

LEARNING STYLE DETECTION BY USING LITERATURE-BASED APPROACH: A CONCEPTUAL DESIGN

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ABSTRACT : *Learning style refers to student's different methods in approaching learning and gaining knowledge. It is important for educators to understanding different learning styles among students, in order to provide students, different ways to learn and approach information. Therefore, the teacher could share the knowledge and experiences, and apply the best method to match the students' learning preferences. The best practice strategies in their daily activities, curriculum and assessments can also be implemented. One of the most common learning styles is that, students' learning styles through three preferences; visual learners, auditory learners and kinesthetic learners. These learning styles are known as VAK, that refers to the three types of learning styles: visual, auditory, and kinesthetic. VAK learning style determines students either they are under collaborative or automatic models. Automatic approach is considered as a better approach to identify learning style because it is based on the actual student's behaviour while learning pattern. Therefore, the main aim of this paper is to discover VAK learning style based on literature-based approach. The architecture of VAK is also proposed for detecting learning styles based on learner's behaviour using a simple rule-based technique.*

KEYWORDS: Automatic detection, Literature-based approach, Learning style, VAK

1.0 INTRODUCTION

Learning style is not something new in education. There has been a great interest in the field started in 1960s and now this area still remained significant in the development of educational technology [1, 2, 3]. Most practitioners and researchers in the field of education believe that knowing learning styles of individuals, plays an important role in the learning process by matching the materials and learning activities with learning styles can make learning easier and more effective [4, 5, 6, 7].

There are two different approaches for identifying learning styles; first, the collaborative student modelling (CSM) and second, the automatic student modelling (ASM) [3, 8, 9]. In CSM learner needs to fill out a questionnaire to identify their learning style [3, 8], while in the ASM, the system monitors the learners' actual behaviour patterns during their learning processes within the system. CSM is noticeably less accurate because not all of the students are motivated and not willing to fill out questionnaire [10]. While the process of automatic identifying learning styles is more accurate, dynamic and comprehensive due to the information technology that can deliver clear information during online learning.

The objective of this study is to identify the learning style model of Visual-Auditory-Kinesthetic (VAK) automatically using literature-based method. The rest of this paper is organized as follows - Section 2, Learning Style; Section 3, A Concept for Identifying Learning Styles; Section 4 VAK Learning style Architecture. Finally the paper concludes with the conclusion and future work at Section 5.

2.0 LEARNING STYLE

This study is based on widely accepted theory that each learner has an individual or specific learning style [11, 12,

13]. A learner with a specific learning style can face difficulties while learning, when their learning style is not supported by the teaching environment. Many authors proposed different definitions for learning style. Learning style can be defined as individual preferences of learning and differences in students' learning, and it is considered as one of the factors influencing learner's achievement [14, 15].

There are several theories refer to learning styles, such as Felder-Silverman learning style model (FSLSM), Honey and Mumford, and Kolb's Learning style model, and VAK learning style model. While other learning style models classify learners in few groups, the VAK learning style model categorizes the learning styles of learners based on three modalities (visual, auditory and kinesthetic), so that each learner has a preference for each of these three modalities.

VAK Learning Styles is a well-known model because of its applicability and compatibility to the principles of interactive learning systems design, straightforward, and its results are easily understood [16]. According to VAK learning style, learners who learn visually learn best by seeing and think in pictures. For these learners, pictures, flow diagrams and videos are the best learning material. Auditory learners learn best by hearing. These learners, audible lectures are the best learning material. Kinesthetic learners are those who learn best by feeling and doing. For example, the learning materials include component such as computer games, interactive animations and practical hands-on experiences [17, 18, 19]. Table 1 shows the features for visual, auditory and kinesthetic dimension to VAK learning style model [20].

Table 1: Features for visual, auditory and Kinesthetic dimension

Visual	Auditory	Kinesthetic
Organized	Talks to self	Responds to physical reward
Neat and orderly	Easily distracted once engaged	Touches people and stands close
Quieter	Moves lips/says words when reading	Physically oriented
Observant	Appearance oriented	Moves a lot
More deliberate	Math and writing more difficult	Larger physical reaction
Good speller	Spoken language easier	Early large muscle development
Less distracted by noise	Speaks in rhythmic pattern	Learns by doing
Has trouble remembering verbal	Likes music	Memorizes by walking through it
Mind wanders with too much verbal	Can mimic tone, timbre and pitch	Points when reading instruction
Rather read than be read to sequence	Memorizes by steps, procedure	Responds physically

Source: Grinder, M. 1999 - Behavioral Indicators of the Three Modalities

The next section describes matching learning material and activities suitable teaching learning style and learning style need to identified first. It will describe several approaches that can be used to identify learning style automatically.

3.0 A CONCEPT FOR IDENTIFYING LEARNING STYLES

The method to identify the learning styles automatically is based on the attributes used, such as the personality factors, behavioural factors and time. Many studies were done using data-driven method (DDM) and literature-based method (LBM) to identify learning styles in automatic student modeling (ASM) [3, 21, 22]. Data-driven method is focused in building a model that imitates the Inventory Learning Style (ILS) questionnaire and uses sample data to develop a model. The common techniques use for data-driven approach are decision trees, hidden

markov model, neural networks, fuzzy clustering and bayesian networks [3, 23].

On the other hand, literature-based is a method for identifying learning style based on behaviour [4]. This method uses simple rule-based to calculate learning style from the number of matching hints. Furthermore, the LBM is practically focusing more on the content of the objects such as quizzes, tests, assignments and forum which are known as features. Literature-based method uses the behaviour of students in order to identify their learning style preferences and then apply a simple rule-based method to calculate learning styles from the number of matching hints. A method using this approach was proposed by Graf et al. [4]. This study is based on VAK learning styles model. Generally, the idea of identifying learning style can be simplified as Figure 1.

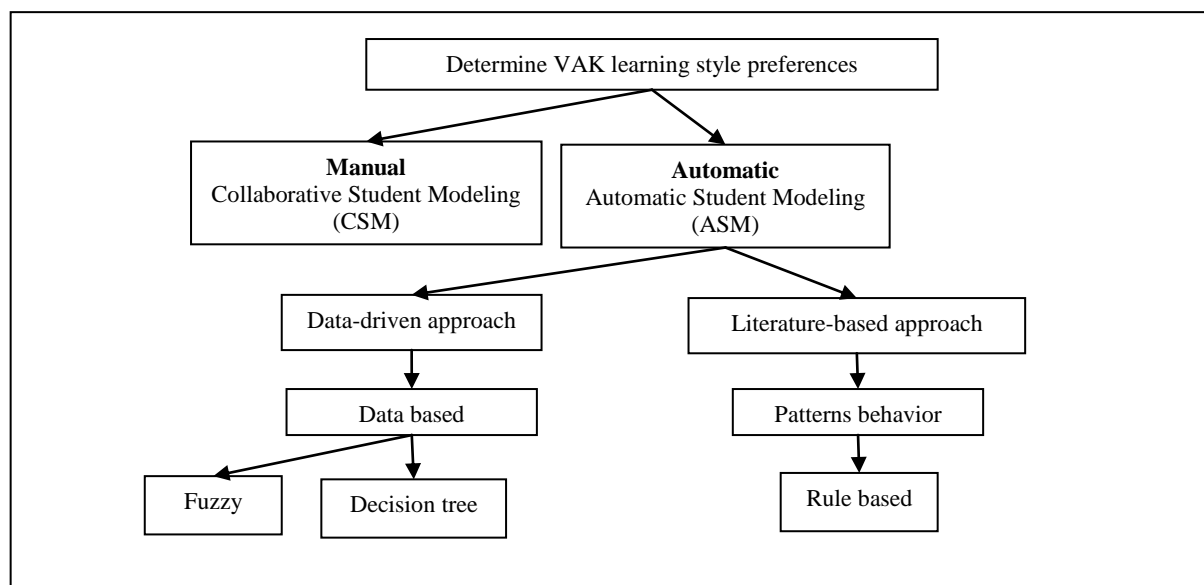


Figure 1: Idea of identifying learning style.

Table 2: Patterns of behavior for VAK learning style

No.	Patterns of Behaviour
P1.	Time spent learning/reading each activity i.e. contents
P2.	Time spent learning/reading contents containing graphics/diagram
P3.	Time spent solving exercises
P4.	Number of incorrect answers in each exercise related to graphics/diagrams.
P5.	Number of incorrect answers in each exercise
P6.	Number of incorrect answers in final miscellaneous exercise.
P7.	Number of changes to the exercise answer
P8.	Number of questions left unattended in each exercise per session.
P9.	Number of independent sessions of work with the system.
P10.	Number of solved exercises.
P11.	How many times the student has reviewed the topic/contents.
P12.	Attempted order to answer questions in exercise (sequential/ random).
P13.	Skipping pages/slide content sections.
P14.	Mouse clicking through the interface.
P15.	How often and how insistent the learner looks for help.
P16.	How often and how insistent the learner looks for hints

Source: Khan, Weippl et al. 2009 – Integrated approach for the detection of learning styles and affective states.

3.1 Patterns of Behaviour

Identifying learning styles is done by detecting patterns of behaviour that indicates a preference for specific modalities. The patterns of behaviour considered for detecting learning styles is listed in Table 1 [9]. The learning style is detected based on patterns of behaviour is represent the entire activity using the rule-based technique.

3.2 Rule-Based

Rule-based techniques have been applied by many previous researchers in many fields and domain such as education [24]. It was also applied in many artificial intelligence applications including decision support system [25], expert system, and computer aided system [26]. Thus, in this study we applied rule-based artificial intelligence technique for automatic detection of learning styles. Simple rule-based structure is based on syntax IF-THEN to represent associate in form of condition-action, IF condition THEN action [27].

The learning styles based on data-driven methods identified through questionnaires. While learning styles based on literature based methods use user's pattern behaviour. This method matches the overall activities of the users using the technique of simple rule-based. Following are example of learning style rule-based for VAK dimension.

Rule 1:

IF *click_image* THEN *Ls_Modality Visual*

Rule 2:

IF *click_sound* THEN *Ls_Modality Auditory*

Rule 3:

IF *click_> image* THEN *Ls_Modality Visual*

Rule 4:

IF *click_>sound* THEN *Ls_Modality Auditory*

Rule 5:

IF NOT *click_image* AND NOT *click_sound*
THEN *Ls_Modality Kinesthetic*

4.0 VAK LEARNING STYLE ARCHITECTURE

In this section we present architecture for detecting learning styles based on a learner's behaviour using simple rule-based technique. Building on the VAK learning styles model, this system aims to create an individualized learning environment that accommodates specific learning styles. The architecture is divided into two components inference engine and knowledge-based as shown in Figure 2. The detection activities begin with user's registration then simple exercises completed by users. The results of this exercise will determine the initial learner preferences either they are visual or auditory or kinaesthetic learners. Lastly, the result explanation and recommendations on a material content module are given based on learning style preferences.

5.0 CONCLUSION AND FUTURE WORK

In this study we propose VAK architecture to detect students' learning style. Based on real behaviour patterns of students during interacting with the system analysis, literature-based method is used to identify learning styles automatically. Literature-based method uses a simple rule-based technique to calculate learning style from the number of matching hints. It also refers to all of three modalities of VAK. For the future work, we will carry on with the development of a prototype to validate the proposed system and the efficiency of the method.

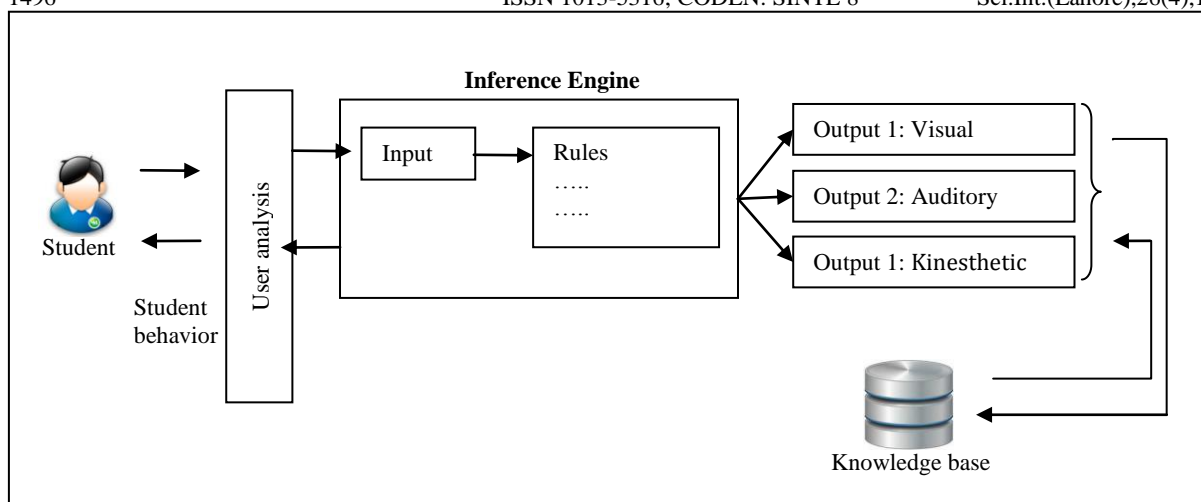


Figure 2: VAK Learning Style Architecture

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