Journal of Engineering Sciences
& Information Technology
Issue (4), Volume 1
2017 December
ISSN: 2518-5780

المجلة العربية للعلوم و نشر الأبحاث
Arab Journal of Sciences & Research Publishing
AJSRP

An intelligent agent to detect learner's learning style automatically through E-learning system in Saudi Arabia

Azrilah Abdul Aziz **Alia Abdulrahman Assiri**

Department of Information Systems || Faculty of Computing and IT || King Abdul-Aziz University

Abstract: Most of the successful conventional E-learning system lack of automatic detecting of learner learning style based on their preference. An Automatic approach marked as a better approach to characterize learning style because it is based on real student behavior. The purpose of this study is to propose a new literature-based method (Automatic approach) using intelligent agents to identify learner's learning style based on behavior using Felder-Silverman Learning Style Model (FSLSM). The new method implemented in new developed LMS. After obtaining the proposed method result, the result validates and compared with Felder-Silverman Learning Style Model questionnaire (ILS) and García method .After comparing the proposed method with the results of previous studies, the researcher got satisfactory results on precision percentage and the lowest percentage in the results was 66.6 %.

Key words: automatic learning style detection, intelligent agent, learning system.

Introduction

There are many activities in the field of learning, activity such as experimentation, problem Solving and interpretation. However, learning theories divided into three sections according to A. Ertmer and J Newby (2008): first the constructivism theory which accentuates that the learner should be active by choosing the way he/she prefer, second the cognitive theory which is related to the changes in learner understanding that outcome from learning and third the conventional classroom which is called face-to-face learning. The traditional way is based on instructor control in the class room, materials, assignments, and exam, where the knowledge transferring from the expert or instructor to the student.

Learning process efficiency of learning styles (LS), or learning preference have been considered since the seventies. With the advent of various learning style model. However, Q. Dung and Adina (2013) accept that each learner has a particular learning style. However, each learner should be provided with appropriate learning style based on his/her preference even in traditional face to face class or LMS. Therefore that improve the learning process and help a learner to learn better. Some learner's find a specific learning style easy such as

video or listening. On another hand, some learners find the same LS difficult to go through Q. Dung and Adina (2013).

These days, in spite of the development of science and technology, especially in the field of learning management systems (LMSs) have various features such as controlling timetable, attendance, and track assignment. But most of the LMSs have the same way to provide student learning material without taking into account individual differences between learners in learning style. Each learner has different learning style, but the learner cannot take advantage of his/her LS preference when using LMS. Because of lacks LMSs to identify the learning style. Due to the static option in LMS when users have various learning styles preferences, Developers are taking up the challenge to develop new options in LMS to suit user learning preferences. Q. Dung and Adina (2013)

Adaptive learning is computer-based or online educational system that changes the course material (adapt) the system to the learner based on preference Dreambox (2017). According to Brusilovsky and Peylo (2003), adaptive learning is online educational system computer application based to adapt the courses or subject presentation based on what they prefer. On the other hand, the intelligent agent detects learner learning style automatically then delivers adaptive courses or material to the learner. Moreover, this study aims to detect (automatically) learner learning style, based on preference using an intelligent agent. The benefit of finding learner LS then deliver an appropriate lesson that matches learner LS.

Purpose of Research

The purpose of research is to develop an online prototype of LMS Learning Management System, able to detect student learning style (LS) automatically by an intelligent agent by tracking the behavior of learner during taking courses. To provide learner LS to the tutor to be able to deliver courses or lessons to a student based on his/her learning style that detected by the system.

Problem

The LMS focus on instructor's services and courses scheduling to be provided to students on time. Without consideration Individual differences among students in learning style and deliver materials to the learner in an appropriate way based on his/her preference.

determination of learner learning style is one of the challenges in the design of learning systems (LMS) Graf and Kinshuk (2006). Moreover, each learner has a different preference. Most of learning systems provide the same learning style for all learner with little adaptively and With no, consideration of learners characteristics Graf and Beate (2005). Therefore, that will affect learning efficiency.

Objective

The objective of this thesis is to develop a new prototype of LMS to implement intelligent agent (reflex agent) that able to detect learner learning style based on learner behavior. The reason for developing a new prototype of LMS because of the difficulty of finding good documented open source LMS (web-based) and most open source commercial software.

Tools and technology used

PHP language used to develop this study project with JavaScript and jQuery. In addition, MySQL used for the database.

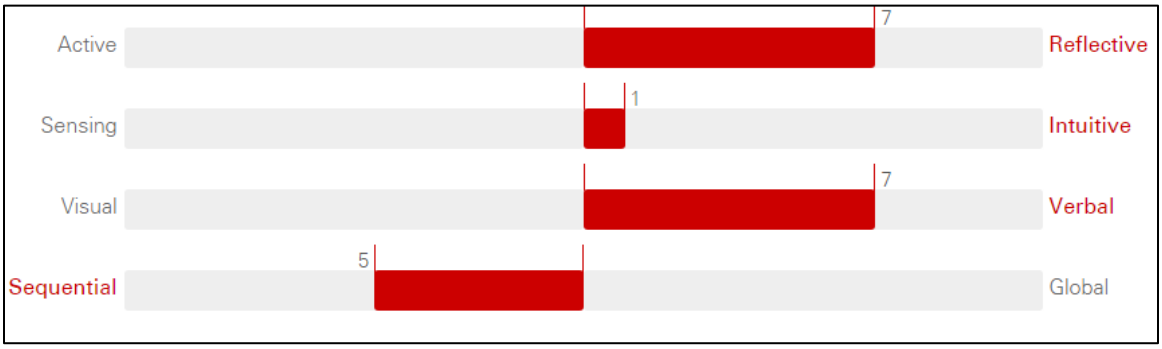
Literature review

1. A Concept for Identifying Learning Styles

Felder-Silverman learning style FSLSM model (FSLSM):

Learning Style (LS) means, the best way for learner to learn something. For example some learner learn quickly if lesson provided as video, and some learner by practical. Keefe (1979) defines learning styles as the "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment."

Felder-Silverman learning style model (FSLSM) Graf, Viola, Tommaso, & Kinshuk (2007) designed for classify learner learning style to four dimensions, each dimension having two opposite categories (such as Sensing and Intuitive).



An example of learner ILS questionnaire result

The purpose of FSLSM model is to detect learner learning style based on questionnaire called Index of Learning Styles (ILS)[(1)], consist of 44 questions. The goal from this model is to detect learner LS. there are 16

(1) An example of ILS questioner in the appendix.

type of combination of learning style out of the main four dimensions, each type of combination have 4 Learning styles. There are condition to make combination of the LS: cannot combine any type of LS located in same group. For instance, this combination is not acceptable: (Active – Reflective – Visual – Global), because Active and Reflective are in the same group (Group1). The reason of previous combination, student cannot be in fact Active and Reflective Graf, Viola, Tommaso, & Kinshuk (2007). The main four dimensions as the following:

A. Active – Reflective
   - learning by thinking (Reflective) and or doing(Active)
   - Active: like activity in class room
   - Reflective: they prefer work individually rather than groups
   - Able to work with group and or alone.

B. Sensing – Intuitive
   - concrete material – abstract material
   - more practical – more innovative and creative
   - patient / not patient with details
   - standard procedures – challenges

C. Visual – Verbal
   - learning from images and or words

D. Sequential – Global
   - learn in large leaps , learn in linear steps
   - learner good in using partial knowledge

   In this manner, why we should detect LS automatically while it can be obtain by ILS questionnaire? Because the conventional ILS:

   - It is depend on learner mode during conduct ILS questionnaire.
   - Lack of learner motivation.
   - The learner may results influence by other learner.
   - Learner LS may changes from time to time. So the ILS not dynamic.
   - Literature-based approach LBM
   - Literature-based method is a way in identifying learning styles by tracking students' behavior and interactions while using LMS. The advantages of using LBM is it can detect changes in learner LS during the course and data can be collected from any course that is incorporated in the LMS.

2. Rule-Based:

Rule-Based in AI means, a system take action based on pervious store Knowledge by human. Many of the research and studies applied Rule-Based techniques such as education Cutler & Turk (1998). Moreover, many fields in computer science area, applied this technique such as AI application together with computer aided system, expert system Belle, Ji, Chen, Huynh, & Najarian (2014) and decision support system Musen, Middleton, & Greenes (2014). However, Rule-Based general term needs to be detailed. For example, is the rule applied once or continuously and how it is work? Therefore, this study will use Model-based Reflex Agents.

3. Artificial Intelligence in Education:

AI has many applications such as (ES) Expert System, Natural Language Processing, Speech Recognition, Computer Vision, Automatic Programming and Robot. The alternative way to powerful AI are by meditation of human perception and search how to support it in difficult and compacted situation. For example, fighter aircraft commander may need help from intelligent systems to support the commander to control the highly complex aircraft. Which is cannot controlled without assistance from intelligent systems. The purpose of these methods are not to work stand-alone, but it for purpose of cognitive-improvement to support human in several tasks. In the field of medicine, for example, artificial intelligence systems used to support health workers while on duty, in certain tasks based on the deliberation of data and knowledge. Artificial intelligence system may work within an electronic medical system, for instance, and alerts the clinician when he discovers indicators against the therapeutic plan. According to Norvig & Russell (1995) intelligent agent IA definition is 'An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors'. Which mean it is able to take action as Autonomous without completely relying on built-in knowledge. Moreover, the General purposes of intelligent agents are to help humans in doing some routine tasks. Thaiupathump (1999). IA interact with environment by giving actions based on the precepts from environment via sensors.

The concept of learning style is not new in education field. The first appearance of this concept was in the 1960s Coffield, Moseley, Hall, & Ecclestone (2004) & Dag & Gecer (2009). Since that time, this concept has a direct relationship between the development of education and technical development of education including feature of online adaptive learning figure 3 Akbulut & Cardak (2012) & Dung & Florea (2012). In addition, there are two ways to detect learner styles, first is the conventional way static approach by applying a questionnaire to learner such as Felder–Silverman Learning Style Model (FSLSM). The problem with static approach that the learner are not interested to fill the questionnaire and the results depend on learner mode (Pham & Florea, 2013). Second is automatic way such as (1) Literature-based approach which is based on

Rule-based, (2) Data-driven approach which is based on one of the following (Bayesian, Neural Networks, Fuzzy clustering, Decision tree).

4. Definitions and Characteristics of Intelligent Agents

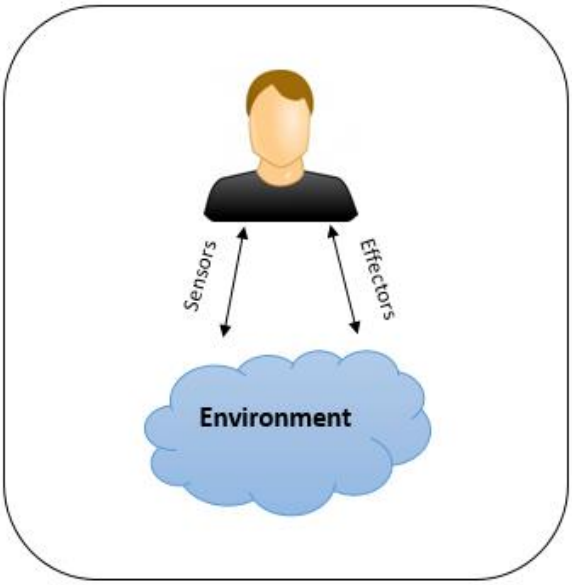
Artificial Intelligence science start appearing about 1956, although researchers started with Artificial Intelligence several years earlier McCarthy & Minsky (1955).

Intelligent Agent definitions differs between researchers and there are two groups. First group define it by the way how to work, (a software intended to act on behalf of a particular person) IBM (2005). The other group define the intelligent agent based on its characteristics (intelligent agent is a computer software distinguish in four properties: autonomy, ability to deal and connect to other agent, ability to take action and initiative) Foner (1993). By Integrate the previous two groups definition concepts, intelligent agent can be defined as: (intelligent agent is a computer software able to act based on behalf of a particular person who use it, with feature of autonomy).

5. Agent structure or Architecture

Based on several definitions given by researchers such as Norvig & Russell (1995), Thaiupathump (1999) and others, Conclude that the agent consists of a set of elements: which is a sensors (one or more) are used to recognize the surrounding environment of agent, effectors (one or more) to make changes in the environment and control system for planning consist of sensors and effectors to provide intelligent behavior (rational).

Main structure of Agent



6. Applications of Intelligent Agents

The difference between Application of IA and other applications is the ability to solve problem independently (automation). However, A number of intelligent agent applications investigated by Huhns and Sing (1997) which Huhns & Singh (1997) summarizes that the intelligent agent application are numerous and most related or participate to different Personal assistants PA, specialized to information-rich environments and subjects like drama, art and design.

7. Intelligent Agents as Personal Assistants (PA):

Personal Assistants (PA) is intelligent agent and it help human to get things done such as Siri application on IPhone(2). Siri allows user to use voice command to call some body, send text message or view the weather and other functions available in the mobile phone iPhone.

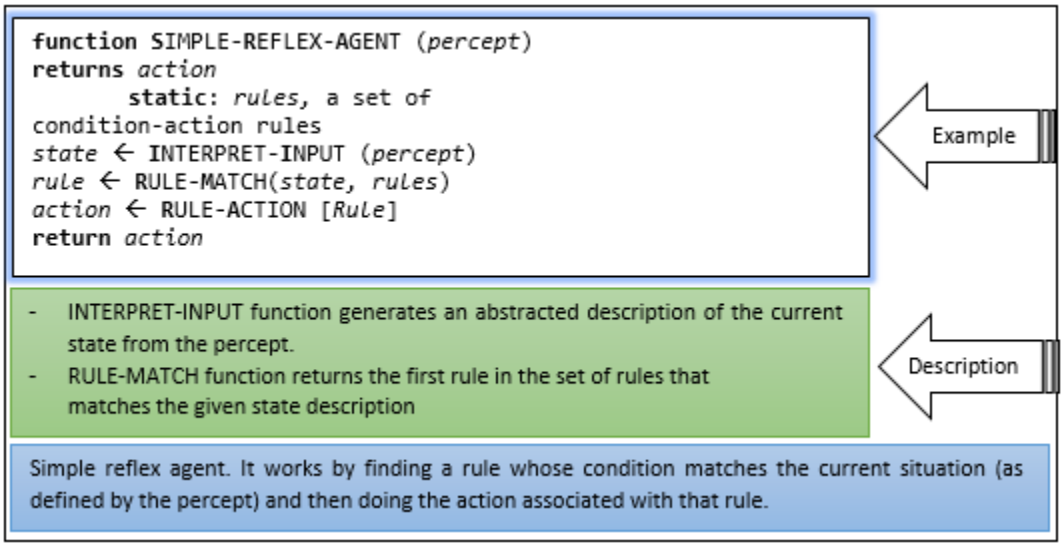
According to Huhns & Singh (1997) a particular IA application it's the one that interact closely with user function as PA .The following figure illustrate characterized of Personal Assistants.

Multi-modal	support interactions in different input and output modalities
Dialogue based	Carry out a conversation, not necessarily spoken, with the user.
Mixed-initiative	If dialogue based, let the user control the dialogue dynamically or make unexpected request
Anthropoid	Endowed with a personality: typically emotional
Cooperative	Assist the user in defining the user's real needs -- this typically requires some ability to model the user and the task the user is engaged in
Adaptive	Learn from past interactions with the user

Caracterized of Personal Assistants *(Huhns & Singh, 1997)*

In this thesis the author studied and design LMS to detect learner style using Felder–Silverman Learning Style Model applying automatic way (Literature-based approach) which is based on Rule-based/ Model-based Reflex Agents.

(2) Siri application on IPhone from Apple www.apple.com/ios/siri/



Simple reflex agents /Condition-Action Rule *(Norvig & Russell, 1995, p. 38)*

8. Over view of LMS Web-Based

The use of the Internet to provide courses requires more than just the creation of content; it goes beyond that to design a full learning environment. Which is called Web Learning Environment, Digital Learning Environment or Virtual Learning Environment. There is a further point to be considered, the quality of provided content must be appropriate and include appropriate interaction/interface tools to provide the content and achieve interaction. Jawdat (2005).

In E-learning systems there are three types of systems that use for management of the educational process through the electronic environment Talbh (2007):

- (LMS) Learning Management System:
- (CMS) Content Management System.
- (LCMS) Learning Content Management System. This system is an integration of the two systems LMS and CMS.

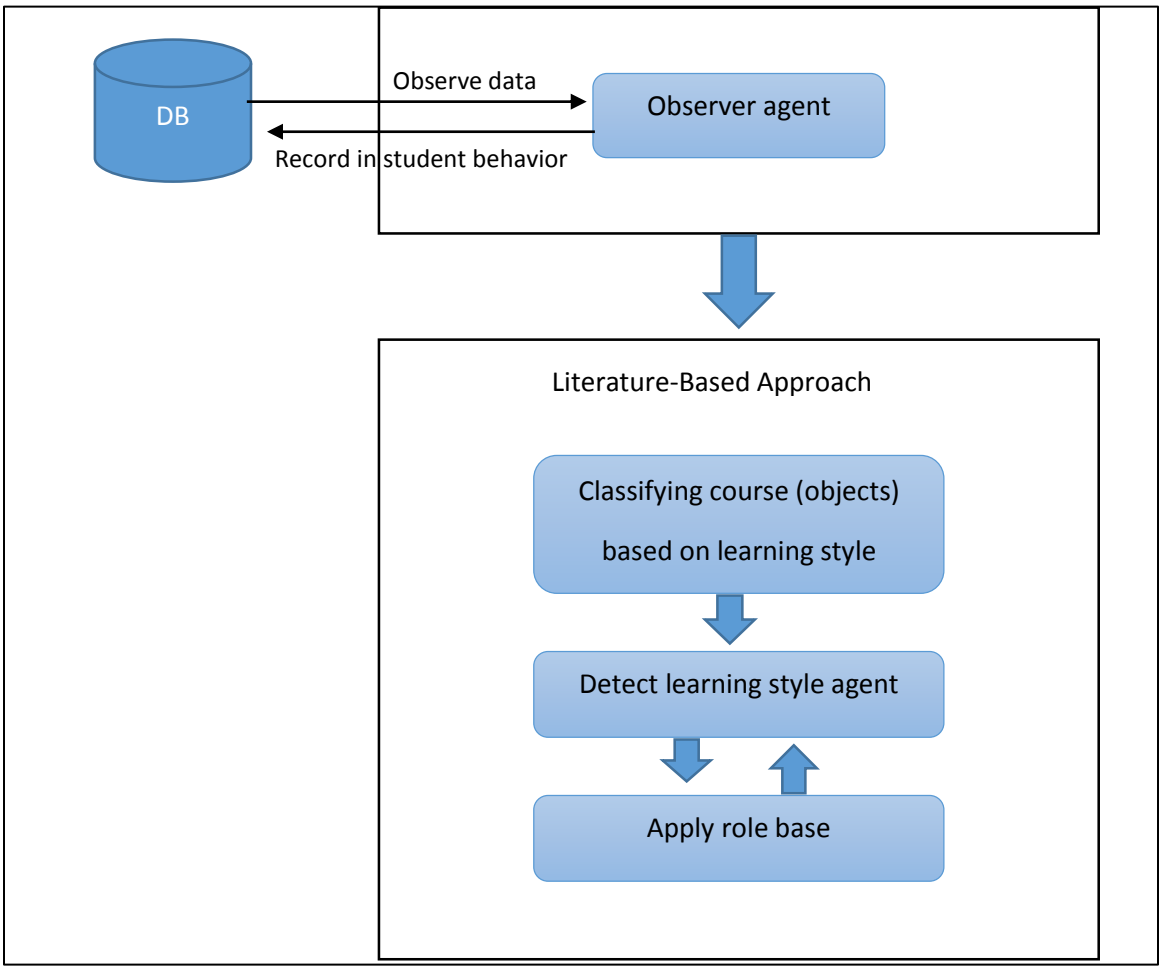
9. Literature-based approach LBM

This research will use LBM approach to develop an intelligent agent to detect learners' learning style based on their behavior. The behavior will be recorded during opening/ during lesson (object). It will also record the time in millisecond for the learner to stay on the lesson page and number of visits for same lesson. LBM will only collect these data which is related to learning style and not the lesson itself.

System modeling (Auto detect model approach):

Graf, Kinshuk and Liu (2008) suggested an automatic approach in detecting the LS on FSLSM model by inferring learner LS from their behavior during the online learning process.

The automatic student modelling approach is developed using Model-based Reflex Agents to observe and detect learner LS during an online course.



Auto detect model, describe how the system detect learning style

The system starts with Observer agent (Reflex Agent) recording student behavior during attending lessons. The next step is classifying course objects by learning style, to calculate each learning individually by the Detect LS Agent.

Labeling learning objects LO:

Learning object LO referring to a single lesson or lecture. Each learning object has different properties as the following:

- Learning object Title
- Learning object Learning style LS. (Can chose 4 out of the 16 learning style). Based on lesson content as the following:

learning objects leabling

Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
Exercise	Summaries	Practical	algorithms	Video	Audio	exercises	Summaries
Multiple questions	Outline	Facts	definitions	Image	Text	Step by step	All link pages
Self-assessment	examples	examples	Equation	Graphics		Constrict link pages	Outlines
		explanation		Animation			

- Learning object expected time to spend on it.(the expected time from student to attend a particular lesson, which set by the tutor)
- Learning object short description. (To view it under the title on course menu.)
- Learning object content. (the main content of lesson)

Each one of LO's must have 4 LS or less but not zero, Based on Felder-Silverman learning style FSLSM model: any learner have LS preference, which are 8 dimensions. However, there are 16 types of combination of learning style out of the 8 dimensions, each type of combination has 4 dimensions you want to use dimensions or grouping? Moreover, there is a requirement to make the combination: cannot combine any kind of Ls fall into the same set. For instance, this combination not accepted: (Active – Reflective – Visual – Global), because Active and Reflective are in the same group (Group1). The reason of previous combination, student cannot be in fact Active and Reflective Graf, Viola, Tommaso & Kinshuk (2007). The following table shows the four dimensions group (I think, because not too confused between the 8 dimensions you said earlier) of FSLSM model:

The four dimensions of FSLSM model

Group 1	Group 2	Group 3	Group 4
Active – Reflective	Sensing – Intuitive	Visual – Verbal	Sequential – Global

The following are the 16 types of combination:

FSLSM model 16 type of combination *(Graf, Viola, Tommaso, & Kinshuk, 2007)*

1. active/sensing/visual/sequential	2. reflective/sensing/visual/sequential
3. active/sensing/visual/global	4. reflective/sensing/visual/global
5. active/sensing/verbal/sequential	6. reflective/sensing/verbal/sequential
7. active/sensing/verbal/global	8. reflective/sensing/verbal/global

9. active/intuitive/visual/sequential	10. reflective/intuitive/visual/sequential
11. active/intuitive/visual/global	12. reflective/intuitive/visual/global
13. active/intuitive/verbal/sequential	14. reflective/intuitive/verbal/sequential
15. active/intuitive/verbal/global	16. reflective/intuitive/verbal/global

Estimating learning styles:

The following steps shows how the system estimate LS during learner taking a course online:

- the system named any lesson as Learning Object LO
- In each time learner enter a lesson (LO), the system Agent record the visit and how long time learner spent taking the LO. And the Agent store the data, based on Learning Object LS.
- To calculate Time Ratios for a specific LS, system group all LO based on LS. Then sums total of all Spent Time for each LS. And do the same for sum total of Expected Time and total Number of Visit.

$$\text{Time Ratios of (LS)} = \frac{\sum \text{Spent Time of (LOs)}}{\sum \text{Expected Time of (LOs)}}$$

- To system count all the LO in the database based on LS, and assigned to Number of Learning Object. To get the Visit Ratios, divide total Number of Visit with the total Number of Learning Object

$$\text{Visit Ratios of (LS)} = \frac{\sum \text{Number of Visit (LOs)}}{\sum \text{Number of (LOs)}}$$

- To get the Average Ratios:

$$\text{Average Ratios of (LS)} = (\text{ Time Ratios of (LS)} + \text{Visit Ratios of (LS)})/2$$

- After get the Average Rations for each LS, the learning style estimated based on the following rule:

Average Ratios LS	Learning Style Preference
0 - 0.3	Week
0.3 - 0.7	Moderate
> 0.7	Strong

The following is an example of Average Ratios LS result for one learner:

Example of Average Ratios LS result for one learner

Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
0.6465	0.1465	0.0754	0.7179	0.6466	0.1458	0.2881	0.5045
Moderate	Week	Week	Strong	Moderate	Week	Week	Moderate

Any two strong LS in the same dimensions group will be rejected as shown in previous table. For example if sensing and Intuitive both strong, both will reject. Because learner cannot have to LS in same time Graf, Viola, Tommaso & Kinshuk (2007).

Experiment:

The experiment conducted on 30 students of high school, the first-grade student in major of Computer and Information Technology. However, the duration of the experiment is eight weeks with a 24-course object. Before the system applies any formula, the system sorts the sort the all LO based on LS.

After ordering LO based on LS, the system applies formula (1) and (2) then formula (3) to obtain Average Ratios of (LS). The result of Average Ratios of (LS) for each learner as the following:

Example of result for user No: 1

User	Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
1	0.3	0.2	0.4	0.1	0.5	0.2	0.7	0.2

The final estimated LS of all 30 learners

User	Auto Detect	Value	User	Auto Detect	Value
1	SEQ	0.7	16	ACT	0.7
2	SEQ	0.5	17	SEQ	0.7
3	VIS	0.8	18	VIS	0.6
4	SEN	0.6	19	ACT	0.8
5	ACT	0.5	20	GLO	0.3
6	VER	0.7	21	VER	0.2
7	REF	0.8	22	GLO	0.6
8	SEN	0.7	23	GLO	0.7
9	INT	0.3	24	VIS	0.9
10	VIS	0.7	25	INT	0.7
11	GLO	0.8	26	SEQ	0.8
12	ACT	0.7	27	ACT	0.2
13	SEN	0.5	28	SEN	0.7
14	GLO	0.1	29	VIS	0.7
15	VIS	0.6	30	SEN	0.8

After the finish of the experiment duration for all learner. The system shows all learner LS as is shown in the table (14), here comes the second step which is validation. But before validation step will compare our result with FSLSM (ILS) method.

ILS questionnaire conducted on all the learners online[3] in the classroom to obtain learner LS again with FSLSM method to compare it later with the result of the proposed system. The following table shows ILS questionnaire results:

FSLSM (ILS) result

User	ILS	Value	User	ILS	Value
1	SEQ	0.9	16	ACT	0.8
2	GLO	0.6	17	SEQ	0.9
3	VIS	0.7	18	VIS	0.8
4	SEN	0.8	19	ACT	0.7
5	REF	0.4	20	GLO	0.8
6	VER	0.8	21	VER	0.8
7	REF	0.7	22	SEQ	0.7
8	INT	0.5	23	GLO	0.9
9	INT	0.8	24	VIS	0.3
10	VIS	0.9	25	INT	0.8
11	GLO	0.7	26	SEQ	0.9
12	ACT	0.8	27	ACT	0.8
13	SEN	0.7	28	SEN	0.9
14	GLO	0.8	29	VIS	0.5
15	VER	0.4	30	SEN	0.9

The FSLSM method result comes as an Integer number from 1 to 11. To be comparable with the proposed method, divide it on 10. For instance if FSLSM result = 1 the 1/10 = 0.1.

(3) https://www.webtools.ncsu.edu/learningstyles/ilsweb_3.php

The following table shows how the comparison between the two results table (14) and table (15) (ILS questionnaire and the proposed method results):

Comparison between the two results from table (14) and table (15)

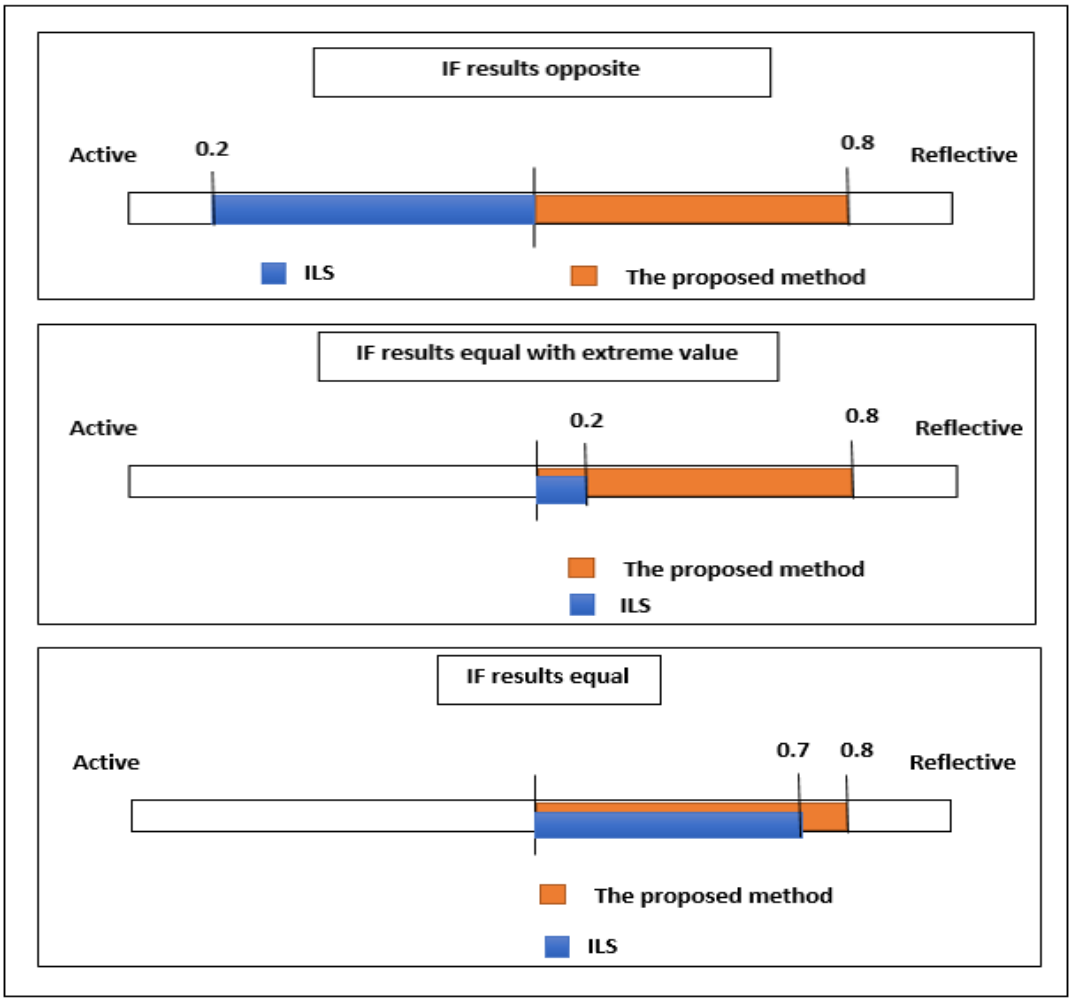
User	Auto Detect or determined	Value	LS(ILS)	Value
1	SEQ	0.7	SEQ	0.9
2	SEQ	0.5	GLO	0.6
3	VIS	0.8	VIS	0.7
4	SEN	0.6	SEN	0.8
5	*ACT*	*0.5*	*REF*	*0.4*
6	VER	0.7	VER	0.8
7	REF	0.8	REF	0.7
8	*SEN*	*0.7*	*INT*	*0.5*
9	INT	0.3	INT	0.8
10	VIS	0.7	VIS	0.9
11	GLO	0.8	GLO	0.7
12	ACT	0.7	ACT	0.8
13	SEN	0.5	SEN	0.7
14	GLO	0.1	GLO	0.8
15	*VIS*	*0.6*	*VER*	*0.4*
16	ACT	0.7	ACT	0.8
17	SEQ	0.7	SEQ	0.9
18	VIS	0.6	VIS	0.8
19	ACT	0.8	ACT	0.7
20	GLO	0.3	GLO	0.8
21	VER	0.2	VER	0.8
22	*GLO*	*0.6*	*SEQ*	*0.7*
23	GLO	0.7	GLO	0.9
24	VIS	0.9	VIS	0.7
25	INT	0.7	INT	0.8
26	SEQ	0.8	SEQ	0.9
27	ACT	0.2	ACT	0.8
28	SEN	0.7	SEN	0.9
29	VIS	0.7	VIS	0.5
30	SEN	0.8	SEN	0.9

To compare the results will use the Precision formula (4). The precision formula proposed by Garcı´a et al. (2008):

$$precision = \frac{\sum_{i=1}^{n} x(LS_{Dtermined}, LS_{ILS})}{n} \qquad formula\ (4)$$

- $LS_{determined}$ = determined Learning Style (from our method)
- LS_{ILS} = Index Learning style questionnaire results (LS)
- n = number of students or learners.
- x value (rule):
  - If $LS_{determined}$ and LS_{ILS} are equal then x= 1.
  - If $LS_{determined}$ and LS_{ILS} are opposite[((4))] then x=0.
  - if one of neutral and the other has extreme value then x= 0.5

The following Figure describes how to calculate an x value (Rule):



How to calculate x value (Rule)

(4) Opposite mean (Active and Reflective) are opposite look at Figure 1.

In addition, the following figure shows how to calculate x value

User	*LS determined*	Value	*LSILS*	Value
1	SEQ	0.7	SEQ	0.9
2	SEQ	0.5	GLO	0.6
3	VIS	0.8	VIS	0.7
4	SEN	0.6	SEN	0.8
5	*ACT*	*0.5*	*REF*	*0.4*
6	VER	0.7	VER	0.8
7	REF	0.8	REF	0.7
8	*SEN*	*0.7*	*INT*	*0.5*
9	INT	0.3	INT	0.8
10	VIS	0.7	VIS	0.9
11	GLO	0.8	GLO	0.7
12	ACT	0.7	ACT	0.8
13	SEN	0.5	SEN	0.7
14	GLO	0.1	GLO	0.8
15	*VIS*	*0.6*	*VER*	*0.4*
16	ACT	0.7	ACT	0.8
17	SEQ	0.7	SEQ	0.9
18	VIS	0.6	VIS	0.8
19	ACT	0.8	ACT	0.7
20	GLO	0.3	GLO	0.8
21	VER	0.2	VER	0.8
22	*GLO*	*0.6*	*SEQ*	*0.7*
23	GLO	0.7	GLO	0.9
24	VIS	0.9	VIS	0.7
25	INT	0.7	INT	0.8
26	SEQ	0.8	SEQ	0.9
27	ACT	0.2	ACT	0.8
28	SEN	0.7	SEN	0.9
29	VIS	0.7	VIS	0.5
30	SEN	0.8	SEN	0.9

- Italic font: two results of LS value are opposite, then x value = 0
- Bold font: equal LS value with extreme value (high or low), then x value = 0.5
- Normal: the two value of LS are equal, then x value = 1

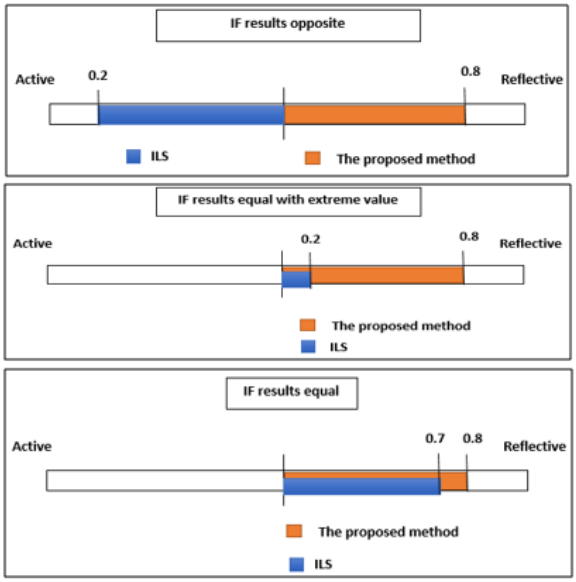


Figure 1 how to calculate x value (Rule)

The following table illustrates *x* value for all users:

X value for all 30 user

User	*LS determined*	Value	*LSILS*	Value	*x* value
1	SEQ	0.7	SEQ	0.9	1
2	SEQ	0.5	GLO	0.6	0
3	VIS	0.8	VIS	0.7	1
4	SEN	0.6	SEN	0.8	1
5	*ACT*	*0.5*	*REF*	*0.4*	0
6	VER	0.7	VER	0.8	1
7	REF	0.8	REF	0.7	1
8	*SEN*	*0.7*	*INT*	*0.5*	0
9	INT	0.3	INT	0.8	0.5
10	VIS	0.7	VIS	0.9	1
11	GLO	0.8	GLO	0.7	1
12	ACT	0.7	ACT	0.8	1
13	SEN	0.5	SEN	0.7	0.5
14	GLO	0.1	GLO	0.8	0.5
15	*VIS*	*0.6*	*VER*	*0.4*	0
16	ACT	0.7	ACT	0.8	1
17	SEQ	0.7	SEQ	0.9	1
18	VIS	0.6	VIS	0.8	1
19	ACT	0.8	ACT	0.7	1
20	GLO	0.3	GLO	0.8	0.5
21	VER	0.2	VER	0.8	0.5
22	*GLO*	*0.6*	*SEQ*	*0.7*	0
23	GLO	0.7	GLO	0.9	1
24	VIS	0.9	VIS	0.7	1
25	INT	0.7	INT	0.8	1
26	SEQ	0.8	SEQ	0.9	1
27	ACT	0.2	ACT	0.8	0.5
28	SEN	0.7	SEN	0.9	1
29	VIS	0.7	VIS	0.5	1
30	SEN	0.8	SEN	0.9	1

For all LS's one by one, apply the formula (4), for example, will take first dimension (Active /Reflective) then highlight any user who has Active /Reflective that for propose of calculating it with formula (4) as the following:

Highlight all the target dimension (Active /Reflective)

User	*LS Determined*	Value	*LSILS*	Value	*x* value
1	SEQ	0.7	SEQ	0.9	1
2	SEQ	0.5	GLO	0.6	0
3	VIS	0.8	VIS	0.7	1
4	SEN	0.6	SEN	0.8	1
5	ACT	0.5	REF	0.4	0
6	VER	0.7	VER	0.8	1
7	REF	0.8	REF	0.7	1
8	SEN	0.7	INT	0.5	0
9	INT	0.3	INT	0.8	0.5
10	VIS	0.7	VIS	0.9	1
11	GLO	0.8	GLO	0.7	1
12	ACT	0.7	ACT	0.8	1
13	SEN	0.5	SEN	0.7	0.5
14	GLO	0.1	GLO	0.8	0.5
15	VIS	0.6	VER	0.4	0
16	ACT	0.7	ACT	0.8	1
17	SEQ	0.7	SEQ	0.9	1
18	VIS	0.6	VIS	0.8	1
19	ACT	0.8	ACT	0.7	1
20	GLO	0.3	GLO	0.8	0.5
21	VER	0.2	VER	0.8	0.5
22	GLO	0.6	SEQ	0.7	0
23	GLO	0.7	GLO	0.9	1
24	VIS	0.9	VIS	0.7	1
25	INT	0.7	INT	0.8	1
26	SEQ	0.8	SEQ	0.9	1
27	ACT	0.2	ACT	0.8	0.5
28	SEN	0.7	SEN	0.9	1
29	VIS	0.7	VIS	0.5	1
30	SEN	0.8	SEN	0.9	1

From the above table the total number of users N for (Active\Reflective) dimension=6, that for all users and both $LS_{Dtermined}$ (the proposed method) and LS_{ILS} FSLSM (ILS) method

$$precision = \frac{\sum_1^6 x(LS_{Dtermined}, LS_{ILS})}{6} \qquad formula\ (4)$$

$$precision = \frac{4.5}{6} = 0{,}75$$

We convert the result to a percentage by multiplying the output by 100 percent. So (0, 75 × 100 = 75)

$$\therefore (Active\backslash Reflective) precision = 75\ \%$$

However, will repeat the pervious calculation to obtain all the precision for the rest of 3 dimensions (Sensing\Intuitive), (Visual\Verbal) and (Sequential \Global). The following illustrates the result of precision for all four dimensions:

Result of precision

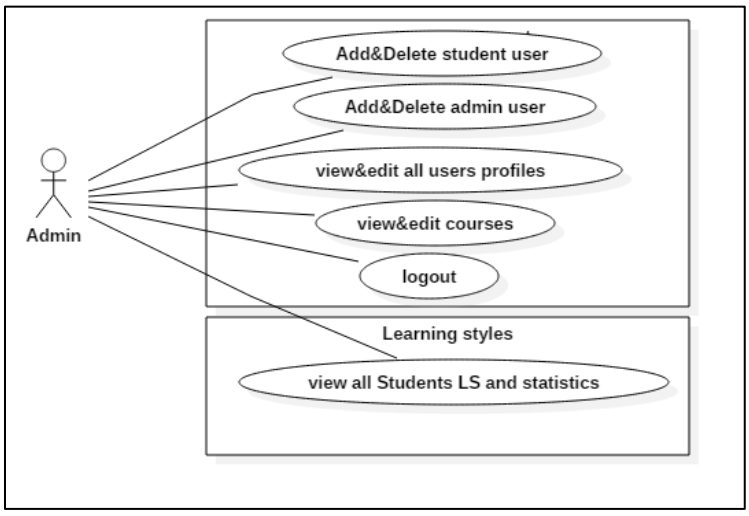
Active – Reflective	Sensing – Intuitive	Visual – Verbal	Sequential – Global
75	71	81.25	66.6

The proposed method results over 66.6% table (19). The result higher than Garcı´a et al. (2008) result, while Garcia results (58%, Active/Reflective),(77%, Sensing/Intuitive),(63%, Sequential – Global). On the other hand, Graf et al. (2008)result as the following (Our method results are approximate in comparison with the two previous methods) .

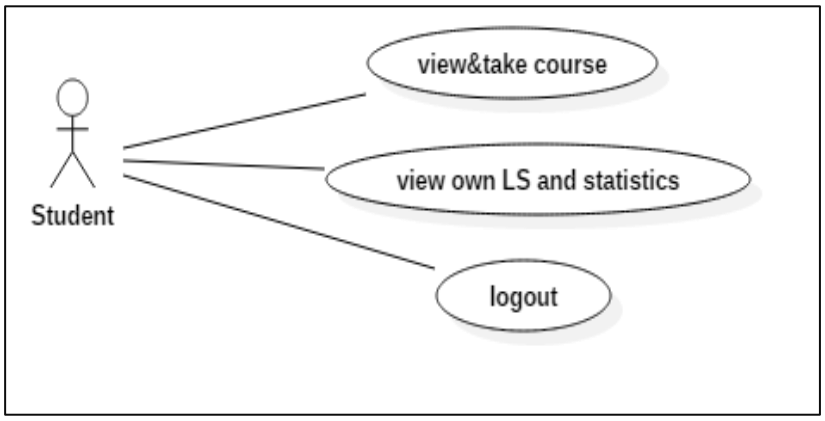
Active – Reflective	Sensing – Intuitive	Visual – Verbal	Sequential – Global
79.33%	77.33%	76.67%	73.33%

System Design

- Use-case diagram:



Admin Use-case diagram



Student Use-case diagram

Database relations (database structure):

List of Database Tables

No	Table Name	Description
1	Learning_objects	Object mean a single course with all its properties such as course name, course learning style etc.
2	ls_members	All system members (users). LS indicate to Learning Style.
3	Student_behavior	This table store student behavior during a particular course, such as how long time spent on N course, number of visit.

Table No 1: Table name (Learning_objects)

Database-Table name (Learning_objects)

Column	Type	Null	Default	Extra	Links to	Comments
obj_ID	int(11)	No		auto_ increment		
obj_title	varchar(255	Yes	NULL			
obj_desc	Text	Yes	NULL			Object description
obj_cont	Text	Yes	NULL			Object content
obj_expected _time	int(11)	Yes	NULL			
obj_date	Datetime	Yes	NULL			
obj_ls1	int(11)	Yes	NULL			Learning Style 1
obj_ls2	int(11)	Yes	NULL			Learning Style 2
obj_ls3	int(11)	Yes	NULL			Learning Style 3
obj_ls4	int(11)	Yes	NULL			Learning Style 4

Table No 2: Table Name (ls_members):

Database designed, if a member deleted from ls_members table. Then any related record in all tables will be deleted accordingly. For example an admin user create a course object. If the user who creates the item is deleted, all the user-created objects will be deleted.

Database-Table Name (ls_members)

Column	Type	Null	Default	Extra
memberID	int(11)	No		Auto_ increment
user_full_name	varchar(255)	Yes	NULL	
username	varchar(255)	Yes	NULL	
password	varchar(255)	Yes	NULL	
email	varchar(255)	Yes	NULL	
Role	varchar(255)	Yes	NULL	

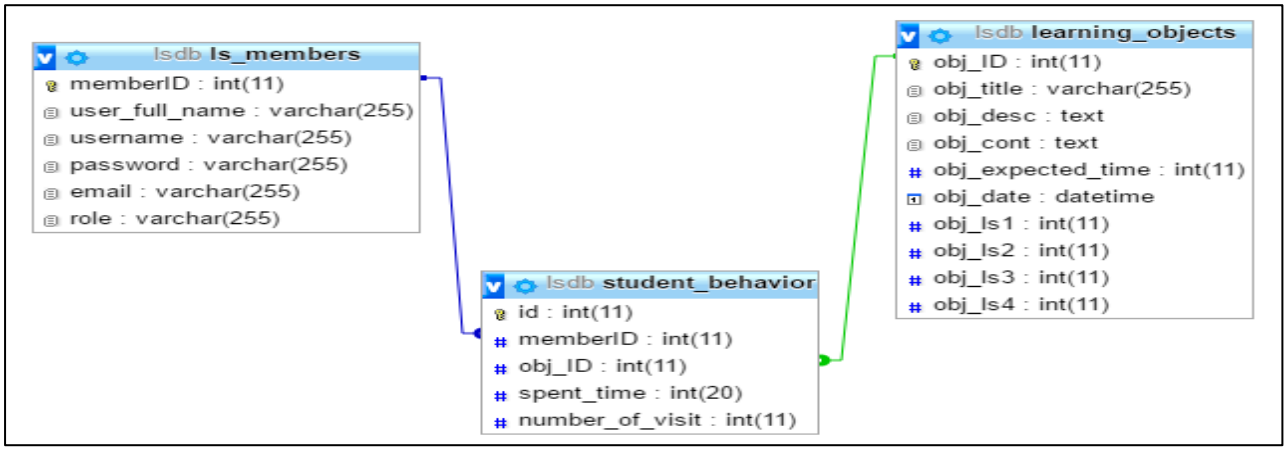
Table NO 3: Table name (student_behavior)

The relation between student_behavior table and ls_members is CASCADE. Which is mean if any user deleted from ls_members, cascading will delete related record in student_behavior.

Database-Table name (student_behavior)

Column	Type	Null	Default	Extra	Links to
Id	int(11)	No		Auto_ increment	
memberID	int(11)	Yes			->ls_members.me mberID ON UPDATE CASCADE ON DELETE CASCADE ON UPDATE CASCADE ON DELETE CASCADE
obj_ID	int(11)	Yes			->learning_objects .obj_ID ON UPDATE CASCADE ON DELETE CASCADE
spent_time	int(20)	Yes	NULL		
Number_of _visit	int(11)	Yes	NULL		

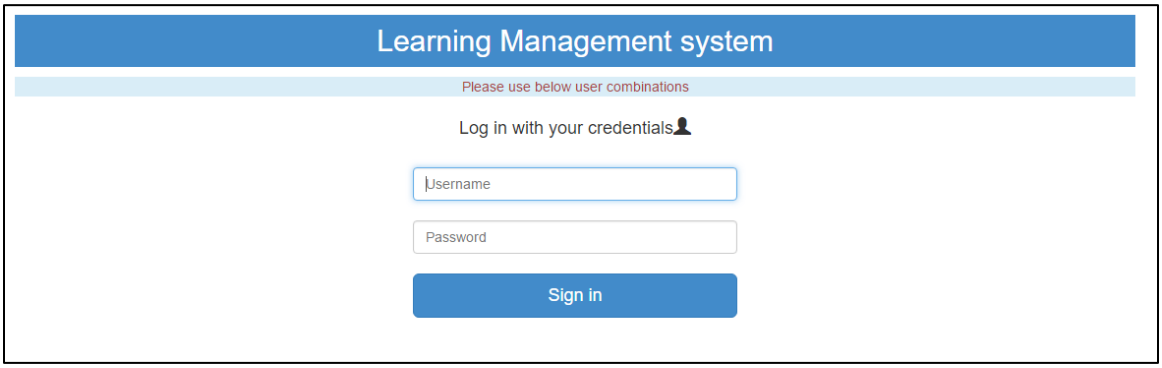
Entity Relationship Diagram:



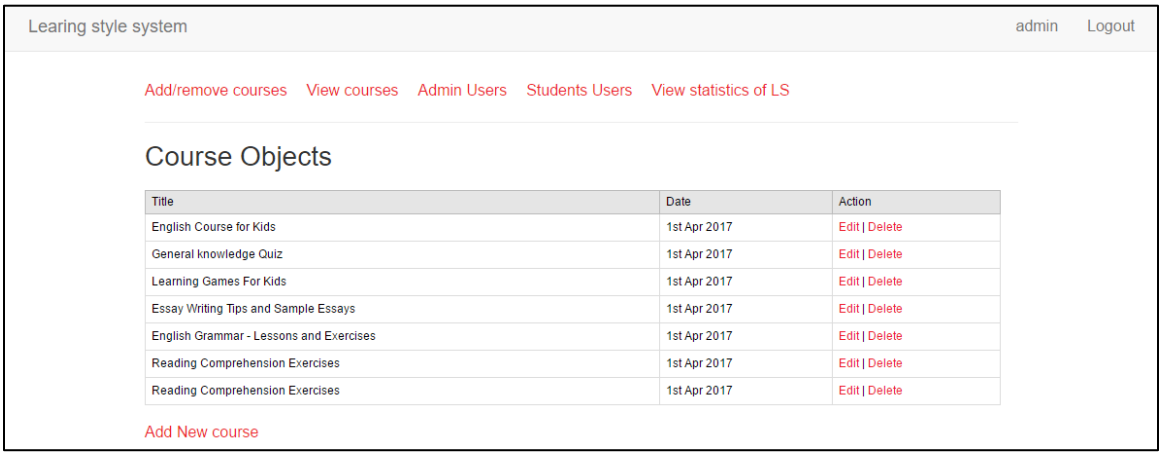
Database Entity Relationship Diagram

Software interfaces

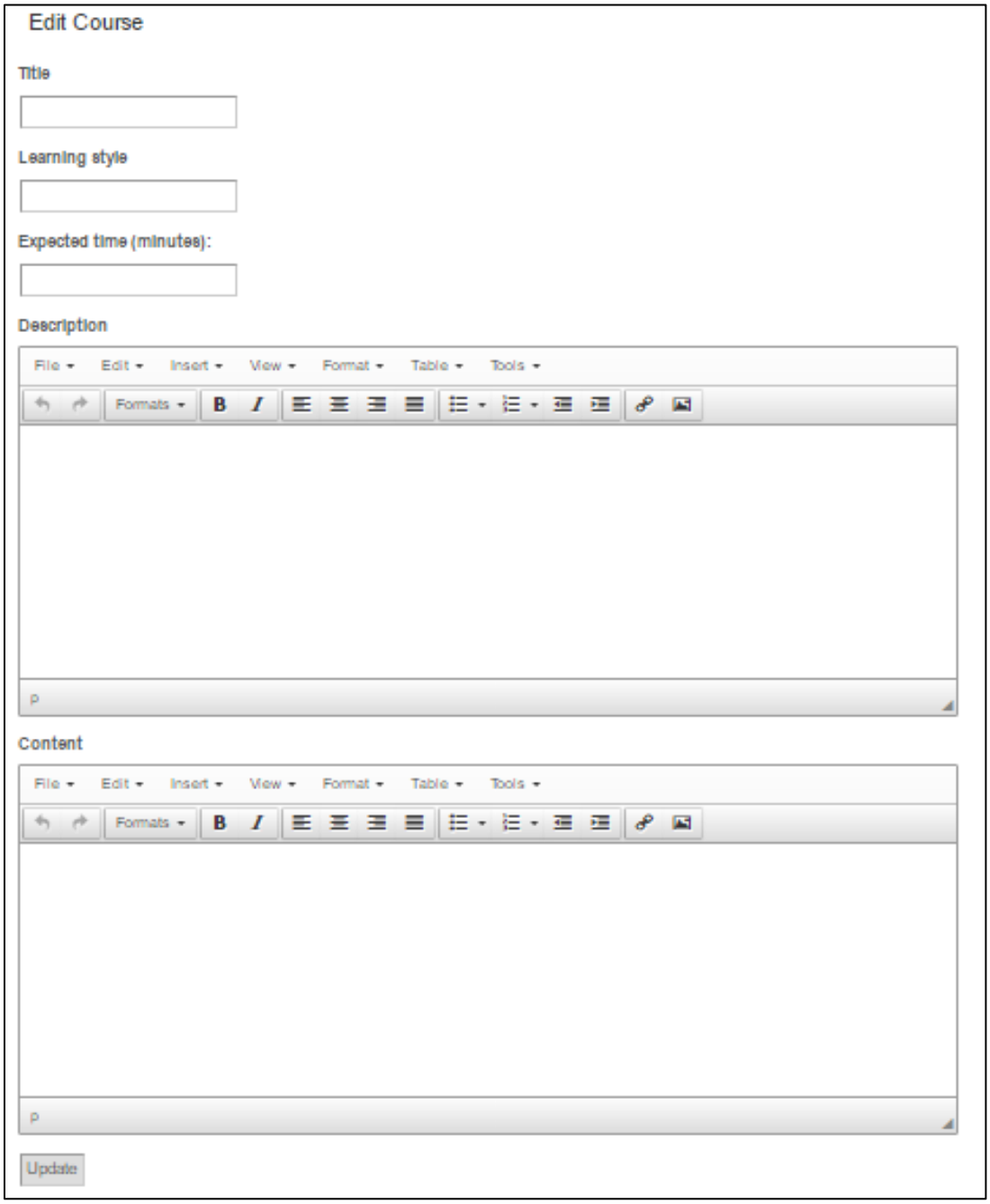
Login to an interface:



Main homepage for admin (add remove courses):

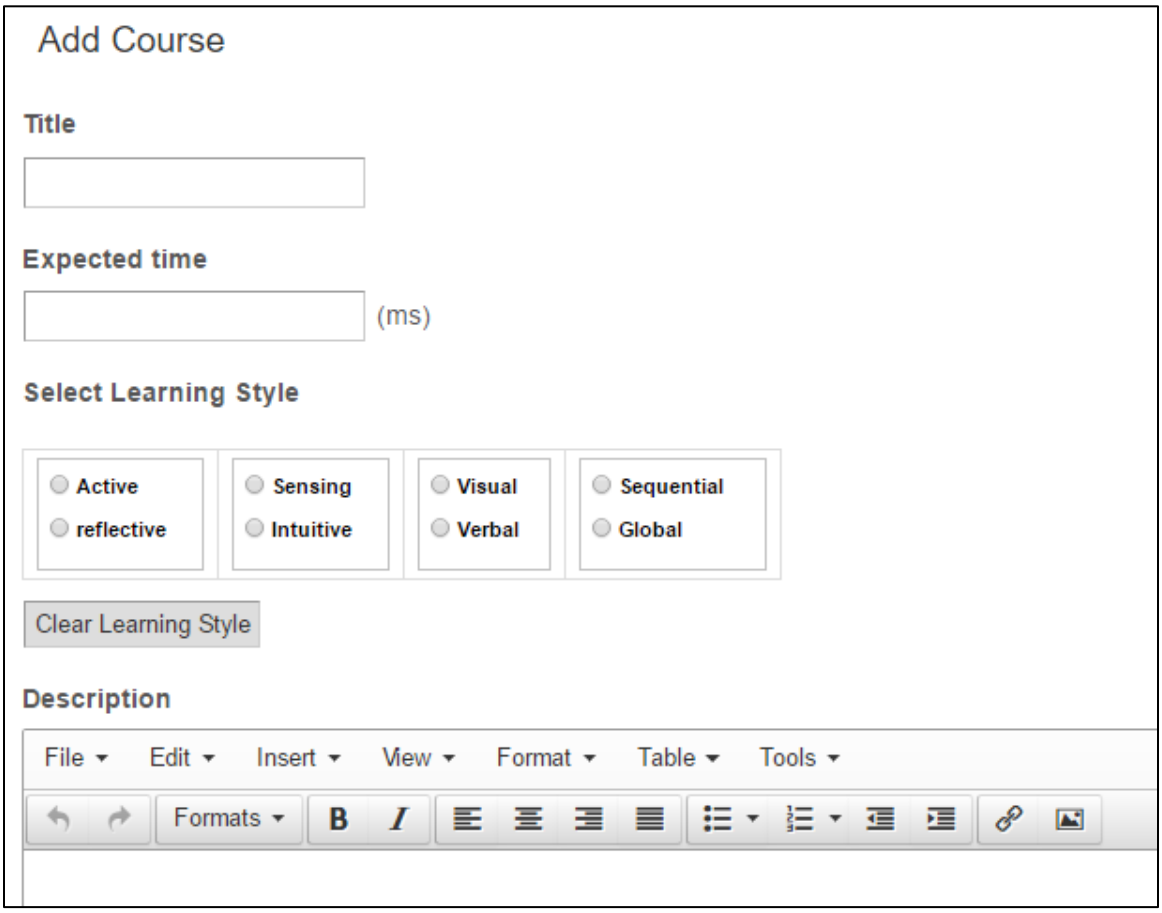


Edit course interface:

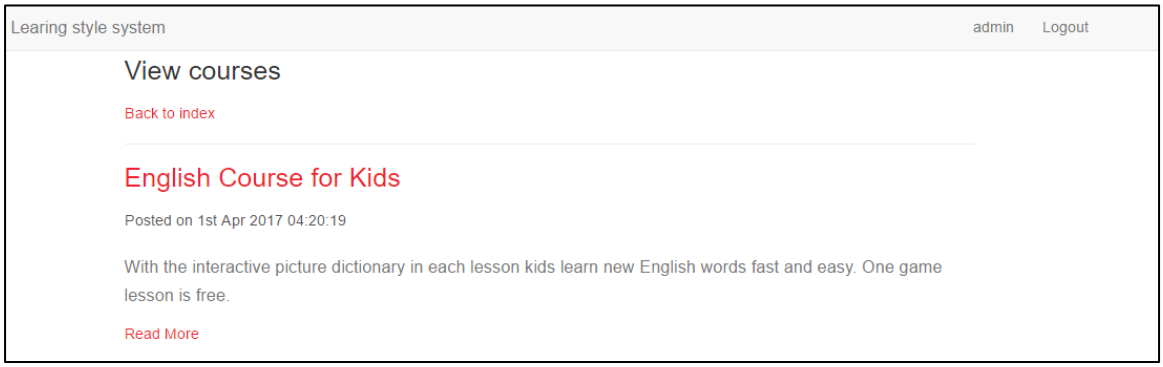


Add new course interface:

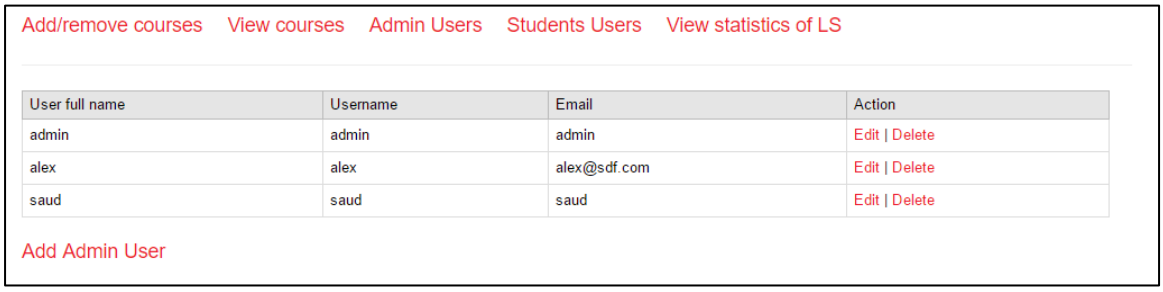
Here in (Select Learning Style) options, the user cannot select two learning style in the same group for example (Active and reflective) only one can select. Each course must have minimum one out four LS.



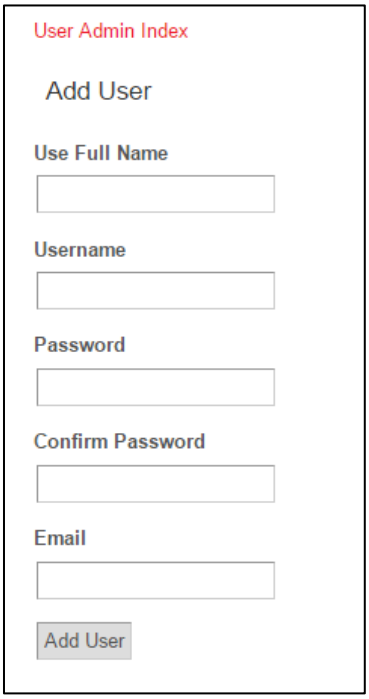
View course interface:



Admin users interface:



Add new User Interface:

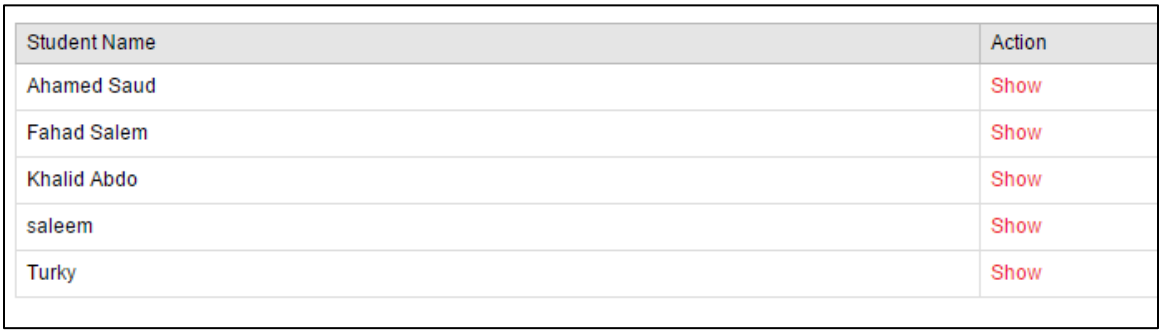


Admin users list:

User full name	Username	Email	Action
admin	admin	admin	Edit | Delete
alex	alex	alex@sdf.com	Edit | Delete
saud	saud	saud	Edit | Delete

Add Admin User

View statistics of LS list interface:



Student Name	Action
Ahamed Saud	Show
Fahad Salem	Show
Khalid Abdo	Show
saleem	Show
Turky	Show

Show statistics of LS for a learner:

View statistics of LS page

Back

Student name: Ahamed Saud
Total of attened courses: 11
student ID: 47
Student Email: Ahamed@Ahamed.com

Average ratios to all 8 Learning style

Learning Style	Total spet Time	Total expected time	Total number of visits	Time ratios:	Visits ratios:	Average ratios
1 Active	18	2450	9	0.0073469387755102	1.2857142857143	0.6465306122449
2 Reflective	4	540	2	0.0074074074074074	0.28571428571429	0.14656084656085
3 Sensing	2	250	1	0.008	0.14285714285714	0.075428571428571
8 Intuitive	20	2740	10	0.0072992700729927	1.4285714285714	0.71793534932221
5 Visual	19	2490	9	0.0076305220883534	1.2857142857143	0.64667240390132
6 Verbal	3	500	2	0.006	0.28571428571429	0.14585714285714
7 Sequential	6	1250	4	0.0048	0.57142857142857	0.28811428571429
8 Global	16	1740	7	0.0091954022988506	1	0.50459770114943

Average ratios to all 8 Learning style

Active	Reflective	Sensing	Intuitive	Visual	Verbal	Sequential	Global
0.6465306122449	0.14656084656085	0.075428571428571	0.71793534932221	0.64667240390132	0.14585714285714	0.28811428571429	0.50459770114943
Moderate	Week	Week	Strong	Moderate	Week	Week	Moderate

Conclusion and Future Work

This study present new method to detect learner learning style using reflex-agent and literature-based method. Moreover, classifying learning styles and evaluation based on FSLSM model. The study method help instructors to find learner learning style by detecting LS automatically instated of using ILS, and provide continues detecting through the system while learner using it. This study method is suitable to integrate with any web-based LMS.

For future work, researcher or developer may apply our method to provide adaptive learning system based on learner learning style preferences. That by deliver the course to the learner based on learner style that detected by our method. Adaptive learning is computer-based or online educational system that changes the course material (adapt) the system to the learner based on preference Dreambox (2017). According to Brusilovsky and Peylo (2003), adaptive learning is online educational system computer application based to adapt the courses or subject presentation based on what they prefer. On the other hand, the intelligent agent detects learner learning style automatically then delivers adaptive courses or material to the learner. Moreover, this study aims to detect (automatically) learner learning style, based on preference using an intelligent agent. The benefit of finding learner LS then deliver an appropriate lesson that matches learner LS.

References

A. Ertmer, P., & J Newby, T. (2008). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective. *Performance Improvement Quarterly*, 50-72. doi:10.1111/j.1937-8327.1993.tb00605.x

Adaptive Learning. (2017, 4 17). Retrieved from Dreambox: http://www.dreambox.com/adaptive-learning

Akbulut, Y., & Cardak, C. S. (2012). Adaptive Educational Hypermedia Accommodating Learning Styles : A Content Analysis of Publications from 2000 to 2011. *Computers & Education*, 835-842. doi:10.1016/j.compedu.2011.10.008

Bassiouni, A.-H. (2007). mobile education & e-learning education . In *mobile education & e-learning education* (pp. 257-283). Cario: dar al kotob al ilmiyah books.

Belle, A., Ji, S.-Y., Chen, W., Huynh, T., & Najarian, K. (2014). Rule-based Computer Aided Decision Making for Traumatic Brain Injuries. In S. B. Heidelberg (Ed.), *Machine Learning in Healthcare Informatics*, *56*, pp. 229-259.

Boldi, P., Codenotti, B., Santini, M., & Vigna, S. (2004). UbiCrawler: a scalable fully distributed Web crawler. *Software: Practice and Experience, 34*(8), 711-726.

Brusilovsky, P., & Peylo, C. (2003). Adaptive and Intelligent Web-based Educational Systems. *13*, 156-169.

Capterra. (2015, 12). *THE TOP 20 MOST POPULAR*. Retrieved from Capterra: http://www.capterra.com/learning-management-system-software/#infographic

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning Styles and Pedagogy in Post-16 Learning: A Systematic and Critical Review. *London: Learning and Skills Research Centre, University of Newcastle upon Tyne.*

Cutler, R., & Turk, M. (1998). View-based interpretation of real-time optical flow for gesture recognition. *in 2013 10th IEEE International Conference and Workshops on Automatic Face and Gesture Recognition (FG)*, (pp. 416-416).

Dag, F., & Gecer, A. (2009). Relations between online learning and learning styles. *Procedia- Social and Behavioral Sciences, 1*(1), 862-871. doi:10.1016/j.sbspro.2009.01.155

Dung, P. Q., & Florea, A. M. (2012). A Literature-Based Method To Automatically Detect Learning Styles In Learning Management Systems. Paper presented at the In Proceedings Of The 2nd International Conference On Web Intelligence, Mining And Semantics.

Dung, Q., & Adina, M. (2013). A METHOD FOR DETECTION OF LEARNING STYLES IN LEARNING MANAGEMENT SYSTEMS. *U.P.B. Sci. Bull, 75*.

Etzioni, O., & Weld, D. S. (1995). Intelligent Agents on the Internet: Fact, Fiction, and Forecast. 44-49.

Foner, L. (1993). Agents and appropriation. *appears in: The Proceedings of the First International Conference on Autonomous Agents (AA '97).*

Garcı´a, P., Amandi, A., Schiaffino, S., & Campo, M. (2008). *Computers & Education, 49*, 794-808.

García, P., Amandi, A., Schiaffino, S., & Campo, M. (2005). Using Bayesian Networks to Detect Students' Learning Styles in a Web-based education system. *7º Simposio Argentino de Inteligencia Artificial - ASAI2005*, 115-126.

Graf, S., & Beate, L. (n.d.). An Evaluation of Open Source E-Learning Platforms Stressing Adaptation Issues. *Fifth IEEE International Conference on Advanced Learning Technologies (ICALT'05)* (pp. 163-165). Vienna: IEEE. doi:10.1109/ICALT.2005.54

Graf, S., & Dr Kinshuk. (n.d.). An Approach for Detecting Learning Styles in Learning Management Systems. *Advanced Learning Technologies, 2006. Sixth International Conference on.* IEEE.

Graf, S., Kinshuk, & Liu, T.-C. (2008). Identifying Learning Styles in Learning Management Systems by Using Indications from Students' Behaviour. *ICALT '08 Proceedings of the 2008 Eighth IEEE International Conference on Advanced Learning Technologies* (pp. 482-486). DC, USA: IEEE Computer Society Washington.

Graf, S., Viola, S., Tommaso, L., & Kinshuk. (2007). In-Depth Analysis of the Felder-Silverman Learning Style Dimensions. *Journal of Research on Technology in Education, 40*(1), 79-93.

IBM. (2005). *Building an agent, A strategy white paper written for IBM.* Retrieved from http://www.devx.com/assets/download/14089.pdf

I-TUTOR. (2016, 7 10). *About*. Retrieved from I-TUTOR project: http://intelligent-tutor.eu/about/

Jawdat, M. S. (2005). *the provision of educational courses systems across networks* (1 ed., Vol. 1). (M. Abdel-Hamid, Ed.) Cairo: the world of books (Alam ALkotob). Retrieved Aug 18, 2016, from http://www.alamalkotob.com/

Jennings, N. R., & Wooldridge, M. (1998). *Agent Technology.* London: Springer Berlin Heidelberg. doi:10.1007/978-3-662-03678-5_1

Jones, M. T. (2015). *Artificial Intelligence: A Systems Approach.* U.S: Jones & Bartlett Learning. Retrieved 8 6, 2016

LI-LONG. (June 2009). *An intelligent tutoring system based on a gent.* Chicoutimi: Library and Archives.

McCarthy, M., & Minsky, J. (1955, Aug 31). A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence. *IA Mag, 27*(4).

Mohamed, H. M. (2010). *online effective in achieving the aims of education universities remote.* Egypt: Faculty of Education, Ain Shams University.

Musen, M. A., Middleton, B., & Greenes, R. A. (2014). Clinical decision-support systems. (Springer, Ed.) *Biomedical informatics*, 643-674.

Noel, B., & Wallace, R. S. (2001, july 16). *A.L.I.C.E. Press Releases*. Retrieved from A.L.I.C.E. AI Foundation: http://www.alicebot.org/press_releases/2001/aiml10.html

Norazlina, A., Zaidatun, T., Jamri, K., & Harun, S. (2013). Automatic Detection of Learning Styles in Learning Management Systems by Using Literature-based Method. *Procedia - Social and Behavioral Sciences. 103*, pp. 181-189. Malaysia: Elsevier. Retrieved 7 2016

Palsberg, J., & Tian, Z. (2003). Type Inference for Record Concatenation and Subtyping. *UCLA Engineering*.

Parag, C., Pendharkara, James, A., Rodgerb, & Girish, H. (2008). *An empirical study of the Cobb–Douglas production function properties of software development effort.*

Pham, Q. D., & Florea, A. M. (2013). A method for detection of learning styles in learning management systems. *UPB Scientific Bulletin, Series C: Electrical Engineering, 75*, 3-12.

Pillai, A. (2013). *Data Driven Framework in QTP : The Complete Guide – Part 1*. Retrieved 4 18, 2017, from Automation Repository: http://www.automationrepository.com/2012/05/qtp-data-driven-framework-design-with-examples/

Rebenich, T., Gravell, A. M., & Tiropanis, T. (2010). Survey of Students' Technology Use for Time Management. *World Conference on Educational Multimedia, Hypermedia & Telecommunications 28 Jun - 02 Jul.* Toronto, Canada.

Rebenich, T., Gravell, A. M., & Tiropanis, T. (2010). Survey of Students' Technology Use for Time Management. *World Conference on Educational Multimedia, Hypermedia & Telecommunications 2010 28 Jun - 02 Jul 2010.* Toronto Canada.

Research-IBM. (2016, 9 7). *Aglets*. Retrieved from IBM Research-Aglets: http://www.research.ibm.com/topics/popups/innovate/java/html/aglets.html

Saleh, M. J. (2005). *The provision of educational courses systems across networks in: education system across networks.* Cairo: Alam ALkotob.

services, c. o. (27-3-2008). APPROACH, SELECTING A DEVELOPMENT. *center of medicare and medicaid services*.

Talbh, M. (2007). e-learning: towards the development of education strategy in the atheist and the twentieth century. *Arabic Network and Open Education for Distance Education*(1), 37-41.

Thaiupathump, C. (1999). *INTELLIGENT AGENTS FOR ON-LINE LEARNING.* Retrieved 8 7, 2016

W.S, A. (2004, 10 6). *Aglets web site*. Retrieved from Aglets: http://aglets.sourceforge.net/

W3C. (2008, Nov 26). *Extensible Markup Language (XML) 1.0 (Fifth Edition)*. Retrieved from W3C: https://www.w3.org/TR/REC-xml/

Woo, E. (2011, Oct 27). *John McCarthy dies at 84; the father of artificial intelligence*. Retrieved from Los Angeles Times: http://www.latimes.com/local/obituaries/la-me-john-mccarthy-20111027-story.html

الملخص: معظم أنظمة التعلُيم الإلكتروني الحديثة تفتقر إلى الكشف التلقائي عن نمط التعليم للمتعلِم ، كما أن النهج الآلي يصنَف على أنه أفضل نهج لاستنباط نمط المتعلِم ، حيث يكشف النمط الحقيقي للطالب في بيئة التعليم عن طريق التَعليم الإلكتروني.

الغرض من هذه الدراسة اقتراح طريقة جديدة لكشف نمط المتعلِم والتي تعتمد على الكشف التلقائي الآلي ، وسيتم استخدام وكيل ذكي لتحديد نمط المتعلِم على أساس السلوك باستخدام نموذج فلدر- سيلفرمان، وهذه الطريقة المقترحة تم تنفيذها باستخدام نظام إدارة التعلُم .

بعد استخلاص النتائج عن طريق النظام المقترح ، سيتم التحقق من النتائج عن طريق مقارنتها مع نتائج استبيان نموذج فلدر- سيلفرمان بالإضافة إلى ذلك سيتم استخدام (طريقة غارسيا) لإثبات صحة لنتائج .

وبعد مقارنة الطريقة المقترحة مع نتائج الدراسات السابقة، حصلت الباحثة على نتائج مرضية جداً وأدنى نسبة تم الحصول عليها كانت 66.6٪ .

الكلمات المفتاحية: الكشف عن نمط التعلم التلقائي، العميل ذكي، ونظام التعلم.