Matching Instructional Strategies to Learning Styles: Does it Contribute to Students' Achievements?

Nissim Sabag[1] and Elena Trotskovsky[2]

[1] Ort Braude College, Karmiel, Israel, nsabag@braude.ac.il
[2] Ort Braude College, Karmiel, Israel, elenatro@braude.ac.il

ABSTRACT

Some researchers claim that a good match between students' learning styles (LS) and teachers' instructional strategies (IS) contributes to students' achievements. Accordingly, in order to maximize student achievements teachers should adjust their teaching strategies to fit their students' Learning Styles. The current paper presents a study designed to examine the impact on students' learning achievements when teachers' IS matches students' LS. The Felder-Silverman method was used to measure students' preferred LS as well as teachers' preferred IS. A method—two questionnaires—for measuring the IS–LS distance and its effect on students' grades was developed. The research population, comprising 74 students and 5 teachers from two high schools and one college, were asked to fill in the LS and IS questionnaires, correspondingly. The absolute value of the difference between the LS to IS defined the IS–LS distance; the distances were calculated for each student and the relevant teacher. If the argument that a good IS–LS match contributes to a student's achievement is valid, then a significant negative correlation between the IS–LS distance and the student's achievements must exist. The correlations between the IS and LS distances and students' achievements in five courses were calculated in order to answer the above question. The full paper will present the research findings that do not support the assumption that matching IS to LS improves student achievements.

KEYWORDS: *Learning Styles, Instructional Strategies, engineering education*

1. Introduction

Felder and Silverman [1] claim that student learning is determined by the student's ability, the student's background and the match between the student's learning style (LS) and the teacher's instructional strategies (IS). They conclude that teachers can do nothing about students' given characteristics such as ability, background and LS. Therefore, in order to maximize students' achievement, teachers should adjust their IS to fit students' LS. Waks [2] takes into consideration the match between LS and IS as part of his model for curriculum design. He raises numerous questions concerning the *IS–LS* match. The question whether good matching indeed improves the learning process is the subject of the research described in this paper.

A method for measuring the match between each IS dimension to each corresponding LS dimension, as well as for measuring the match between the overall IS to overall LS, is needed. The correlation between these matching variables and students' achievement should be calculated, in order to answer the research question.

2. Theoretical Aspects of Learning Styles and Instructional Strategies

The idea that different students have different LS has been known and investigated for a long time. According to Guild and Garger [3], the first one to use the term style was Hippocrates. The use of LS in education is rooted in psychological theories such as Jung's psychological types in [2, 3].

There are several approaches concerning the analysis and use of LS. There is the three-factor model associated with Sternberg [4] and Lemire [5], among others. Kolb and Boyatzis [6] present four types of learners. Lemire [7] argues that Gardner's [8] multiple intelligences are simply LS. Felder and Silverman [1] define five LS dimensions and their corresponding IS dimensions, which are relevant to engineering and technology [2]. These dimensions are presented in Table 1 below.

Table 1. Preferred Learning Styles and Corresponding Instructional Strategies.

	Instructional Strategy		Learning Style	
1.	Concrete	Content	Sensory	Perception
	Abstract		Intuitive	
2.	Visual	Presentation	Visual	Input
	Verbal		Auditory	
3.	Inductive	Organization	Inductive	Organization
	Deductive		Deductive	
4.	Active	Involving the learner	Active	Processing
	Reflective		Reflective	
5.	Sequential	Perspective	Sequential	Understanding
	Global		Global	

Felder [9] [10] presents cases of students with different types of LS. There are no bad or good LS; they are just different. Felder and Silverman [1] and Felder [11] show the way to measure Preferred Learning Styles. Each dimension has a scale. The student is asked to mark his or her preferred style on this scale.

For example, the two ends of the scale for the *perception* dimension are sensing and *intuitive*. Each direction has three levels (mild, moderate, or strong) as shown below.

Sensing……..……!……..……Intuitive
Strong Moderate Mild Mild Moderate Strong

Each dimension has a distinct meaning. A *sensing* learner tends to focus on sensory information such as what is seen, heard, touched. An *intuitive* learner focuses on intuitive information (ideas, memories, possibilities). For the research described here, we prepared an LS questionnaire for students and an IS questionnaire for teachers [12], using the Felder and Silverman method (see appendix). [1]

Lemire [7] raises three serious problems associated with LS: confusion in definitions, weaknesses in reliability and validity, and the identification of relevant characteristics in the instructional setting. Many researchers in the area of LS make claims concerning validity and reliability, and professionals should be skeptical of these [7]. We deal with this issue later. For the moment we present the discussion in the literature on using LS for advancing the learning process.

Delahoussaye [13] gathered together seven experts (Kolb, Honey, Curry, Salton, Fields, Daly, and O'Brien) for a debate on LS. All those who were invited to participate in the discussion believe that there is merit in using LS for training. Honey (ibid.) argues that preferences are more subjective and harder to measure accurately than manifest behaviors. Salton (ibid.) answers "yes" to the question: is there evidence to validate the practical relationship between LS and learning effectiveness? However, he adds, that this does not mean anything in practice. In the real world, training occurs in a group context. The paper presented here shows what happens within groups. Kolb (ibid.), referring to the question "should we teach exclusively to an individual's preferred style?", says that this is a bad idea. He prefers designing a curriculum so that every type of learner has an initial way to create a specific or particular linkage with the material.

3. Methodology

3.1 The research question

Does a good match between LS and IS improve learning achievements?

3.2 Research hypothesis

If a good match between IS–LS influences student achievements, then there must be significant negative correlation between IS–LS distance and student achievements. Distances will be defined and explained in the next section.

3.3 Research population

The research population consisted of 74 students and five teachers. 31 students from high school 1 (and their two teachers), 13 students from high school 2 (and their two teachers), and 30 college students studying for a practical engineer degree (they had one teacher). All the students took electronics courses.

3.4 LS and IS questionnaires

For the purpose of measuring IS–LS distance, LS and IS questionnaires were created (see appendix) in line with the Felder and Silverman method [1, 11]. A scale was determined for each dimension as shown in Figure 1 below.

Sensing……..……!……..……Intuitive						
	Strong	Moderate	Mild	Mild	Moderate	strong
Value:	-3	-2	-1	0 1	2	3

Figure 1. The method of measuring an LS dimension.

The student's LS is calculated in the following manner. Let S_{ik} indicate the value written by Student i for dimension k. LS_i identifies the LS measure for Student i. The formula for LS_i is $LS_i = \sum_{k=1}^{5} S_{ik}$.

Meaning: LS_i is the sum of five dimensions. Similarly we can define IS_j for Teacher j. The LS and IS questionnaires were validated in two ways.

1. Interviews were conducted with both students and teachers to ensure that they understand the spirit of the questionnaires, as recommended by Felder and Silverman [1]. As a result of these interviews, explanations were added to each scale for each dimension. Likewise, the interview findings indicate that teachers have different strategies when they teach different subjects. Therefore, three scales were designed for each dimension. In the appendix, we present only one scale per dimension, for simplicity.

2. A second round of interviews with students and teachers showed that they understood the meaning of the questionnaires as explained by Felder and Silverman [1], thus verifying the content validity of the questionnaire. The internal consistency was checked by calculating correlations between each S_{ik} and LS_i. The results in Table 2 show significant correlations. Therefore, it can be said that the internal consistency of the questionnaire is satisfied.

Table 2. Correlation coefficients between each dimension to the total one, in the LS questionnaire.

Dimension	Understanding k=1	Processing k=2	Organization k=3	Input k=4	Perception k=5
Correlation (n = 74)	0.51	0.65	0.43	0.47	0.37

Since there were only five teachers, the internal consistency of the IS questionnaire had no meaning; it, therefore, was not calculated.

3.5 IS to LS distance definition

Let S_{ik} be the value given by Student i for dimension k, and T_{jk} the value given by Teacher j for the corresponding dimension. The absolute difference $|T_{jk} - S_{ik}|$ is the *IS–LS distance* for dimension k. The total distance between Teacher j's IS to Student i's LS is the sum of all five distances for five dimensions. It is calculated by the formula $D_{ij} = \sum_{k=1}^{5} |T_{jk} - S_{ik}|$.

3.6 Research implementation

Forty-four students from two high schools and their four teachers were asked to fill out the LS and IS questionnaires, accordingly. The *IS–LS distances* were calculated for each student and his or her teacher.

Students' final grades in five subjects were collected and correlations between *IS–LS distances* and students' achievements were analyzed. The results are presented in Table III.

In order to verify the outcomes mentioned above, a second group of 30 students and their teacher were asked to answer the LS and IS questionnaires. For this group the grades used to correlate with the *IS–LS distance* came from five tests in the field of digital electronics. Cronbach's alpha was calculated for Tests 2 through 5, but not for Test 1. The students' test notebooks were checked by two judges and between-judges reliability was computed. The results are shown in Table IV. Correlations between *IS–LS distance* and students' grades were calculated for this group as well as for those of the previous groups. The results are shown in Table V.

4. Results

Table 3 indicates the correlation matrix for the two high schools. It presents correlations between students' grades and distances calculated for each dimension, according to Felder and Silverman's model [1]. The matrix also contains the correlations between students' grades and total distances.

Table 3. *IS to LS distance* vs. students' achievement correlation coefficients.

Correlation Matrix – High School 1						
31 – students, 2-teachers, 3-subjects	Perception	Input	Organization	Processing	Understanding	Total distance
Teacher 1: Micro-processors	0.10	-0.30	0.19	0.1	-0.02	0.01
Teacher 2: Analog Electronics	0.42	-0.20	0.22	0.2	0.30	0.30
Teacher 2: Electronics Lab	0.16	-0.20	0.09	0.1	0.03	0.03
Correlation Matrix – High School 2						
13 – students, 2-teachers, 2-subjects	Perception	Input	Organization	Processing	Understanding	Total distance
Teacher 1: Micro-processors	0.24	0.47	0.00	-0.60	0.03	-0.03
Teacher 2: Analog Electronics	0.18	0.25	-0.20	0.00	0.25	0.15

As it can be seen, there are very few negative correlations. The most meaningful correlation is a single instance of -0.30. The negative correlations shown in Table III are not significant and not stable in High Schools 1 and 2. No dimension has a consistent negative correlation.

In the light of these results, it can be said that matching *IS–LS* contributed very little, if at all, to the high school students' achievements.

This issue was checked again with 30 college students and their lecturer. Tests 2 to 4 were designed according to a bi-dimensional table to assure validity of contents and were validated by experts. Questions were classified according the PST–Problem Solving Taxonomy [14]. The in-between-judges reliability was examined, and Cronbach's alpha was calculated for each test. The findings are presented in Tables 4 and 5.

Table 4. Internal consistency and reliability of the tests in digital electronics.

Test no.	Between judges reliability	Cronbach's alpha

Test 2	0.95	0.72
Test 3	0.92	0.87
Test 4	0.87	0.81
Test 5	0.90	0.78

Table 5. *IS-LS distance* vs. students' grades' correlation coefficients in a college.

Correlation Matrix – Practical Engineering College						
30 – students, 1-teachers, 1-subjects	Perception	Input	Organization	Processing	Understanding	Total distance
Test 1	- 0.07	- 0.1	0.16	0	- 0.13	- 0.05
Test 2	- 0.3	- 0.2	- 0.1	0	0	- 0.26
Test 3	- 0.01	- 0.2	- 0.1	- 0.1	0.15	- 0.09
Test 4	- 0.31	- 0.3	- 0.3	- 0	0.11	- 0.32
Test 5	- 0.06	- 0.1	- 0.2	- 0	0.28	- 0

The data in Table V were similar to the results derived from the two high schools. In the case of the college students, more negative correlations appear but still not to any meaningful degree. Again, the assumption that matching *IS–LS* affects students' grades is not substantiated.

5. Discussion

The correlations reached in this research for the two high schools and the college do not lead to the conclusion that a good match between LS and IS contributes to students' achievements. These embarrassing results match Lemire's [7] statement that serious problems are associated with LS, and that professionals should be skeptical about claims in the LS research area.

An attempt to analyze the research results leads us to Lemire's [7] declaration that there is a weakness in the reliability and validity of LS. Let us look only at the LS dimension *input* and its corresponding IS dimension *presentation*, in order to prove or disprove Lemire's assertion. There is a consensus among LS researchers [1-4, 6, 7, 15] that some people prefer visual presentation while others prefer auditory presentation. Therefore, significant negative correlations should be revealed, at least for this pair of dimensions. This was not verified in our study, as can be seen in Tables III and V, thereby bolstering Lemire's claim.

The research outcomes can be partially explained by the fact that preferences are more subjective and harder to measure accurately than manifest behaviors (Honey, in [13]).

The fact that the research was conducted in a real world situation, a group context, supports Salton's (ibid.) opinion that even if there is evidence to validate the practical relationship between LS and learning effectiveness, it means nothing in practice. This declaration is in line with this paper's conclusion, which deals with the relationship between *IS–LS distance* and achievements.

Above all, it is vital to remember that the main goal of good teaching is encouraging the student to learn. The student is the one who is responsible for learning—which brings us to Kolb's (ibid.) idea of designing a curriculum so that every type of learner is given the choice of determining the initial specific way to create contact with the material, rather than teaching exclusively to an individual's preferred style. The current research results reinforce Kolb's statement, calling on educators to focus on enriching teaching methods rather than matching *IS–LS*.

It is suggested that more research using the *IS–LS distance* measuring method, with different IS and LS questionnaires, should be carried out. One idea would be to use Soloman and Felder's [16] index of learning styles questionnaire (web version). This questionnaire comprises 44 questions. The student is offered two different learning styles and asked to select the one he or she prefers. A second idea for further relevant research is to try to measure the correlation between *IS–LS distance* in a homogenous

population. Locating such a population does not represent a normal situation, but it may help isolate the *IS–LS distance* variable so that measuring its influence on student achievement will be more reliable. Another suggestion is to use a behavioral questionnaire rather than the preferences one used here.

Bibliography

[1] R.M. Felder, and L.K. Silverman, Learning and teaching styles in engineering education. *Engineering Education, 78*(7), pp. 674-681. 1988.

[2] S. Waks, Curriculum Design – *From an Art towards a Science*. Oxford/ Hamburg: Tempus Publication, 1995.

[3] P.B. Guild, and S. Garger, Marching to Different Drummers. ASCD – Association for Supervision and Curriculum Development, 1985.

[4] R.J. Sternberg, *Thinking Styles.* New York: Cambridge University Press, 1998.

[5] D. Lemire, *Technical Data for Five Learning Styles Instruments with Instructional Applications*. Reno: Creative Therapeutics Publishers, 1998.

[6] D.A. Kolb, and R.E. Boyatzis, *Learning Skills Profile*. Boston: McBer and Company, 1993.

[7] D. Lemire, Brief report: What developmental educators should know about learning styles and cognitive styles. *Journal of College Reading and Learning*, 32(2), pp. 177-181, 2002.

[8] H. Gardner, *Frames of Mind*. Reading: Addison Wesley, 1985.

[9] M.R. Felder, Meet your students Stan and Nathan. *Chemical Engineering Education*, 23(2), pp. 68-69, 1989.

[10] M.R. Felder, M.R.Meet your students Susan and Glenda. *Chemical Engineering Education*, 24(1), pp. 7-8, 1990.

[11] M.R. Felder, Reaching the second tier – Learning and teaching styles in college science education. *Journal of College Science Teaching*, 22(5), pp. 286-290, 1993.

[12] N. Sabag, Characteristics of Project Based Learning in Electronics. Doctoral dissertation (in Hebrew; abstract in English), Technion – Israel Institute of Technology, Haifa, Israel, 2002.

[13] M. Delahoussaye, The perfect learner: An expert debate on learning styles. *Training*, 39(5), pp. 28-36, 2002.

[14] H.L. Plants, R.K. Dean, J.T. Sears, and W.S. Venable, A taxonomy of problem solving activities and its implication for teaching. In: J.L. Lubkin, *The Teaching of Elementary Problem Solving in Engineering and Related Fields*, pages 21-34. Washington, DC: American Society for Engineering Education, 1980.

[15] H. Hlawaty, Comparative Analysis of the Learning Styles of German Adolescents by Age, Gender, and Academic Achievements Level. (Report no. TM033774). Paper presented at the annual meeting of the *American Educational Research Association* (New Orleans, LA, April 2002). (ERIC NO. ED464094).

[16] B.A. Soloman, and R.M. Felder, Index of Learning Styles Questionnaire (web version), 2004. http://www.engr.ncsu.edu/learningstyles/ilsweb.html

Authors

Principal author: Nissim Sabag is a senior lecturer at the Department of Electronics & Electrical Engineering, Ort Braude College, Karmiel Israel. He holds a BSc in EEE, a BSc, MSc, PhD in Technology and Science Education from the Technion-Israel Institute of Technology. Will present the paper.

Co-author: Elena Trotskovsky is a lecturer at the Department of Electronics & Electrical Engineering, Ort Braude College, Karmiel Israel. She holds MSc in electronics from Ufa Aviation University, Russia; PhD and MSc in Technology and Science Education from the Technion – Israel Institute of Technology, Haifa.

Appendix – Learning Styles and Instructional Strategy Questionnaires

Learning Styles Questionnaire

Dear Student,

This questionnaire is for a research task. It is designed to identify preferred Learning Styles. Please be as candid as possible.

Thank you for your time and cooperation.

Name _____. School_____

Sensing and Intuitive Perception

A sensing learner tends to focus on sensory information such as what is seen, heard, touched. An intuitive learner focuses on intuitive information (ideas, memories, possibilities).

Examples: A sensing learner likes facts and data, and solving problems by standard methods. An intuitive learner likes theory and models and solving problems by a variety of methods. Which mode of perception do you prefer? Mark an X on the sensing side (mild, moderate, or strong) if you are a sensing learner. Mark an X on the intuitive side (mild, moderate, or strong) if you are an intuitive learner.

Sensing……!……Intuitive

Strong Moderate Mild Mild Moderate strong

Visual and Verbal Input

Which mode of input do you prefer? Mark an X on the visual side (mild, moderate, or strong) if you feel comfortable with visual information such as pictures, diagrams, schematics. Otherwise, mark an X on the verbal side (mild, moderate, or strong) if you like written or spoken words.

Visual……!……Verbal

Strong Moderate Mild Mild Moderate strong

Inductive and Deductive Organization

If you prefer getting some examples before the common rules concerning the learning material, mark an X on the inductive side (mild, moderate, or strong). Otherwise, mark an X on the deductive side (mild, moderate, or strong) if you like starting your studies with rules and principles, and then deduce consequences.

Inductive……!……deductive

Strong Moderate Mild Mild Moderate strong

Active and Reflecting Processing

What is your preference? Mark an X on the active side (mild, moderate, or strong) if you tend to process information while doing something (e.g., talking or doing an experiment). Otherwise, mark an X on the reflecting side (mild, moderate, or strong) if you prefer processing introspectively.

Reflecting……!……Active

Strong Moderate Mild Mild Moderate strong

Mark an X next to each of the following questions that reflects your preferences:

1. □Do you tend to experiment in order to understand how an electronic circuit is working,
   □ Or will you try to understand the principle of operation first?
2. □Will you start an assignment (a project, for example) even if you are not familiar with all the details,
   □ Or will you wait until you are sure about the whole picture before starting the assignment?
3. □ Do you prefer team work,
   □ Or do you like to work on your own?

Sequential and Global Understanding

If you are a sequential learner, you probably can learn one step at a time, and function with partial information. If you are a global learner, you may see the whole picture before the details; sometimes you can figure out a truly complex solution instantly without being able to explain how you did it.

Mark an X on the sequential side (mild, moderate, or strong) if you are a sequential learner. Or mark an X on the global side (mild, moderate, or strong) if you are a global learner.

Sequential……!……Global

Strong Moderate Mild Mild Moderate strong

Thanks for your cooperation

Instructional Strategy Questionnaire

Dear Teacher,
This questionnaire is for a research task. It is designed to identify preferred Instructional Styles used by teachers. Please be as candid as possible.
Name _____. School_____

Content
A concrete teacher tends to start explanations with examples, while an abstract teacher emphasizes theory and models. Example: An abstract teacher first presents the transform function of an amplifier using the general model. A concrete teacher starts by designing a simple amplifier and calculating its quiescent point.
Mark an X on the abstract side (mild, moderate, or strong) if you are an abstract teacher. Otherwise, mark an X on the concrete side (mild, moderate, or strong) if you are a concrete teacher.

Abstract……..…!……Concrete
Strong Moderate Mild Mild Moderate strong

Presentation
There are several modes of receiving external information. A visual mode uses pictures, diagrams, flow charts, demonstrations. A verbal mode uses written and spoken words.
Which mode of presentation do you prefer? Mark an X on the visual side (mild, moderate, or strong) if you use visual means in your lessons. Mark an X on the verbal side (mild, moderate, or strong) if you mainly use spoken or written words in your lessons.

Visual……..……!……..…..……Verbal
Strong Moderate Mild Mild Moderate strong

Organization
If you prefer showing some examples, then explaining the common rules concerning the learning material, mark an X on the inductive side (mild, moderate, or strong). Otherwise, mark an X on the deductive side (mild, moderate, or strong) if you like starting your lesson with rules and principles, and then deduce consequences.

Inductive……..…….……!…….……..……Deductive
Strong Moderate Mild Mild Moderate strong

Student participation
What is your preference? Mark an X on the active side (mild, moderate, or strong) if you tend to activate your students during your lessons. Or mark an X on the passive side (mild, moderate, or strong) if you prefer explaining the complete concept, and only then permit your students to ask questions (the students are passive most of the time).

Passive……..……..……!……..……Active
Strong Moderate Mild Mild Moderate strong

Mark an X next to each of the following questions that reflects your preferences:

1. □ Do you permit your students to experiment in order to understand how an electronic circuit works,
   □ Or do you tend to explain the principle of operation first?
2. □ Will you let your students start an assignment (a project, for example) even when they are not familiar with all the details,
   □ Or do you prefer explaining in detail what the students should do before they start carrying out the assignment?
3. □ Do you prefer team work,
   □ Or do you like your students to work individually?

Perspective
If you are a sequential teacher, you probably teach step by step. If you are a global teacher, you may show the whole picture before explaining the details.

Mark an X on the sequential side (mild, moderate, or strong) if you are a sequential teacher. Otherwise, mark an X on the global side (mild, moderate, or strong) if you are a global teacher.

Sequential……..……..…!…….……Global Discipline_____
Strong Moderate Mild Mild Moderate strong

Thank you for your cooperation.