Personalized Learning Style for Adaptive E-Learning System

Nashwa AbdelAziz Ali[#1], Fathy Eassa[*2,] Essam Hamed[#3]

[#]College of Computing and Information Technology, Computer Science Department
Arab Academy for Science, Technology & Maritime Transport AASTMT, Egypt
[1]Nashwaa.aziz@gmail.com
[3]dodessammisr@gmail.com

[#]King Abdulaziz University KAU, Saudi Arabia SA
[2]fathy55@yahoo.com

ABSTRACT

An adaptive learning system has attracted many researchers in the field of E-learning. The concept of adaptive learning is initially introduced to modify teaching strategy based on learner' needs. The aim of this paper is to identify the learning style of the learner and provide the recommended learning strategy that fits each learner individually. Learning strategy design includes learning object type and sequence of study. The motivation to this research is to improve the learner performance and achieve the ICDL certificate with the minimum number of failure in exam. International Computer Driving License ICDL program is well known certificate that is necessary for ensuring computer skills. The certificate has seven modules to exam which is mixture between theoretical and practical concepts of computer. The adaptive system proposed by this paper chooses to apply and verify the model on ICDL program because of the diverse attributes of the learners. Using two groups A&B where the model is applied only on group A, the proposed adaptive system succeeds to enable 36% of learners to get the certificate without fail while only 3% for B group. Proposed adaptive e- learning system has the ability to tuning learning strategy based on personalized learning style and achieving ICDL certificate with high performance in real exam using data mining application of WEKA software.

Key words : Learning Style, Adaptive E-Learning, Learning Strategy, ICDL, WEKA

1. INTRODUCTION

Learning style is not a new concept in education but until now this area is still in developing. It can be considered as a valuable factor for enhancing learning process by adopting an effective learning technology. It focuses on the methods of collecting, comprehending, interpreting, organizing, and thinking about learners to help instructor respond appropriately to learners' expectations, requirements and needs and recognize the patterns in which learners tend to concentrate more [1]. Personalized learning is a key in the field of E- learning as there is no fixed learning strategy which is appropriate of all learners. In order to design an adaptive learning content and enable delivery of learning content according to specific learners' needs [1], it is important to personalize and tailor the E-Learning teaching strategy to particular characteristics, knowledge, didactic aims, and the preferences of learner. On this concept the adaptability of E-Learning system is to match learning style with contents that can make learning easy and effective. Adaptive E-Learning enables to combine and integrate contents and learning services to improve the learner experience. An adaptive system provides solutions to a problem based on various factors. Moreover adaptive system consists of syllabus sequence, problem solving support and intelligent solution analysis [2]. Learning Management System LMS is software that records, tracks, follows the activities of learners and handles learning and training process automatically [3]. LMS Standards provide learner with simple and modern user interface. LMS uses Aviation Industry CBT (computer-based training) Committee AICC and Sharable Content Object Reference Model SCORM standards for tracking the e-learning courses. The standards depend on the development of the courseware where LMS contains different components or modules [4] [5].

International Computer Driving License ICDL is a mandatory course for all education levels before university and also is basic requirement for applying to jobs. From this context, it is perfect material to be used as application course for this work. In this paper, researchers develop an adaptive learning model that applied on sample of 142 trainees divided into two groups, group A which applied the proposed system and includes 107 trainees while group B includes 35 trainees and study with the ordinary system. Learning style for both groups are determined using same methodology.

The problem statement is that as the ICDL certificate is considered a fundamental program for college graduation and essential to apply to jobs and also because of cold start

even reaching to the appropriate learning strategy. This process is highly cost in money and time to government and learners. The research works on tailoring learning strategy so that it will maximize learner performance and minimize cost and time to achieve the certificate.

This paper is organized as following: Section 2, about related work. Section 3, explains the proposed adaptive E-learning model. Section 4 for experiment details applying the adaptive model on ICDL certificate. Section 5 is for results and analysis. At last, conclusion at section 6.

2. RELATED WORK

The related work for this paper browses the adaptation of E-learning based on different techniques in adaptive e-learning systems. One worked on learner model by representing, storing and maintaining learner preferences, knowledge and learning style. The other one focuses on adaptive model that represents the necessary information about user model, the content domain model and the adaptation model [6].

-Kafadar. et,al [7] used Felder-Silverman and tailored ICT subject on the Faculty of Informatics and Management (FIM), University of Hardec Kralove, Czech Republic. The methodology compares learner's performance before and after using their learning style. The experiment applied on 3 versions of online course reflecting (1) individual student's style, (2) teacher's style of instructions and (3) providing students all types of materials that can choose the appropriate ones. The results did not prove statistically significant differences in learner background.

- Herman and Surjono, [8] proposed an adaptive E-Learning system based on student's learning styles. The system is designed to help teachers in selecting appropriate learning object based on student's learning styles. The adaptation role is based on two learning style models: VAK and Felder. The system combined these two learning styles to modify course presentation to each student and maximize the advantages of traditional e-learning.

- Outmane et al, [9] proposed a personalized E-Learning based on recommender system. This work proposed a design of personalized E-learning system based on model of Felder and Solomon and the collaborative filtering techniques using learner profile. The system selected the most appropriate learning objects based on adaptation process.

3. ADAPTIVE E-LEARNING MODEL

The aim of E-Learning system is to offer the most appropriate learning materials to specific learner by taking into consideration his/her learning style. However, the main components for recent E-learning systems developed are three main models which are learner model, content model, and adaptive model [5].

The paper browses the proposed adaptive system as follows: *Learner Model* refers to the data about learner which stores, updates and reflects their current beliefs and also added information about knowledge; preferences; cognitive style; abilities and, learner responses.

Content Model refers to the way the specific content or learning object, is structured, with fully detailed LO and identifying learning tasks. Sequencing of content is pre-determined so as it can be changed to maximize learner performance   [3].
Adaptive Model refers to gathering the information from the learner model and content model to; ideally, extract the learning object or material that will be most likely to advance the learner's performance.

3.1 A Proposed Adoptive Model

The proposed adaptive learning system based on learning style contains the three main components mentioned above, shown in figure (1). Learner repository represents learner model and domain learner model. The learner model contains all data about learner that collected from questionnaire. Also the domain model contains metadata about learner data such as: title, language, description, format, size, resource type, copyrights, and others. 2. Content repository represents the content model and the domain content model. Content model includes content materials called learning objects LO in different format. Domain content includes metadata about content using SCORM standard. Figure (1) illustrates the classification process to identify the learning style for each learner using data mining tool. Through adaptation rules the system can extracting specific learning style and matching it with suitable LO. Lastly, system delivered a recommended content pattern to each learning style and received feedback results to modify the learner model.

The Conceptual Model in figure (2) explores the learner model that is designed based on ILS standard and dynamic attributes. Also content model, according to specific rules system, uses classifier tool to identify learning style for each learner so that system assigns appropriate content and maintain system understanding with learner profile [10][11]. Content model is the main partner in adaptive system which has metadata about learning object. Metadata is the data about data for learning object addressed the needs for each learning object. Content model repository stores LO in multi ways using SCORM
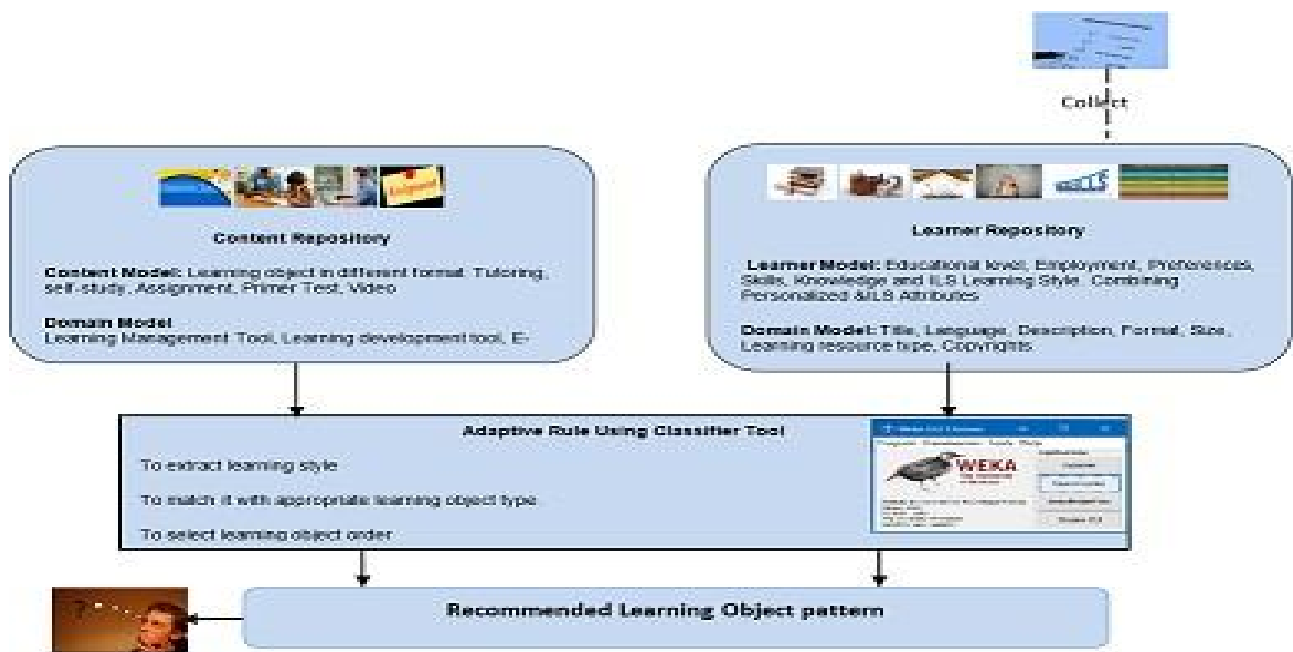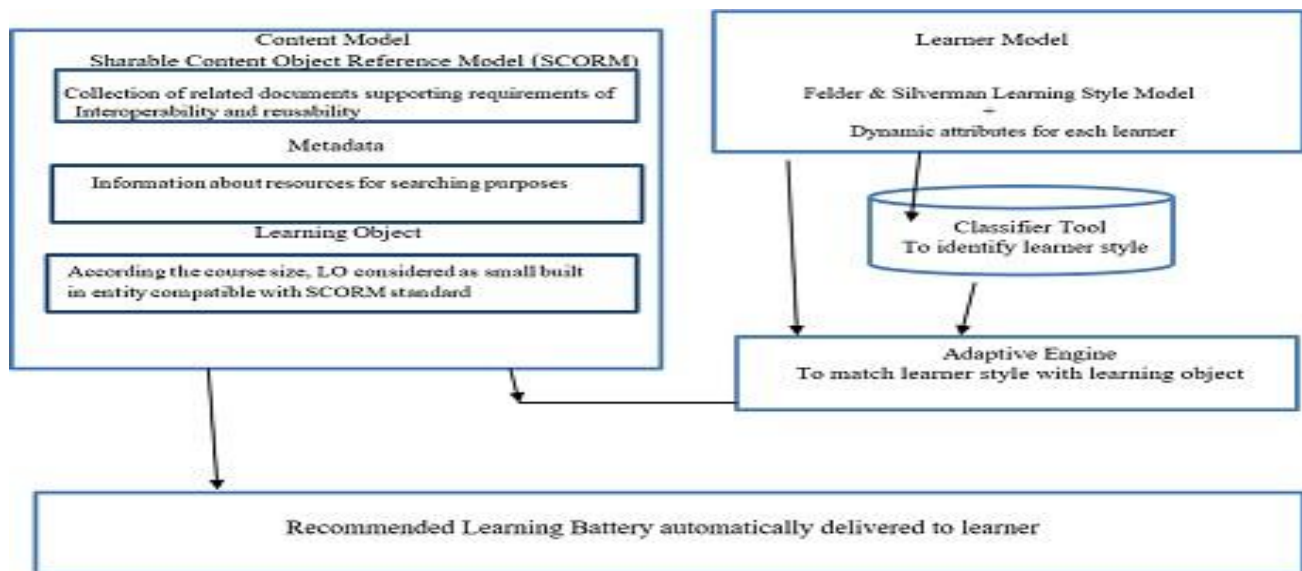
Figure (1): Adaptive Learning Model

Figure 2: Conceptual Adaptive Learning Model

E- learning standard so that meets different learning styles. Lastly, the process implemented automatically to deliver learner a recommended suitable content and achieve high efficiency by maximize performance in real exam and achieve certificate with no retake exams.

3.2 Learner Model

A learner model is a key component of any adaptive e-learning system as it maintains information about learners in order to provide them adaptation according to their current learning needs. The proposed learner model stores all learner-related data, i.e. the learner's profile, including personal information, preferences and knowledge. It enables the system to deliver customized attributes, on the basis of the individual learner's, or the learner groups, learning style. According to conducted questionnaire the personality of the learner is recognized and calculated then stored the preferences in learner model. It considers the four dimensions for FSLS as shown in figure (3) [12][13].

3.3 Content Model

Personalization is a contemporary key requirement of the E- learning systems to adapt the content or services to the learner profile. The personalization includes how to find and filter the learning information and fit preferences and needs [13]

The Content Model (CM) figure (4) represents the graphical "road map" of content in support learner along with their associated relationships. A certain content will be selected where learning style is identified. This model performs the following tasks [11][5]:

i.   It acts as a repository contains all the learning objects, learning content development and management tools.

ii.   Using SCORM learning standards to make this system compatible, shareable and interoperable with other e- learning systems.

4. ADAPTIVE E-LEANING FOR ICDL COURSE

ICDL *[www.icdlarabia.com]* [14] is a fundamental course to certify student, educator, citizen, government, employer, job seeker to friendly use the office programs, improving the speed and efficiency of work, getting an international certificate to prove qualifications. It aims to prove the computer skills and is designed for beginning computer professionality. ICDL has two main values empower and format the uniqueness of this course. These values are:

- Social Responsibility: ICDL program is designed to improve digital skills proficiency and to be accessible for all citizens, irrespective of age, gender, status, ability or educational level.

- Quality: ICDL program is implemented to consistent standards internationally so that it is the key factor behind the success of the ICDL program.

4.1 ICDL Learning Objects

A lot of LOs may be used to represent the required methodology in the e-learning environment of certain style and also enables to assemble a new course who is divided into parts like ICDL course. The system approved 5 types of LOs varying between instructing materials as a real method to transfer knowledge, exercises and E-books. Tutorial as a basic LO depends on interaction and discussion between instructorand learning in class. Another LO is the electronic virtual media which is called video materials. It refers to display, playback, and record the material. It is self-paced learning method where learner can use it independently and out of the class. The exercise LO is based on visual answered questions. It is also self-paced learning and may be conducted in-class to discuss with instructor upon learner needs. The proposed adaptive system depends on one of the most effective LO which is the primer tests issued by ICDL Arabia's organization test system. This LO is real time test that familiarizes the candidate or learner with test exam system. It helps learner to aware with real exam environment by the same exam time, similar questions type and gives a result at the end of the exam. Another and last learning object used by this research is the virtual method which is E-book. E-book is based on self-study and explains materials with examples. It is the material offered by ICDL Arabia Foundation.

4.2 Adaptive Learning Strategy

A wide range of teaching methodologies that match learner's style and some other attributes is suggested in the literature to precisely decide suitable learning strategy. The learning strategy adopted in this research is mainly based on learner's style that is determined by FSLS and identified by WAKA package [18]. Another important factors contribute in deciding the LO type that is used with certain learner style, are the assessment and English level. Assessment conducted before learner starts studying the certificate material and is important to determine the student's background and how is learner professionality in computer skills. Two main attributes that construct the adaptive E-learning strategy applied for ICDL program. They are learning strategy type and learning strategy order. The following subsections details these two attributes.

4.2.1 ICDL Learning Strategy Type

By learning strategy type, we mean the LO that matches the learner's need. The research considers some issues that
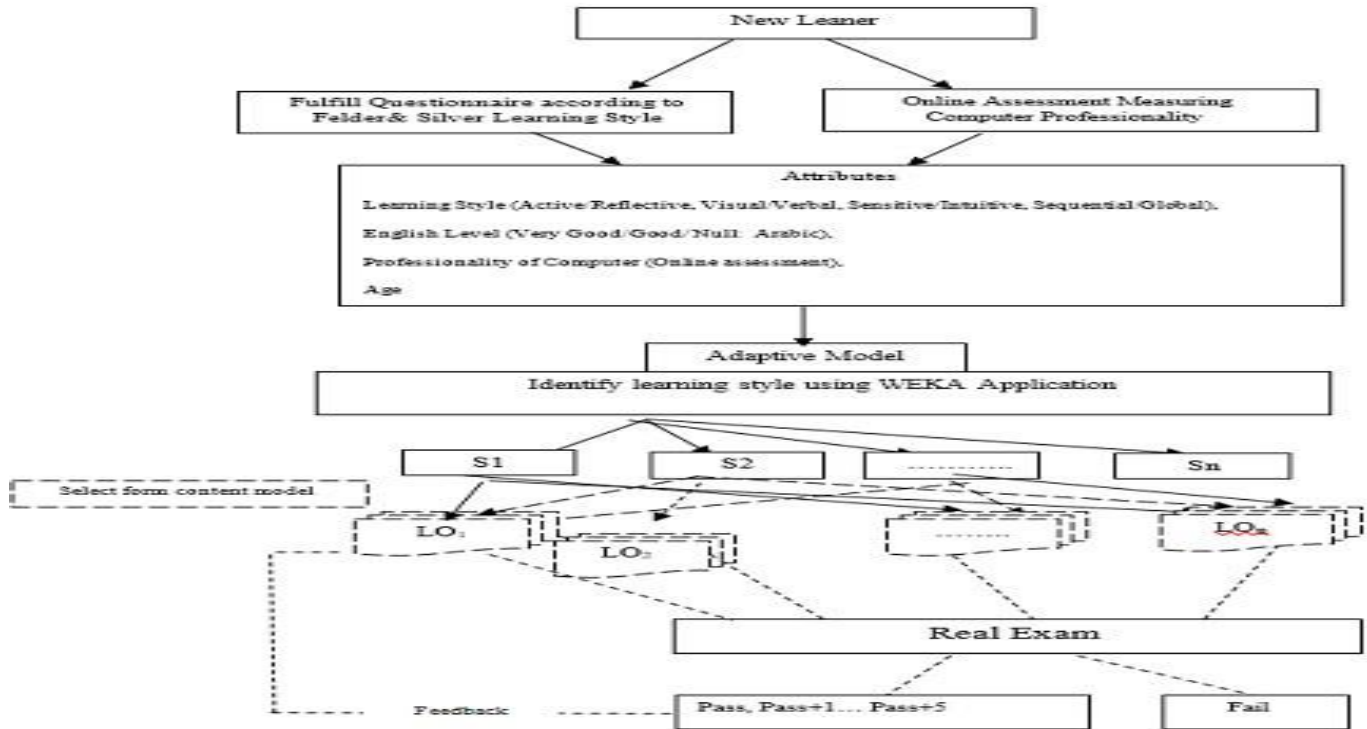
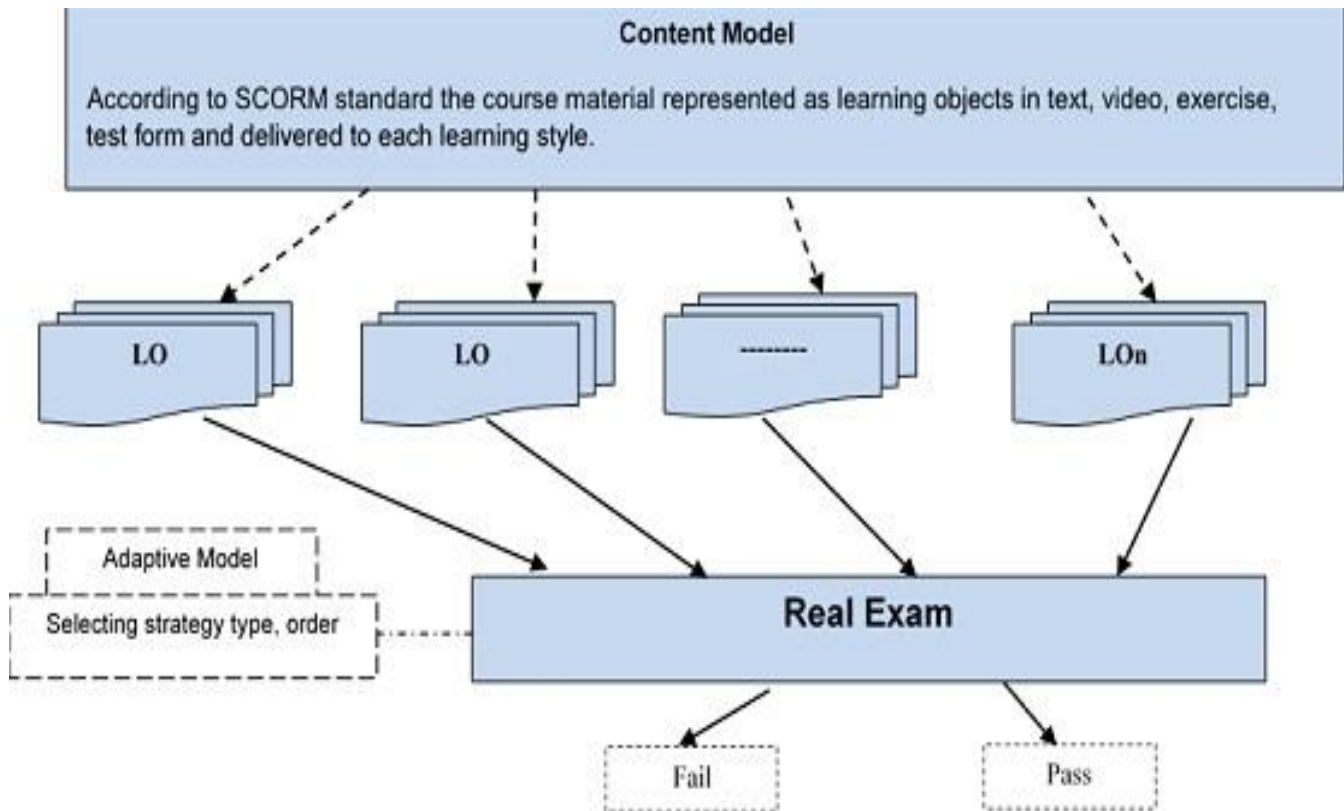**Figure 3:** Learner Model Relationships

Figure 4: Content Model Flowchart

support selecting an appropriate LO for each learning style as shows in table 1:

- The approved proposed system strategies are: Tutorial, E- Book, Video, Primer Test, and Exercise.
- Each learning style has only two dimensions which have highest score out of the four dimensions of FSLS
- Learning style is the attribute that determines the strategy type.

Active/verbal style is characterized by interacting and discussing. So the suitable LO type for this style is tutorial. Also Verbal/sequential style prefers to discuss material step by step. So tutorial LO is also suitable for this style. The active/sensitive style depends on itself for understanding. This style does try, repeat and navigate. So exercise LO is the most suitable for this style. The same is Sensitive / Visual style which tends to practice and solve problems. While it is noticed that Active/Visual style depends on understanding by watching answered and explained exercises and Visual/Sequential style also tends to understand in liner steps and follow logical steps. Video LO is suitable for both these styles. Reflective/Intuitive learning style is characterized by getting information by thinking and working alone on getting new concepts and methods to solve problems. Primer test is preferable to this style because it focuses on solving problems in the same real exam environment. Active/Sequential style tends to study by activities and examples in step by step details so E-book LO is most suitable for this style.

Table 1: Learning Strategy Type

Learning Style	LO Type
Active Verbal	Tutorial
Active Sensitive	Exercise
Active Visual	Video
Reflective Intuitive	Primer Test
Verbal Sequential	Tutorial
Sensitive Visual	Exercise
Visual Sequential	Video
Active Sequential	E-Book

4.2.2 ICDL Learning Strategy Order

The strategy order is the sequence of the seven ICDL modules required to get the certificate. It depends on online assessment status (pass, fail) and English level (Very good, good, Null) of each learning style.

- Assessment is conducted by ICDL Arabia foundation which is used as feedback about learner computer knowledge.
- English Level is determined by pre- test level
- If English level is Null, it means studying or examining or both in Arabic language.

Table (2) browses the learning module order which depending on online assessment deployed by ICDL Arabia website and English level determined. From the table:

S1: 1,2,3,4,5,6,7 is specified to learner who passed in online assessment and very good English level which it means good background in computer and excellency in English language.

S2: 2,7,1,3,4,5,6 is assigned to passed assessment and good learner because of his/her good computer background and moderate English level so the strategy order starts with module based on practical wise and delays the theoretical part to be third module.

S3: 2,3,4,5,6,7,1 which is studied and/or examined in Arabic language and online assessment results is passed. This strategy based on good computer background but not good in English. S4: 1,2,7,3,4,5,6 is the order which focuses on modules of high English level and delays the modules require good computer background.

S5: 2,3,4,5,6,7,1 order strategy assigned to learner with no computer background and good English level where the theoretical modules are delayed to the end of pattern and strategy starts with the practical modules in sequential order.

S6: 2,3,6,4,5,7,1 the system is assigned the closest modules in content like 3, 6 to be easier for learner who has not computer background. Also, it delays the theoretical modules to the end of strategy order which matches his need to study in Arabic language.

Table 2: Learning Strategy Order

Online Exam	English Level	Learning Modules Order
Pass	Very good	S1: 1,2,3,4,5,6,7
	Good	S2: 2,7,1,3,4,5,6
	Null (Arabic)	S3: 2,3,4,5,6,7,1
Fail	Very good	S4: 1,2,7,3,4,5,6
	Good	S5: 2,3,4,5,6,7,1
	Null (Arabic)	S6: 2,3,6,4,5,7,1

5. RESULTS AND ANALYSIS

It is important before proceeding with evaluating the proposed e-learning adaptive model to figure out the nature of the sample trainee used in both A&B sample groups. Group A which the adaptive E-learning model is applied is 75% of the total sample and Group B is represented by 25% of the total sample. It is also important to show the participation percentage of each style in both groups A&B shown by figure 5. As shown in the figure Active Visual learning style is the highest percentage with 26% in group A and 17% in group B, while Sensitive Visual is the lowest in group A with only 4%.

In this section, the research compares the percentage results of passing the ICDL certificate in the two groups A&B. First, learners who have passed after seven real exams, without any fail, shown by figure (6). Then learners passed the certificate exam with only one retake exam as shown in figure (7), and so on. From figure (7), group A where proposed adaptive model is applied has

36% of the sample passed while only 3 % from group B passed. The distribution of passed learners based on their learning styles are: Active Visual learning style is the highest percentage in group A with 12%, while Visual Sequential is the lowest and equal to visual sequential with only 3%. The learning styles: Visual Intuitive, Active Sequential and Verbal Sequential are not represented in this case. Also there is only one learning style is represented in group B in this case which is Sensitive Visual and the other learning styles do not show up.
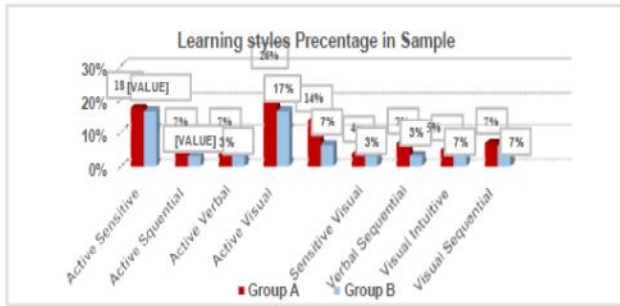
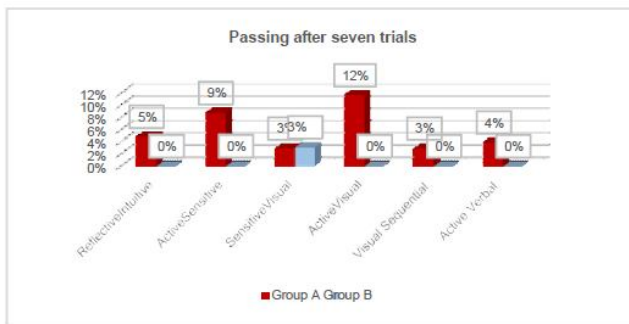**Figure 5:** Representing Learning Styles in Sample

Figure 6: Results for Passing after Seven Exams

Figure (7) displays learners passing after one retake exam for any of ICDL module. As shown in the figure, 9% from group A passed after this one exam and 3% from group B. It is worth note that the learners passed after one retake exam are nearly equal distribution with only four styles, while all who passed after one retake exam in group B are from one style.
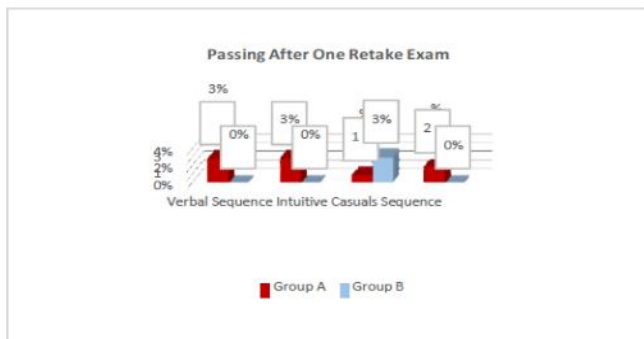

Figure 7: Results of Passing after One Retake Exam

Figure (8) explores the percentage of learners who are passing after two retake exams. It is cleared that there is no high results in this case. Group B is higher in Active Visual style but group A is the higher in Active sequential style. Sensitive Visual and Visual Intuitive learning styles are not represented in this case.
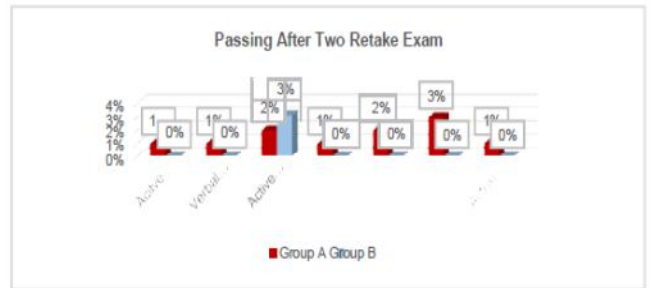

Figure 8: Results of Passing after Two Retake Exams

Figure (9) explores the learners who passed after three retake exams. It displays that the most types of learning styles is represented in this case except Sensitive Visual. Active Visual learning style is the highest percentage and Active Sequential is the lowest one in group A while Active Verbal learning style
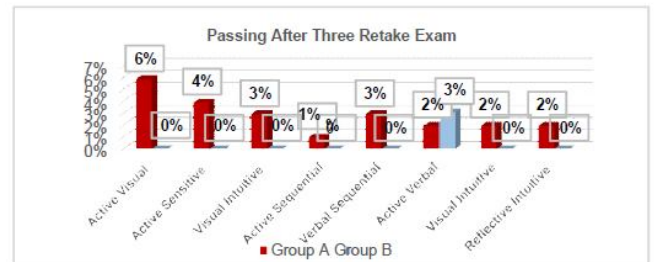

Figure 9: Results of Passing after Three Retake Exams

Learners passed after four retake exams shown in figure (10). It is noticed that all learning styles are represented except Active Verbal style and group B is higher than group A in Active Visual learning style. The highest percentage in group A is Active sensitive which is 4%. In addition all other styles are not represented in this case.
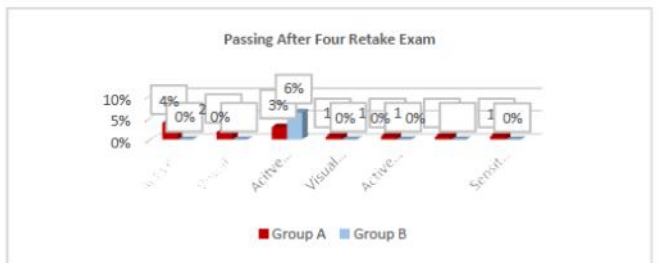

Figure 10: Results of Passing after Four Retake Exams

6. CONCLUSIONS AND FUTURE WORK

This paper is adopted adaptive E-learning system that tuning learning strategy based on learner's learning style, English level and assessment for computer background in ICDL program. The proposed system achieved high performance with 36% of the sample for group A where the recommended strategy are applied. Group B who studied traditionally achieved only 3%. The results approved that adaptive system succeeded to achieve ICDL certificate without any fail with 33% compared with group B. Future work for this study involves developing the adaptive system to open learning environments where learners can study according to their learning styles and retuning the strategy type and order to improve percentage of achieving ICDL certificate with less retake exams.

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