, but all of them agree that most of students can be learn according to their possible strengths and possible tendencies. Also, they agree that no one falls neatly into only one learning style, students may have a secondary learning style that works for them significantly better than another. For example, a student may be primarily a visual learner, have some skills for auditory learning, and have no skill for learning kinesthetically [4][6].

In this paper, the Index of Learning Styles (ILS) will be introduced. It is an online questionnaire (available from www.ncsu.edu/effective teaching) designed to assess preferences on four dimensions of a learning style model formulated by Felder and Silverman[5]. ILS is an example of a mathematical model consists of four scales or groups [3][8]:

- Active and reflective (ACT/REF) learners: Active learners tend to retain and understand information best by doing something active with it, discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first. “Let’s try it out and see how it works” is an active learner’s phrase; but “Let’s think it through first” is the reflective learner’s response.
- Sensing and intuitive (SEN/INT) learners: Sensing learners tend to like learning facts, solving problems by well-established methods and dislike complications and surprises. They tend to be patient with details and good at memorizing facts and doing hands-on (laboratory) work. Intuitive learners often prefer discovering possibilities and relationships, they like innovation and dislike repetition. Intuitors may be better at grasping new concepts and are often more comfortable than sensors with abstractions and mathematical formulations. Sensors tend to be more practical and careful than intuitors who tend to work faster and to be more innovative than sensors.
- Visual and Verbal (VIS/VER) learners: Visual learners remember best what they see: pictures, diagrams, flow charts, time lines, films, and demonstrations. Verbal learners get more out of words: written and spoken explanations. Everyone learns more when information is presented both visually and verbally.
- Sequential and global (SEQ/GLO) learners: Sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly “getting it.” Sequential learners tend to follow logical stepwise paths in finding solutions; global learners may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture, but they may have difficulty explaining how they did it. Figure (1) summarizes Felder-Silverman learning styles groups.

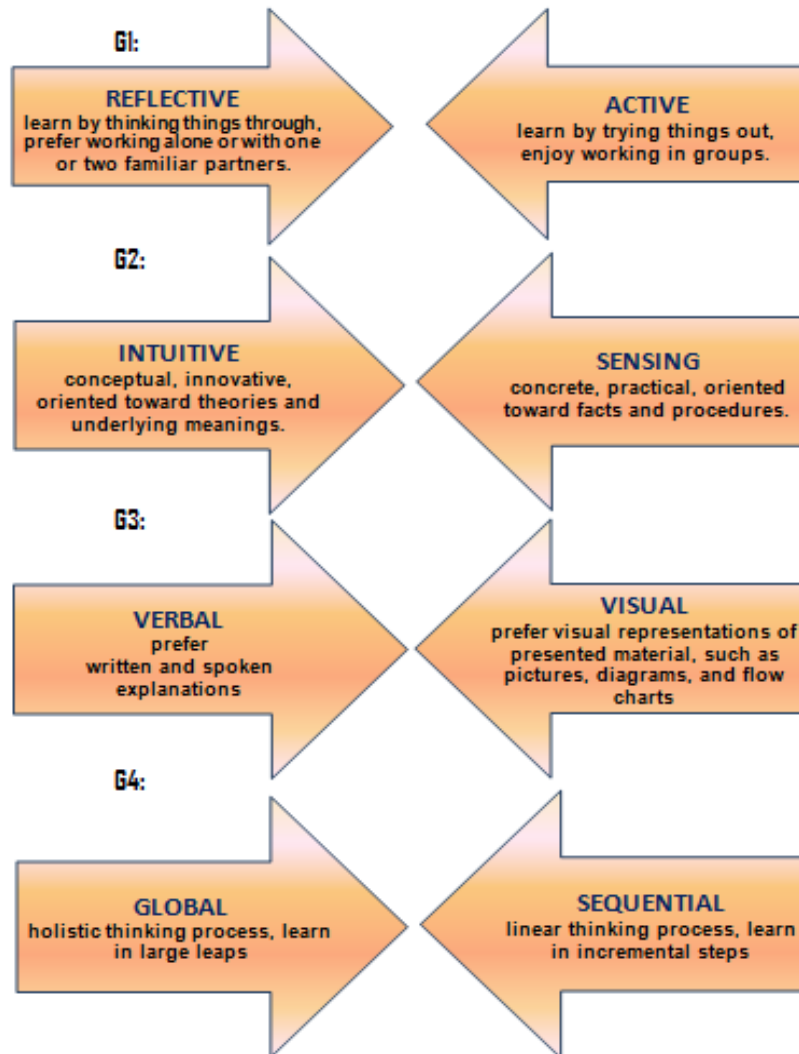


Fig.1: Felder-Silverman learning styles groups

2.2 Methodology

A. Instrument

The ILS questionnaire consists of (44) items, that asks the respondent to choose one of two endings to a sentence that focuses on some aspect of learning in (4) scales (or dimensions). Each scale is related to (11) items, so the items (1,5,9,13,17,21,25, 29, 33,37, 41) are related to (ACT/REF) scale, (2,6,10,14,18,22,26,30,34,38,42) are related to (SEN/INT) scale, (3,7,11,15,19,23,27,31,35,39,43) are related to (VIS/VER) scale and (4,8,12,16,20,24,28,32,36,40,44) are related to (SEQ/GLO) scale. Scoring is 1, 3, 5, 7, 9, and 11, with 1 and 3 showing a balance along the continuum, 5 and 7 showing a moderate preference for one end of the continuum, and 9 and 11 a strong preference for one end or the other.

B. Participants

ILS questionnaire is translated to Arabic language, and was administered with a group of (N=21) students from the first year of BSc Education in King Faisal University in Saudi Arabia. The questionnaire was placed online and students were given a lapse of 2 days to answer to the questions.

2.3 Findings and Analysis

For each questionnaire, if the answer of an item is (a), put (1) in a column (a) beside this item, but if the answer is (b), put (1) in a column (b). Apply this step in all items and all columns to have a sheet as in table (1) which represents analysis of the responses of a student from the participants. For each of the four scales, subtract the smaller total from the larger one. Write the difference (1 to 11) and the



letter (a or b) for which the total was larger on the bottom line. Transfer scores to the LS graph as in fig.(2), then repeat the previous procedures for all students to have a LS map as in fig. (3).

Table1: Learning styles worksheet for responses of a student from the participants

	ACT	REF		SNS	INT		VIS	VRB		SEQ	GLO
Q	a	b	Q	a	b	Q	a	b	Q	a	b
1	1		2		1	3		1	4	1	
5	1		6		1	7		1	8	1	
9	1		10	1		11		1	12	1	
13	1		14		1	15		1	16	1	
17		1	18	1		19		1	20	1	
21		1	22	1		23	1		24	1	
25	1		26		1	27		1	28	1	
29	1		30	1		31		1	32	1	
33	1		34	1		35		1	36	1	
37	1		38		1	39		1	40	1	
41	1		42		1	43		1	44	1	
SUM	9	2		5	6		1	10		11	0
(Larger – Smaller)+Letter of Larger											
	7a			1b			9b			11a	

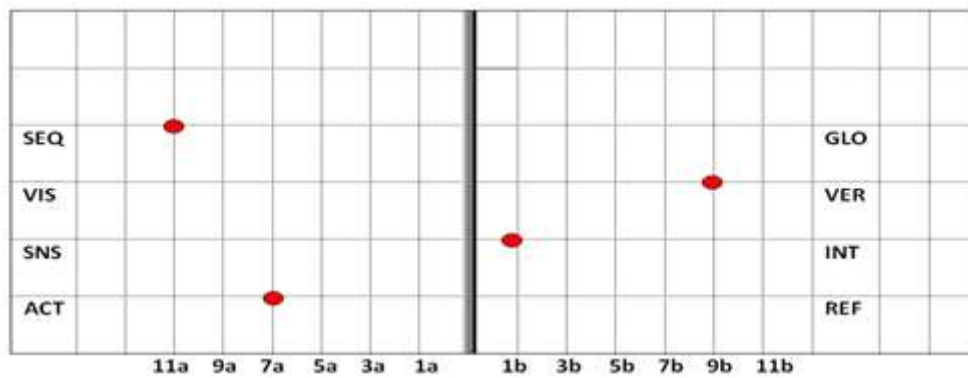


Fig. 2: LS graph of a student from the participants

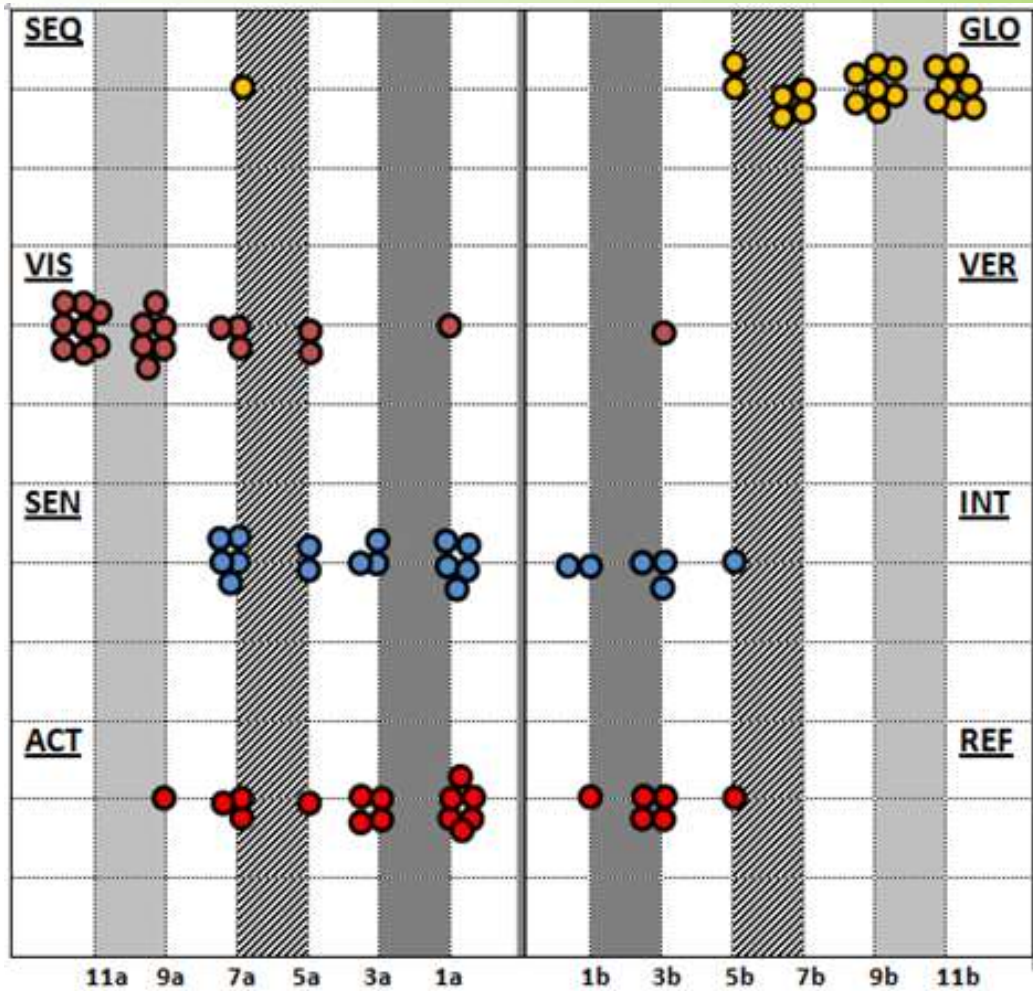


Fig. 3: Students' (N=21) LS map

KEY

	1 - 3	Fairly Well Balanced
	5 - 7	Moderate Preference
	9 - 11	Strong Preference

2.4 Results and Conclusion

The learning styles map shows that the students (N=21) have approximately equivalent preferences lies between fairly well balanced and moderate in the first two groups (ACT/REF and SEN/INT). But in the third group (VIS/VER), the students have strongly preference towards visible LS more than verbal LS. Also they show strongly preference towards global LS more than sequential LS in the fourth group (SEQ/GLO). The previous data helps the teacher to design the instructional situations as the student prefer, change the traditional classrooms to flexible classrooms, and achieving the harmony between teaching styles (TS) and learning styles (LS), which are lead to control and long-range learning.

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