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A Proposed Framework for Learning Style Prediction in Higher Education Environments

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Abstract— In this paper, we survey the previous learning style prediction models and discuss their advantages and drawbacks. A review of seven different models has been accomplished. Moreover, a comparison between the models on the basis of some factors has been presented. Finally, a proposed framework for learning style prediction has been presented and briefly described.

Keywords— E-learning, learning style, data mining,Educational Data mining, Index of learning style.

I. INTRODUCTION

Every learner own different preferences, needs, habits and interests. It is important to know the students skills and preferences in order to personalize the teaching methods to meet each student's learning profile. So we can improve the quality of education by using the learning style[1]. A lot of educational theories presented that the integration of learning styles into learning activities may improve the learning process. Thus, this integration could enhance the learner performance by providing the learner with the personalized learning environment which is suitable to his/her possible needs [2]. Students who acquire effective study skills and full understanding of their personal learning styles may improve their academic success [8].Learning styles can be measured using surveys and questionnaires, but these methods suffer from many drawbacks such as difficulties in monitoring students' preferences over the whole learning process, stability as the learning styles, according to several theories, can be changed over time. So these drawbacks motivated several researchers to integrate the learning style into e-learning system [3].Learning materials have to be related to the learning styles as students will slanted to a learning material based on their learning styles [4].So teachers must design appropriate learning contents according to every one's learning style.A Learning Object is a tool for learning [11]whereas teaching strategy is the tool that given to the students by the teachers to simplify a deeper understanding of the information [12].Finally, leaning style is an individual's natural, habitual and preferred ways of learning and retaining new information.Many information and prediction techniques are needed to determine the accurate learning style for students. There are several models of learning styles have been presented by researchers such as Honey & Mumford, Grasha-Reichermann, Felder & Silverman, Myers-Briggs, Kolbs and many more which have been allowed for the determination of students' learning styles. Data mining techniques such as classification, prediction, association can be used to extract student's knowledge. Many researchers displayed that various algorithms in data mining such as k-means, SVM, Apriori, PageRank including Naïve Bayes and Classification techniques have been combined into learning style prediction [5].Data mining used in different domains such as Marketing, Banking, Insurance, Telecommunication, Health and Medicine, Industry, Internet, Science and Engineering andlately, in the field of education known as Educational Data Mining (EDM) [9]. Data mining technique can be considered as a good vehicle for providing adaptive learning that is related to novelty [10]. This paper is organized as follows:section ii introduces related studies in learning styles prediction, section iii presents a proposed hybrid model for learning style prediction, section ivshowsa comparison of previous learning style techniques, section v presents the conclusions and identifiessome future research areas.

II. BACKGROUND AND RELATED WORK

There are many approaches of learning style instruments in the literature, following the idea that students learn in diverse ways and prefer different teaching approaches. The researchers report enhancement in learning and performance when students are offered leaning approaches adjusted as to make them comfortable and capable of learning.

Tee, T. K. et al., (2015) used questionnaire based on Index of Learning style developed by Felder & Silverman to explore the learning styles of second year students in the Business Management and Hospitality programs at one of the Vocational College in Northern Zone, Malaysia. The respondents consisted of 30 students from each program, a total of 60 students. The Results proved that the learning styles are visual (90%) style for input dimension, active (71.7%) style for procession dimension, sequential (71.7%) style for comprehension dimension and sensing (55%) style for perception dimension [6].

Dagmar El-Hmoudova (2015) used Felder-Silverman learning styles inventory to monitor and check students' proficiency of key language competences. The participants in this study were 132 first-year university students enrolled at Faculty of Informatics and Management, University of Hradec Kralove. Based on the results, the visual and verbal materials are admired by the students more than any others [7].

Noor AzidaSahabudin and Mohamad Bilal Ali (2013) used LSI (Learning Style Inventory) developed by David Kolb to Identify the student's learning styles and Determine the format of learning materials based on Kolb's learning style model. A total of 39 students were involved in this study as respondents. The findings shows that majority of students have grouped from accommodator learning style (43.59%) and the formats of learning materials have been divided into four types: text, graphics, video and XML [4].

L.M. Al-Saud et al., (2013) used (VARK) questionnaire to determine the students' preferred mode of learning at King Saud University in Riyadh, Saudi Arabia. A total of 113 first-year dental students were participated in this study. The results presented that More than half (59 percent) of the first-year Saudi dental students who participated in this study were found to have multimodal learning preferences. The most common single learning preference was Aural (A) followed by Kinesthetic (K) [15].

Juan Yang et al., (2014) used pattern recognition technique to predict the learning style. The prediction model is required to complete two components: the index of learning style (ILS) questionnaire and the PIJ benchmark. The results generated from these users are employed as labeled samples to implement the supervised training procedure. The learning information that has been obtained from these users is mapped onto their learning style preferences using mutual similarity pattern recognition. The participants were 50 sample students who were majoring in computer science. The results presented that the learning styles of new learners with the dimension "active/reflective" can be predicted. This technique achieved high prediction accuracy compared with other methods can be considered as advantage for this study [2].

W. Paireekreng and T. Prexawanprasut (2015) proposed the ensemble technique using vote algorithm as a learning style prediction model. The data was collected from the questionnaire and student's profile. Then the model has been built using the classification technique as Decision Tree, Naïve Bayes, Neural Networks and Support Vector Machine. The participants in the study were 400.The results proved that the proposed technique can perform better an accurate rate compared to other classification techniques [5].

A .K. Hamada et al., (2011) used a social book marking website to identify learning styles based on the Felder-Silverman learning style model. The proposed tool used the learners' behavior while they are browsing / exploring their favorite web pages in order to gather hints about their learning styles. Then the learning styles were calculated based on the gathered indications from the learners' database. The participants of this study were 25 students. There was no need for learners to fill out a questionnaire to get their learning style. The detection/calculation could be done automatically. The author in their studycompared the results of the proposed automatic tool with the results of the ILS questionnaire. The results showed that the tool issuitable for identifying learning styles with respect to the FSLSM [14].

III. LEARNING STYLE PREDICTION MODELS COMPARISON

In this paper we presented some of learning style models as index of leaning style, learning style inventory, VARK model. Also we compared data mining techniques as classification and clustering technique. Under theclassification techniques of data mining various algorithms named: Decision Tree, Naïve Bayes, Neural Networks and Support Vector Machine. Here we have compared the previous models and techniques based on its technology, advantages, disadvantages as shown in Table 1.

Table. 1 Comparison Survey

Algorithms	***Parameters/ Technology***	***Advantages***	***Disadvantages***
Index of learning style [6],[14]	- consist of 44 questions.	- It is user friendly. - The results are easy to interpret. - The number of dimensions can be controlled and implemented. -it is a widespread instrument.	- The questionnaire could not be credible. - Stable environment. - Small amount of data.
Learning style inventory [2]	-	- It has been used within a fully limited range of cultures. - The experiential learning model does not apply to all situations. - provides only limited number of factors that influence learning. - lack of its objectivity, reliability and validity	- can be employed as a guide for understanding learning difficulties, occupational counselling, academic advising - provides an perfect framework for planning teaching and learning activities
VARK Model [4]	-consisting of 13 questions	- It is easy to use. - can be used as validation tool. - encourage teachers to be more conscious and responsive in their teaching practices. -Encourages active participation among learners.	- Small amount of data. - Stable environment. - Other factors influencing learning, such as past educational experience, could be condoned in favor of simplistic labels.
Decision Tree [5]	-	- simple to use - easy to understand	- Instability - do not work well if you have smooth

Algorithms	*Parameters/ Technology*	*Advantages*	*Disadvantages*
		- require relatively little effort from users for data preparation. - easy to interpret and explain to executives	boundaries. - do not work best if you have a lot of un-correlated variables. - High variance. - It's accuracy depends a lot on the data presented.
Naïve Bayes [5]	-	- Fast to train (single scan) and Fast to classify. - Handles real and discrete data - Handles streaming data well - Not sensitive to irrelevant features	- Assumes independence of features. - should train a large training set to use NB well. - Low performance in large dataset.
Support Vector Machine [5]	-	- has good generalization performance - It has a regularization parameter. - It is an approximation to a bound on the test error rate. - Effective in high dimensional spaces.	- give poor performances if the number of features is much greater than the number of samples, - Do not directly provide probability estimates, these are calculated using an expensive five-fold cross-validation. - it has several key parameters
Artificial Neural Networks [5]	-	- require less formal statistical training. - The ability to implicitly detect complex nonlinear relationships between dependent and independent variables. - The ability to detect all possible interactions between predictor variables.	- Greater computational burden. - Proneness to over fitting. - The empirical nature of model development

IV. PROPOSED FRAMEWORK

Based on the previous studies,we proposed a framework for predicting the learning style for current and new learners based on hybrid technique. The architecture of the proposed framework is shown in Fig. 1

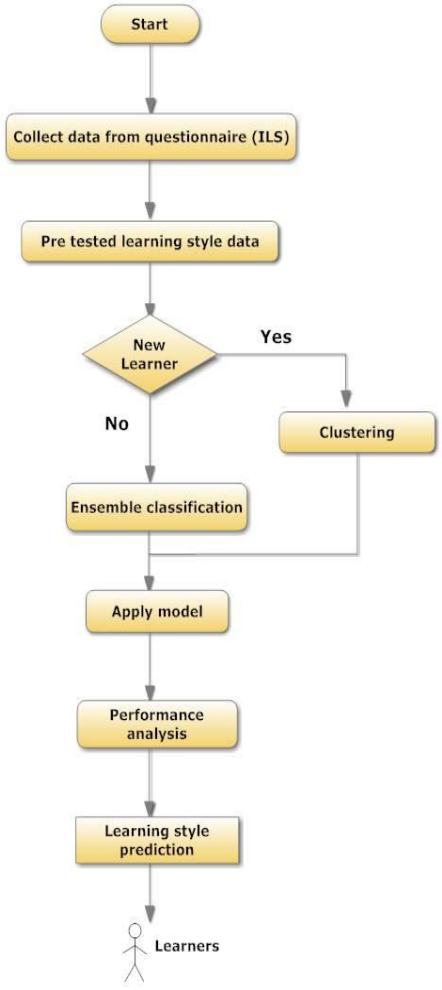

Fig 1. The proposed hybrid learning style prediction

Firstly sample learners are required to conduct a questionnaire. The Felder Silverman learning model can be used in the questionnaire. After that, the result is derived to determine the student's learning style. The model of Felder Silverman [8] is classified into four main groups. They are Active and Reflective, Sensing and Intuitive, Visual and Verbal, and Sequential and Global. Occasionally students are grouped as multiple types of learningstyle.

Thus, they can learn from a various pf sources of learning contents.

The data are preprocessed and combined for the next stage. The gathered data can be tested to determine the type of learner.If the gathered data related to potential learner, the classification technique can be applied directly. The ensemble classification techniques that can be applied in this research are Decision Tree, Naïve Bayes, Neural Networks and Support Vector Machine [5]. Then the ensemble classification model carries out a vote algorithm. So the performance of this stage can be analyzed. Finally, the output of the predicted model is derived. Concerning the new learners, mutual similarity patternsare implemented based on their information related to the same learning topic. After that a clustering algorithm classifies the new learners into three clusters: "positive", "Negative", "unknown".

V. CONCLUSION AND FUTURE WORK

In this paper, we investigated in learning style prediction models. We reviewed the issues of learning style mining and educational data mining. A survey and a comparison of previous learning style models have been accomplished. In addition to a comprehensive overview of the learning style prediction with various commonly models and with data mining techniques such as classification, clustering.

The ensemble technique (Decision Tree, Naïve Bayes, Neural Networks and Support Vector Machine) achieved more accurate rate compared to other classification techniques [5].While Index of learning style models proved their value for small data sets [6],[14].

Due to the importance of higher education enhancement, there is an urgent need to develop a learning style prediction model that could enhance the learning accomplishment process for a student. So this paper presents a learning style prediction framework based on hybrid technique that has the ability to detect the learning style for current and new learners with accurate prediction compared with other methods. For our future work we are planning to implement the proposed hybrid technique and evaluate the model using real data set.

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