

Effectiveness of Learning Style in Popularity of Personalized Mobile Intelligent Tutoring System from View of Learners

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Abstract

Objectives: Each learner shows unique behavior in educational environments to acquire knowledge and skills. It leads to form variant learning styles. **Methods/Analysis:** This paper develops a tutoring system called the Personalized Mobile Intelligent Tutoring System (PMITS). The purpose is evaluating the effectiveness of the learning style (according to the Felder-Silverman model) in rate desire users to use from PMITS. In this paper 93 users exercises by PMITS Then a questionnaire was distributed between them, and the results obtained by the software SPSS Version 22.0 and analyzed by Kruskal-Wallis test. **Findings:** In this analysis p-value=0.000 calculated and the null hypothesis was rejected. Therefore, PMITS popularity was different between users with different learning style; Also, most of the learning style of combined was {Active, Sensing, Visual, Sequential}. Finally, this paper suggests that a PMITS based on learning style is so useful experience to users. **Novelty /Improvement:** PMITS can support learning styles to provide an effective education system for users (according to the Felder-Silverman model).

Keywords: Felder-silverman Learning Style Model, Intelligent Tutoring System, Learning Style, Kruskal-Wallis Test

1. Introduction

Recently, mobile devices are increasing in mushroom species and have been most commonly used in mobile devices. Smart phones are known because these devices are considered as easiest and most effective communication tools. In addition, they have vital role that play of human life. Moreover, they are applicable invariant of time and place. Features such as removable, optimality and easy to use on any mobile device are the advantages of mobile devices¹. Most of educational institutions such as universities, schools and learning centers have been begun to use mobile softwares; because this feature lets the end user have the motivated and desire to learn more. Since 2003, Mr. Cheng and colleagues discuss the e-learning

propounded by mobile devices². The researchers generally concluded that these Mobile Learning (m-learning) as a kind of e-learning, uses mobile devices (e.g. smart phones) instead of desktops. The definition shows that mobile learning like e-learning has the potential to serve in the same field; but it is a different vision of e-learning. It can provide some areas which have been inaccessible so far. Two directions are about Studies of mobile learning field as follows:

- Evaluation and the effectiveness of the mobile learning.
- The design of mobile learning systems.

Özdemir et al.³ state that mobile device technology exists as long as we are. Flexibility of the mobile devices

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leads in ease of communication, interoperability, and improvement in the knowledge level of mobile users. Hence, mobile learning has a special place in:

- Users' mobility;
- Being overarching in comparison with other technologies; and
- Handling the special needs of users.

The most researches¹⁰ have been reported that the mobile learning has a positive rate of effectiveness in the humanity. A mobile intelligent tutorial system includes an application which is installed on a mobile device and uses server-client architecture in order to exchange data with a server. The software should have a high potential for the private recording and transferring learning result, assessment, and activity/performance reports to the teacher; yet it does intelligent learning and evaluation. The aim of this paper is evaluating effectiveness rate of the users learning style on tending to applying PMITS.

This paper is organized in 6 sections. Section 2 surveys the mobile learning technology and its necessity. Section 3 introduces common learning style in intelligent systems as well as the proposed method based on Felder-Silverman learning style model. Section 4 and 5 respectively describe procedure of evaluation and the results. Section 6 concludes this paper finally.

2. Mobile Learning Technology

Rapid development of mobile technology leads to a new concept so-called *m-learning* (i.e. Mobile learning). In education area, M-learning is an emerging field. The growing of smart phones in the community is a major factor in developing m-learning. For instance, in the second quarter of 2005, more than 190 million smart phones have been sold worldwide⁴. In addition to smart phones, applying wireless devices like MP4 player, tablets, and other Personal Digital Assistant (PDA) are also increased in recent years.

One of the advantages of m-learning is execution as you go. Therefore, researchers try to make dependent mobility of learners to their learning environment using this feature. This technology comes from integrating of mobile computing and E-learning⁵. Since the emergence of the m-learning, all researches have investigated cognitive and pedagogical aspects about the use of mobile devices in education. Some findings¹ show that the introduction

of this new form of learning motivates learners to spend more time on education. It leads to improve the test results of learners. Most researchers believe that PDA and smart phones will expand and would not be replaced with any other educational tools⁶.

An increasing trend to use computers in teaching has led to develop several intelligent tutoring systems (ITSs). ITS designers apply Artificial Intelligence (AI) techniques. They also implement extensive modeling of the problem-solving process in specific application⁷. The ITSs are used in academia to augment classroom teaching. They have also penetrated various industries where companies are using these systems to train employees⁸. ITSs have been built for various domains such as mathematics, medicine, engineering, public services, computer science, and so on⁸. Smart phones as a type of ITSs increase students' involvement and effort in the classroom as well as improve their learning⁹.

It is difficult for teachers, administrators and parents that mobile devices as a useful factor for achieving educational objectives accept. The invention of mobile devices, learners are able to interact and work together. Meanwhile, there are some questions to implement this technology in terms of hardware and software. Previous experiments of mobile learning programs showed that some factors can effect on the user learning outcomes in any mobile devices. They are such as ownership of the devices, battery life and network connectivity¹⁰ besides, developing a mobile learning system can be difficult, time consuming and expensive especially for ill-defined domains¹¹. Researchers announce that mobile learning applications have the necessity potential on the side of the traditional training tools¹². They found it after implementing the mobile learning programs and testing them. Notwithstanding the use of mobile learning is effective in making changes, taking the current learning environment into account is essential.

Mobile intelligent tutoring system is now utilized in high schools as well as higher education for teaching math, science, and language⁸. Students usually use these systems during school hours in the computer laboratory and classrooms, or even out of their educational environments on their mobile devices, especially smart phone or Tablet.

These systems must examine methods of identifying learning style and technologies send/receive data synchronization data between mobile devices and systems. Recently, researchers proposed new systems by

focusing on a single/multiple dimensions. They evaluated that each system was effective to raise educational rates of learners. This research investigates the learning style as a factor to raise learning rate.

3. Learning Style

A widely held assumption is that learning style as a useful model can quantify user characteristics for effective personalized learning. One such approach to user modeling is that of basing the model upon students learning style preferences¹³. This research uses an implemented project called PMITS for evaluation. This system is for teaching elementary English to junior students and tries to provide personalized contents to any learner based on his specification using Felder-Silverman learning style model (or contraction FSLSM). In fact, every learner has specific behavior in the learning environment. It leads to form learning style. There is much literature relating to learning styles in the fields of psychology and education. This mode of adaptation may be more advantageous to learners than those simply based on domain knowledge¹³. Learning styles helps learners to learn more efficient and become familiar with

its capabilities¹⁴. The PMITS use FSLSM to can identify users' learning style. The dissimilarities of FSLSM with other models such as the Myers-Briggs, Gregory, Kolb, Pack, Honey and Mumford and Dunn are as follows:

- FSLSM provides the broader and more detailed classification of learning styles;
- FSLSM has a wider application in the different environments such as digital learning environments¹⁵;
- FSLSM uses a simple and fast algorithm to determine the learning style of users;
- The questionnaire of FSLSM has a smaller number of questions than other models; and
- FSLSM has a higher correlation¹⁶.

For detecting Learning style based on FSLSM, a 44 item questionnaire¹⁷ called the ILS will be completed by the user. Learner Scores is displayed in each of the four dimensions according to the questions in this questionnaire in Table 1 after completing by the user.

In FSLSM, learning styles are classified in four dimensions based on user preferences. Table 2 summarizes them^{17,18}. Every learner will be classified in one of 16 compositions mentioned in Table 3. He has a power level in each dimension of learning styles. This strength levels and

Table 1. Number of questions referred to the felder-silverman learning style model questionnaire¹⁷

Dimension	Learning Style	Group Meaning	Question Number in ILS
Conscious-self	Sensing	Available routes	2, 30, 34
		Substances interlocking	6, 10, 14, 18, 26, 28
		Accuracy into detail	22, 42
	Intuitive	New Ways	2, 14, 22, 26, 30, 34
		Separate substances	6, 10, 18, 38
		Inaccuracy to the detail	42
Input	Visual	Photos	3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43
	Verbal	Reads word	3, 7, 11, 23, 31, 35
		Write word	3, 7, 11, 23, 31, 39
		The problem with the visual style	43
Processing	Active	Examination of affairs	1, 17, 25, 29
		Tends to the community	5, 9, 13, 21, 33, 37, 41
	Reflective	Thinking about the materials	1, 5, 17, 25, 29
		Inclined a non-character	9, 13, 21, 33, 37, 41
Intelligible	Sequential	Inclined to the detailed	4, 28, 40
		Sequential development	20, 24, 32, 36, 44
		Except to the total	8, 12, 16
	Global	Inclined general image	4, 8, 12, 16, 28, 40
		Non-sequential progression	24, 32
		Relationships/connections	20, 36, 44

Table 2. FLSM learning styles features¹⁷

Learning Style	Futures
Sensing	They are realistic and sensible and tend to be more practical than intuitive learners; also like to make relation the learned material to the real world.
Intuitive	They prefer to learn abstract material, such as theories and their underlying meanings, with general principles rather than concrete instances.
Visual	Via pictures, diagrams, flow charts, time lines, films, multimedia content and demonstrations.
Verbal	Through written and spoken explanations.
Active	Working actively with the learning material to learn the best one by applying the material and trying things out. Also tending to have communication with others and preferring to learn by working in groups .
Reflective	Thinking and reflecting on the material. Regarding communication, they work alone or in a small group together with just one friend.
Sequential	Learning in small incremental steps and therefore having a linear learning progress and tending to follow logical stepwise paths to find solutions.
Global	Using a holistic thinking process and learning in large leaps and tending to randomly absorb learning material unaware of connections. But They suddenly get the whole picture after learning enough material.

values are between +11 to -11 (for every dimension). As mentioned before, each learner has a personal preference for each dimension. The values between +11 to -11 per dimension express these preferences, with steps +/-2. This range comes from the 11 questions posed per dimension. For example, when answering a question, with an active preference, +1 is added to the value of the active/reflective dimension, whereas an answer for a reflective preference decreases the value by 1.

Table 3. Composition of learning styles based on the FLSM¹⁷

{R, I, V, Q}	{R, S, V, Q}	{A, I, V, Q}	{A, S, V, Q}
{R, I, V, G}	{R, S, V, G}	{A, I, V, G}	{A, S, V, G}
{R, I, B, Q}	{R, S, B, Q}	{A, I, B, Q}	{A, S, B, Q}
{R, I, B, G}	{R, S, B, G}	{A, I, B, G}	{A, S, B, G}

A=Active; B=Verbal; G=Global; I=Intuitive; Q=Sequential; R=Reflective; S=Sensing; V=Visual.

Consequently, each question is replied either with +1 (answer a) or -1 (answer b). Answer “a” corresponds to the preference for the first pole of each dimension (active, sensing, visual, or sequential), and answer “b” to the second pole of each dimension (reflective, intuitive, verbal, or global).

Figure 1 shows an example of the learner record of ILS questionnaire results. The score between 1 and 3 means that the learner is well balanced on the two dimensions; The score between 5 and 7 illustrates that the learner has a moderate preference for one dimension and will learn easily in a teaching environment which favors that

dimension; finally, the score between 9 and 11 represents that the learner has strong preference for one dimension and an environment without that preference may be difficult for him.

The repertoire contained in Figure 1 represents the learners’ learning style is {Active, Intuitive, Visual, Global} in aspect of awareness dimension.

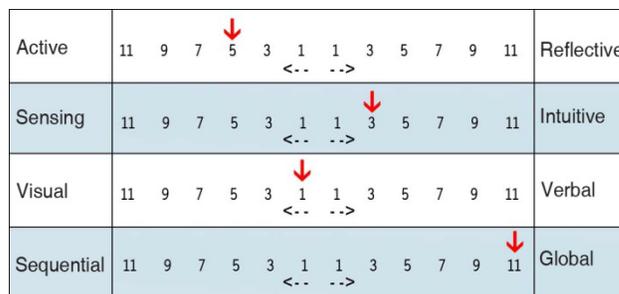


Figure 1. An example repertoire from one learner's learning style (extracted from ILS).

4. Evaluation Method

This study collected a data set including 93 junior students studying at the Hannaneh and PezeshkNia high schools. They were majoring in using smart phone/tablet and going to learn English as second language. Totally, 93 students in 6 classes were in dataset. Participants’ vernacular was Persian; they had different educational backgrounds and were skillful enough to answer the questionnaires. They were between 17 to 19 years old. There were different

proportions of female and male in the classes. This study used the multistage sampling as sampling technique to choose two high schools; first Eslamshahr city was chosen randomly between 20 cities of Tehran province, then using simple random sampling technique, one all-girls high school and one all-boys high school were chosen between all eslamshahr high schools; Eventually 93 junior students who had a smart phone/tablet were chosen to use PMITS. This research examined the gender effect on participants' autonomy level and learning styles. So, both female and male learners participate. 51 and 42 people were female and male respectively, of the 93 participants. This research used two instruments; The ILS Questionnaire developed by Felder and Soloman¹⁹ was used to find students' learning style. Its results were used in another questionnaire for PMITS assessment. The Questionnaire for PMITS Assesment is as follows:

1. Your Name (if you wish):
.....
2. Age:
3. Gender: Female | Male
4. Do you have access to mobile internet? Yes (WiFi, 3G or 4G) | Yes (GPRS) | No
5. Are you interested in English? Yes | No
6. The owner of any of the machines in front of you? Phone | Tablet | Laptop, Notebook or PC | None
7. Use one of several multimedia, you have a role to enhance learning?
 Educational Video | Educational Sound | Figure and Plan | Educational Slide
8. Use PMITS system more attractive than the desktop computer systems (laptops), respectively.
 I agree | Totally agree | Idea | Disagree | Totally disagree
9. What is your learning style?

Dimension	Learning Style		Power Level
First dimension	<input type="radio"/> Active	<input type="radio"/> Reflective
Second dimension	<input type="radio"/> Sensing	<input type="radio"/> Intuitive
Third dimension	<input type="radio"/> Visual	<input type="radio"/> Verbal
Fourth dimension	<input type="radio"/> Sequential	<input type="radio"/> Global

The purpose of the assessment was given into all participants; the questionnaire was designed anonymous in order to participants' answer remain confidential

and their honesty increased in the response. Most items were graded by a 5-point Likert scale where user evaluates PMITS effectiveness; Likert scale for easily of construction, scoring and interpretation of the scores has been welcomed by many: '1'='Strongly', '2'='Disagree', '3'='No comment', '4'='Agree', '5'='Strongly Agree'.

Questionnaire validated with the supervisor and several experts in this research subject. Also, questionnaire reliability was checked by Cronbach alpha coefficient. It should be at least 0.7; the internal consistency of the questionnaire was found to be 0.868 using Cronbach alpha.

Before using PMITS, the participants (experimental group) were aware of logging in the PMITS and responding to questions. In fact, they knew how to log in and how to fix minor defects in advance. Then, they found the opportunity to participate in these courses. The students used PMITS to the reviewing lessons and completed home exercises for a week. After a week the paper Questionnaires were distributed between target group and attempted to complete those. All participants were emphasized that they should not leave the questions unanswered. The Kruskal–Wallis test is the best statistical analysis of data because²⁰:

- Influence of two or more independent groups (such as participants with their learning styles) on the dependent variable (i.e. PMITS popularity) are investigated;
- The data type is nominal; and
- The data used are not normally distributed.

5. Evaluation Results

Learning style is basis of user model in proposed system. The authors assume that they will have optimal learning where the learning environments support its style in the procedure. In this evaluating, frequency of "more than moderate" learning style of each criterion is calculated by addition of participants with its learning style scores between 5 and 11.

Figure 2 and Table 4 show the vertical frequency diagram as "more than moderate" of all participants.

As described in section 3, PMITS used 16 compositions of FLSM to describe the learning style of each learner. Table 5 expresses frequency of learning style composition.

Table 4. In summary the abundance above moderate having of learning styles

Gen.	Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
Female	5	9	24	1	11	0	3	15
Male	11	4	18	5	10	3	2	18
SUM	16	13	42	6	21	3	5	33

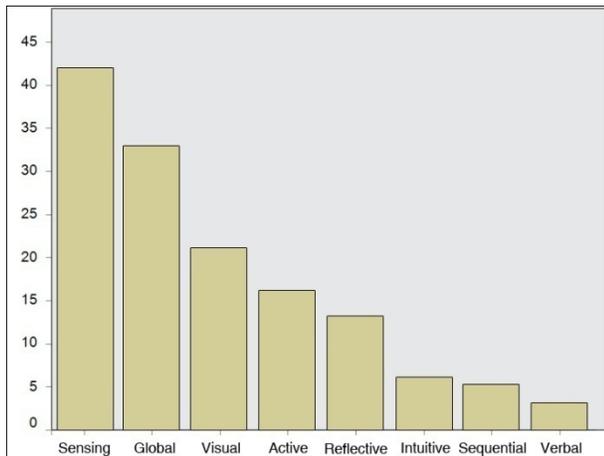


Figure 2. Abundance above moderate having of learning styles.

Table 5. Frequency for each composition of learning style

Learning Style	N	%	Mean Rank
{A, S, V, G}	19	20.4	49.03
{A, S, B, G}	14	15.1	39.93
{R, S, V, G}	13	14.0	47.58
{A, S, V, Q}	11	11.8	52.41
{R, S, V, Q}	11	11.8	44.50
{A, I, V, G}	6	6.5	44.33
{R, I, V, G}	5	5.4	51.30
{R, I, B, G}	5	5.4	53.00
{A, I, B, G}	3	3.2	33.50
{R, S, B, G}	3	3.2	47.67
{A, S, B, Q}	1	1.1	55.00
{R, S, B, Q}	1	1.1	55.00
{R, I, V, Q}	1	1.1	55.00

As described in section 4, since data type is nominal so the data are not normally distributed. This leads to use the Kruskal-Wallis test to test this hypothesis.

Figure 3 and 4 illustrates histograms of two variables PMITS popularity and Participant’s learning styles with their normal curve.

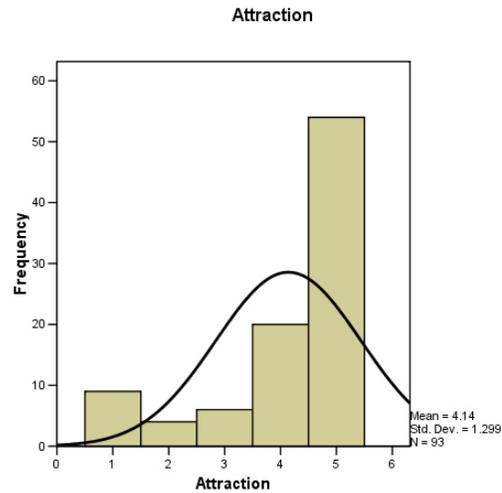


Figure 3. Histogram of variable PMITS popularity.

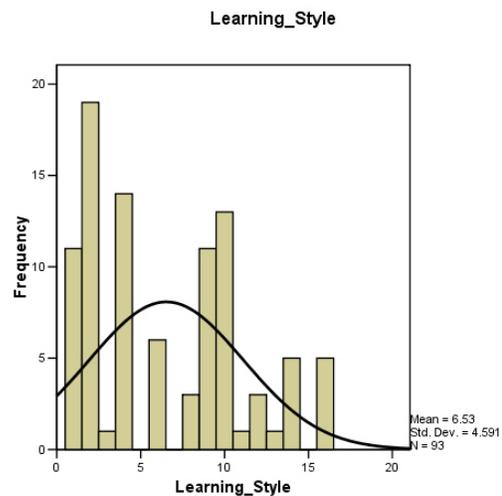


Figure 4. Histogram of variable participant's learning styles.

In this research, the null hypothesis of Kruskal-Wallis test is defined as: PMITS popularity of participants is the

same with every learning style (as shown in equation (1)).

$$H_0: \mu_i = \mu_j \{i, j | i \neq j \text{ and } i, j = 1, 2, \dots, 13\}$$

The alternative hypothesis of Kruskal-Wallis test is defined as: PMITS popularity of participants is not the same when learning style is different (as shown in equation (2)).

$$H_1: \mu_i \neq \mu_j \{i, j | i \neq j \text{ and } i, j = 1, 2, \dots, 13\}$$

A Kruskal-Wallis one-way analysis of variance showed that the p -value=0.000 and $\chi^2=14.833$ so null hypothesis is rejected.

So the conclusion is that there was a statistically significant difference in PMITS popularity and the participants with different learning styles. It means that the interest of a group of participants with a particular learning style in PMITS is meaningful. It leads to configure some intelligent systems (like PMITS) base on the learner's learning style (such as {Active, Sensing, Visual, Global}) in the future.

In this evaluation, the participants were assessed with FSLSM to determine learning style of student; the most common of the 19 students were with a learning style {Active, Sensing, Visual, Global}; this group tend to

- Affairs the test;
- Communicating with other students;
- Learn the material to the real world;
- Contiguous to break down;
- Learn by viewing photos, diagrams, videos;
- consider the overall picture of a subject;
- Act non-sequential to learn a subject; and
- Randomly absorb learning material unaware of connections.

6. Discussion and Conclusion

Mobile intelligent tutoring systems consider learning styles. It leads to improve users learning effectively when installed on mobile devices, especially smart phone/tablet. On recent years, researchers have focused on a single/multiple dimensions. They have evaluated new systems so that each one was effective in raising advantage educational rates of learners. On present study, the authors investigated relation between the independent variable user's learning style (according to the FSLSM) and the dependent variable PMITS popularity. They used a questionnaire including 6 questions based on

5-point Likert scale to gather data base. Validity of the questionnaire has been approved by some experts in this area. Moreover, Cronbach alpha coefficients were calculated equal to 0.868. It also confirmed their reliability.

The evaluation was performed after users applied the PMITS for one week. The most appropriate statistical analysis of the data, Kruskal-Wallis test, was applied to analyse data. The results of questionnaires were analyzed by the software SPSS version 22.0.

In this analysis, the most common learning style is {Active, Sensing, Visual, Global} through 19 participants with a learning style. The p -value considered as 0.000 in Kruskal-Wallis test. Therefore, zero hypothesis was rejected. So, the conclusion is that PMITS popularity and the participants with different learning styles is statistically significant different.

This research used FSLSM to identify learning style, the researcher's proposal, as well as other learning styles evaluated and learning styles effect over another learning system check. So managers and teachers are able to obtain better results in their educational process when will use of a systems based on learner learning style. Developers/designers on the future architecture of these systems are configured to suit the learning style learners.

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