

Framework for e-Learning Recommendation Based on Index of Learning Styles Model

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Abstract— Learning is an important activity for learners. Every learner must learn, but how to learn with the most effective outcome is still in question. A lot of theories about learning styles, for example, Kolb's Learning Styles, VARK Learning Styles and Index of Learning Styles (ILS) were created. This paper has adapted ILS with e-Learning method because e-Learning is an efficient technology that particularly focuses on learners who wish to study anywhere and anytime. A framework of e-Learning recommendation by analyzing Index of Learning Styles Model with data mining was developed. It can reasonably forecast the best learning style for learner by Decision Tree J48 algorithm with an accuracy of 76.92% (49 rules base). According to the experts' evaluation, the framework received the average 3.87 of satisfaction level.

Keywords— *e-Learning, recommendation, ILS, Index of Learning Styles, Learning Styles.*

I. INTRODUCTION

Learning is knowledge, behavior or skill that learners may not have known or have improved from existing knowledge [1]. Everyone can learn anywhere and anytime, especially in a classroom where most learning can be incurred by a teacher giving lessons to learners. Learning in the classroom has many methods such as lecture, exercise, activities or discussion, but the main problem of learning in the classroom is either learners not interested in lessons or learners not understand the lessons. To solve problem, the teacher must know learning styles of learners and then design lessons according to their learning styles.

There are several theories of learning styles such as Kolb's learning styles [2] that divide learning styles by their experiences, VARK learning styles [3] that divide learning styles by sensory perception (eyes, ears, mouth and kinesthetic) or Index of Learning Styles (ILS) [4] that divide learning styles into four dimensions and two sides are Active-Reflective, Sensing-Intuitive, Visual-Verbal and Sequential-Global.

Using ILS to indicate learning styles, teachers can improve their teaching with learners [5, 6]. The research finding about learning styles of 589 nurse students at Chiang Mai University

[5] showed that the most learning styles in year 1-3 were sensing, visual and sequential, but in year 4 visual, sensing and sequential styles were more common. This information can help teachers to adapt techniques for teaching their students. In a similar study of 718 students at Suranaree University of Technology [6], the result is that the most learning style in these students is sensing. According to their gender, male students can learn by visual better than female, but female students can learn by sensing better than male. Moreover, based on major of study, Information Technology and Agricultural Information Technology can learn better by sensing, while Engineer can learn better by visual.

But only theories of learning styles cannot help all learners understand the lessons clearly because, in each classroom, there are many learners who have different learning styles. Teachers will use technology to help learners such as e-Learning [7] to learn by themselves. E-Learning is lessons that base on a website using text, image, and multimedia to design their content. A teacher may find out learning styles of learners and use them with e-Learning.

A study of learning styles from students of 10 branches was performed to find out that their attitudes can affect the design of e-Learning. These findings are very useful for teachers, especially, when using learning styles with multimedia technology like e-Learning [8]. ILS can divide students into 5 types [9]. Also this information can be used with strategies of ILS to develop e-Learning lessons. Another study used ILS data to divide learners into three groups (undergraduates, postgraduates and educators) and analyzed the differences of each person to customize e-Learning lessons [10].

However, this research will lead to data mining to predict learning style for each learner. Because e-Learning has the lesson same as in the classroom. If learners do not know their learning styles, they cannot understand clearly, too. It will be better if e-Learning can recommend learners which learning styles they have and show lesson that design by learning styles, it can help learners to interest and understand lesson clearly. In addition, the learner can get the lesson that

design follows by ILS to develop their learning and learner can learn any time they want.

This paper presents A Framework for e-Learning Recommendation Based on Index of Learning Styles Model by using recommendation system that use technique of data mining to analysis with using e-Learning that based on ILS to find learning styles and design lesson for learners. Because ILS has many learning styles and covers many learning styles. That's good for using in e-Learning [11].

II. RELATED WORK

A. Theory of Learning Styles

“Style” means individual characteristics or personal responding to environment so “Learning Styles” means characteristics or personal responding for learning, divided by many theories for example.

1) *Kolb's Experiential Learning Cycle Theory* by David A. Kolb [12]. The theory claim that people have learned from their experiences. He divides learning styles into 2 dimensions namely Perception and Data processing. In each dimension has 2 sides.

a) *Concrete Experience (CE)* is learning by real experience, use feeling to solve problem more than theory or reason.

b) *Reflective Observation (RO)* is understanding their experience for applying (how to solve problem).

c) *Abstract Conceptualization (AC)* is using theory or reason to understand and solve the problem.

d) *Active Experiment (AE)* is concluding everything then do the action.

Learner can check themselves which learning styles that they have or they can use instrument of David A. Kolb. This instrument has 2 scales - Scaling by making experience and Scaling of kinesthetic skill, with nine questions.

Kolb's Theory focuses on experience only. However, sometimes learning does not always come by experience. Moreover, learners do not hand on practical but still learn other source.

2) *VARK Learning Styles Theory* by Fleming, N.D. and Mills, C. [13,14]. The VARK proposes 4 learning styles.

a) *Visual (V)*: the learner can learn better by viewing picture, diagram, graphs, and story telling.

b) *Auditory (A)*: the learner can learn better by listening or group discussion.

c) *Read/Write (R)*: the learner can learn better by reading or writing.

d) *Kinaesthetic (K)*: the learner who learn better by experience or simulation.

VARK Learning Styles Theory has questionnaire to validate learning styles of learner. The questionnaire come with 16 questions [15], in each question has 4 choices (according to 4 types of VARK's learning styles). The result will be calculate of the most answer frequency that learner

chooses. So, VARK Learning Styles focus learning styles on practical more than thinking. But if learners is good at both styles (practical and thinking), he/she can learn more effectively.

3) *Index of Learning Styles (ILS)* [4] by Felder and Soloman (Fig. 1). This theory starts from engineering learning styles case then develop to another subject of sciences. ILS has 4 dimensions and 2 sides.

a) Dimension of processing

- Active : Learner can learn better by action tends to enjoy group discussion.
- Reflective : Learner who can learn better by thinking like to keep up with themselves.

b) Dimension of recognition

- Sensing : Learner who learn better by real experience, can understand better with some example from real experience.
- Intuitive : Learner who learn better by theory tends to enjoy analysis the problem.

c) Dimension of input data

- Visual : Learner who learn better by pictures, graphs, diagrams.
- Verbal : Learner who learn better by words, listening, writing.

d) Dimension of understanding

- Sequential : Learner who learning things better in sequence.
- Global : Learner who learning better from broad scale then in detail.

Index of Learning Styles covers both sides learning styles (physical and thinking). Also having questionnaire for learner. The questionnaire has 44 questions [17]; in each question has 2 answers (meaning from dimension side). The result will be show from score that incline in each side. If score is in the middle mean learner can learn both sides.

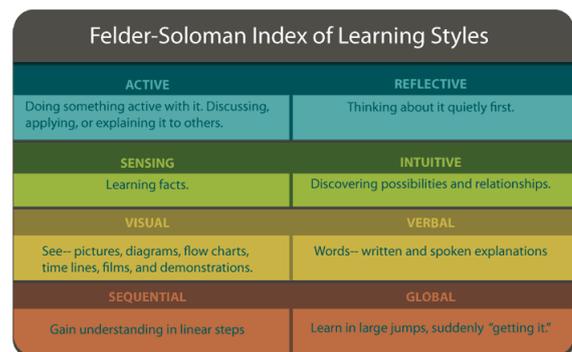


Fig. 1. Felder-Soloman Index of Learning Styles [16]

B. E-learning

The lessons that manage by using program computer for learners to learn by themselves without teacher or trainer. If they have internet they can learn from everywhere (not only in class room) [18]. This technology can help learner to learn easier and have more effective. So, e-Learning is used for many fields for example statistics, researching, education management.

Moreover e-Learning can help learner who doesn't understand and repeat by them self or learner who absent, too. And the contents are same as classroom.

C. Recommendation and Prediction

The concerned data is interested data or business data. In general having 4 steps [19]. First, Basic data for processing. Second, input data from user. Third, algorithms and Fourth, data recommendation – divided in 2 steps. First, prediction phase and second is recommendation phase, the prediction phase is about the data of user interest used or has seen before. Then it will compare with the data that have in database for analyzing and predicating what that person want or need. That is call recommendation phase.

Recommendation systems [20] usually used business, e-commerce, social-network and also in field of education for learners have more effective.

D. Data Mining

Data mining or Knowledge Discovery in Database (KDD) [21] means searching knowledge form global data. So, data mining is searching data that is useful from large database (choose only the data that be concerned). The Main methods that use in data mining have 2 methods. First, Descriptive data

mining is explaining in general format of data for designing. Second, Predictive data mining is predicting from old data then adapting with new data for predicting the future.

III. FRAMEWORK

Design framework for e-Learning Recommendation Based on Index of Learning Styles consists of the following six parts (Fig.2).

1) *Student Survey* is the learners in Thai-Nichi of Technology (Faculty of Information Technology from first year till last year) for 600 students.

2) *Student Survey* is the learners in Thai-Nichi of Technology (Faculty of Information Technology from first year till last year) for 600 students.

3) *Student* is learners in Thai-Nichi of Technology that have been enroll general science for 35 students, for testing system.

4) *Data Module* is the module that storage data of Student Survey by questionnaire. The questionnaire consists of three part as following: 1) general data of learner, 2) the factor that affect to the ILS Model for example your family or your study in the pass made you have learning styles of ILS or not?, and 3) the test of ILS Model by 44 questions. We designed all of questions to analysis rule base in Student Database.

5) *Rule based Module* collect rule base that analysis by WEKA. The procedure this framework as following: 1) learner register when they first log into the e-Learning to start, personalized e-Learning, 2) learner database analyze by rule base, 3) this framework will be provide learning styles and sent to LMS Module.

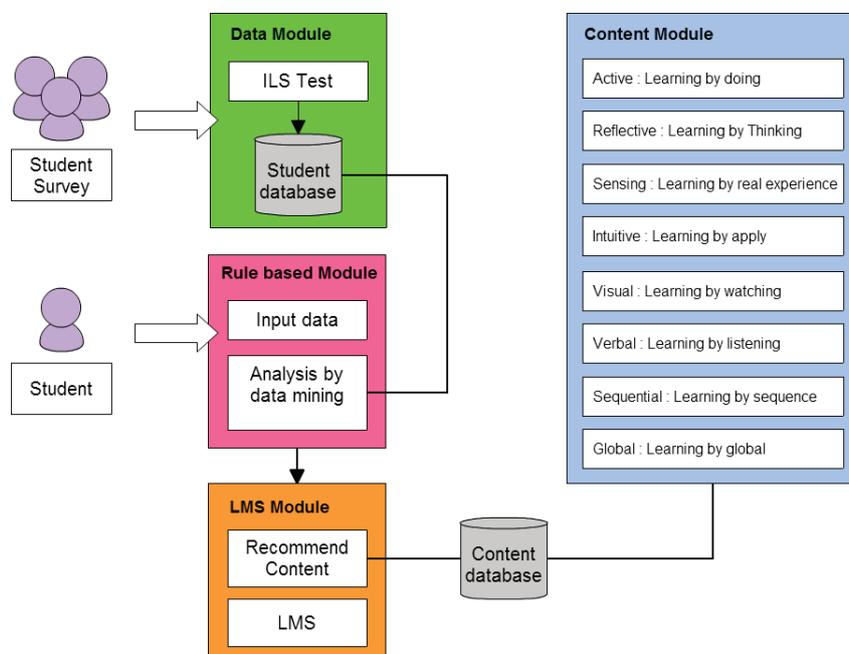


Fig. 2. The framework for e-Learning Recommendation Based on Index of Learning Styles Model

6) *LMS Module* is the module that provide learning style when learners got from Rule based Module. The procedure of LMS as following: 1) they take a pre-test, before the learning begins, 2) they learn lesson that provide learning style by ILS Model, 3) they take a post-test, then the system show score pre and post-tests and 4) they check out by themselves.

7) *Content Module* is the module that storage science's content. It was designed by ILS Model. This framework consists of eight lessons that related to four dimensions as shown in Table I.

IV. DESIGN OF RULE BASE

Rule base method is the procedure of choosing the best rule to forecast the allied data by correcting all information of users then analyze with algorithm and modify that rule for the proper purpose as following details.

TABLE I. COMPARE TECHNIQUE OF J48, LMT AND NAÏVE BAYES.

Learning Styles	Learning by	Dimensions
Active	Doing	Processing
Reflective	Thinking	
Sensing	Real experience	Recognition
Intuitive	Theory and apply	
Visual	Watching	Input data
Verbal	Listening or reading	
Sequential	Sequence	Understanding
Global	Overall, then in detail	

1) *Collecting all information* by gathering all the detail from Student Survey. Questionnaire will be included all the variants which effect to ILS style of learning such as gender, age, faculty, major, years, grade, education background, 6 necessary questions and the 44 questions of ILS testing.

2) *Cleaning data* by checking the details of each questionnaire. Which one doesn't contain all the needed information or miss understand the directions of questionnaire will be removed from database. Only the complete questionnaires will be analyzed and modified by WEKA program to find out the rule base.

3) *Find out the rule base* by using algorithm of J48 which is acceptable and easy to modify in general. According to this research, The accuracy is 76.92% as shown in Table II.

As the Table II, decision tree J48 is the most accuracy if compare with decision tree LMT (75.79%) and Naïve Bayes (74.66%) which the result come from model tree that start from root node till leaf node, but if cannot use immediately. We have to convert to the particular rule base before using and we get 49 rule bases after converted as shown in Table III.

TABLE II. COMPARE TECHNIQUE OF J48, LMT AND NAÏVE BAYES.

No.	Algorithm	Percentage (%) Accuracy
1	Decision Tree J48	76.92%
2	Decision Tree LMT	75.79%
3	Naïve Bayes	74.66%

TABLE III. EXAMPLE OF RULE BASE FROM J48.

No.	Rule Base	Learning Styles
1	if (a5<=4 and a5<=2 and a3<=4 and a2<=1)	Sequential
2	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4<=2)	Visual
3	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5<=1 and a4<=3 and a6<=2)	Global
4	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5<=1 and a4<=3 and a6>2 and study<=1)	Reflective
5	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5<=1 and a4<=3 and a6>2 and study>1)	Global
6	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5<=1 and a4>3 and grade<=2)	Global
7	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5<=1 and a4>3 and grade>2)	Intuitive
8	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5>1 and age<=2)	Sequential
9	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5>1 and age>2 and grade<=2)	Intuitive
10	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4<=4 and a4>2 and a5>1 and age>2 and grade>2)	Global
11	if (a5<=4 and a5<=2 and a3<=4 and a2>1 and a2<=4 and a4>4)	Visual

V. FRAMEWORK EVALUATION

Over questionnaires asked six questions, which related to appropriate for process framework of each module. Experts answered on a 5-point Likert scale [22] where five is the highest (strongly agree) and one is the lower (strongly disagree) as shown in Table IV.

After explanation to all experts and ask for their evaluations, Table V shows results of framework evaluation, the details are described as below:

- Mean of LMS Module ($\bar{x}=4.20$) is highest in framework design. Therefore, LMS Module is the best module.
- Mean of Data Module ($\bar{x}=3.60$) is lowest in framework design. Therefore, Data Module needs to be improved.
- Mean of Overall module ($\bar{x}=3.87$) shows the evidence that framework design was appropriately design for help learner.

TABLE IV. QUESTIONNAIRE ITEMS ON 5-POINT LIKERT SCALE

No.	Question
1	Appropriate of Data Module
2	Appropriate of Rule base Module
3	Appropriate of LMS Module
4	Appropriate of Content Module
5	Appropriate number of Student and Student Survey
6	Appropriate of Overall of Framework

TABLE V. THE EVALUATIONS APPROPRIATE FROM EXPERTS

No.	Detail	\bar{x}	S.D.
1	Data Module	3.60	1.26
2	Rule base Module	4.00	1.10
3	LMS Module	4.20	0.89
4	Content Module	3.80	1.55
5	Student and Student Survey	3.80	0.89
6	overall Model	3.80	1.55
Total		3.87	1.21

VI. CONCLUSION

We have described our approach to designing a framework for e-Learning Recommendation based on ILS Model with data mining. Our framework evaluation results indicate that this framework can help learner more effectively to learn the lesson by their learning styles. We employed WEKA algorithm with J48 to classify and predict learning styles for each learner by questionnaire of Student Survey. The result indicate that this algorithm usefulness in this framework.

In future work, we are a planning development Data Module, Acknowledgements and experiment to help learners. We thank the Thai-Nichi Institute of Technology, which

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