



**المحور الأول: تطبيقات وممارسات التعلم المبتكر... أفكار وتجارب.**  
**Theme I: Innovative Learning Applications and Practices.**

**Adaptive e-Learning using Automatic Learning Styles**  
**The paper is submitted to the 4<sup>th</sup> International Conference of e-Learning and Distance Learning**

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## Adaptive e-Learning using Automatic Learning Styles

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**Abstract:** Integrating learning styles in adaptive e-Learning systems has been considered a growing trend in technology enhanced learning process. Also, when these technologies are obtainable, reasonable and available, they represent more than a transformation for people with disabilities. Providing adaptively based on learning styles can promote interest for learners and make learning easier for them. The purpose of this research is to adopt an e-Learning approach Radio Frequency Identification (RFID) technology in order to model the Visual-Auditory-Kinesthetic (VAK).

learning style focusing on Learning Disabilities (LD) children. Today's technology offers greater opportunities to assist students with disabilities to live freely and to learn easier. Developing learning environments assisted by technology is a new method in order to ensure that their learning processes are successful. VAK learning style can be determined by applying either the traditional or automatic approach. Automatic approach is preferred as it is considered a better approach to identify learning style as it is based on the actual student's behavior patterns while learning. 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 the number of visits and the time spent on learning object.

The purpose of our research is to adopt an e-Learning approach Radio Frequency Identification (RFID) technology in order to model the Visual-Auditory-Kinesthetic (VAK) learning style focused on Learning Disabilities (LD) children. Today's technology offers great chances to assist students with disabilities to live freely and learn easily. Developing the learning environments assisted by technology is a new way in making their learning processes successful. VAK learning style is determining either traditional approach or automatic approach. Automatic approach is preferred as a better approach to identify learning style because it is based on the actual student's behaviour pattern while learning. 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 the number of visit and the time spent on learning object.

**Keywords:** E-Learning, Learning styles, Learning Disabilities, Radio Frequency Identification Visual, Auditory and Kinesthetic (VAK) learning style.



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## Introduction

e-Learning has been applied to the field of education in these recent years. It is due to the fact of several importances of learning which are to ensure high-quality output hence aligning to the aspirations of the education system looking for efficiency and effectiveness. E-Learning provides opportunities to reduce the time and space constraint which are often present in traditional classroom settings. e-Learning is especially important in helping students who have learning disabilities which may stunt from studying anywhere, anyplace, and anytime. This group of children is a special minority group in the society. Therefore, setting down the needs of the students with learning disabilities is an important issue to be addressed and supported as it provides opportunities for them to live freely and learn easier (Akplotsyi & Mahdjoubi, 2011).

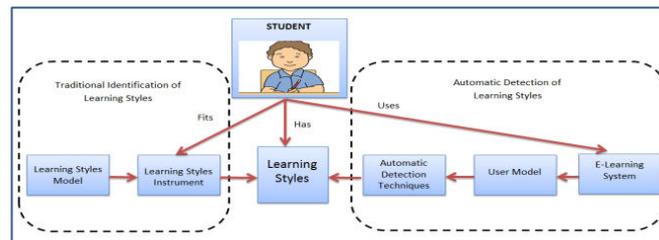
e-Learning is a term that is described by (Qutechate, Almarabeh, & Alfayez, 2013) as the use of technology's computer to deliver information to individuals. However, most of the e-Learning systems do not take individual differences that the learners have into consideration. These differences include the ability of the learners, background, goal, knowledge foundation and learning style (Surjono, 2014; Yarandi, Jahankhani, & Tawil, 2013). The same learning content is provided to different learners. To overcome this constraint and to increase the effectiveness of learning, learning pathways should be adapted to each of the student's requirements and needs (Qutechate, et al., 2013). There are some problems with e-Learning materials as they do not fulfil the conventional multi-sensory approaches to help Learning Disability children (Beacham & Alty, 2006). The element of touch, for example, is usually not available. A technique that has shown potential in creating the element of touch is by using Radio Frequency Identification (RFID) technology. In this study, we present an innovative and adaptive e-Learning integrated with Radio frequency Identification by analysing learning styles to fulfil the requirements of individual learning disabilities among students. Learning style identification is important as it helps to improve learning performance, increase motivation and enhance enjoyment.

Almost seventy-one (71) different learning style models have been stated (Özyurt, Özyurt, & Baki, 2013). Learning styles that are commonly stated in literature are Felder–Silverman, Kolb, Dunn and Dunn, Honey and Mumford and Visual, Auditory and Kinesthetic (VAK) learning style (Mahdjoubi & Akplotsyi, 2012; Özyurt, et al., 2013). The traditional way of identifying learning styles is using a questionnaire that students are required to fill, as shown in Figure.1. The problems with using questionnaires are that questions are fixed and the results are highly dependent on students' mood. Other problems with using questionnaire are uncertainty because of students' lack of motivation, lack of self-awareness about their learning preferences and the influence from others (Dung & Florea, 2012a; Feldman, Monteserin, & Amandi, 2014).

Several approaches for automatically detecting learning styles have been proposed to solve these problems (S. Graf, Kinshuk, & Tzu-Chien, 2008; Latham, Crockett, McLean, & Edmonds, 2012). Data-driven and literature-based are two approaches that automatically detect learning styles (Feldman, et al., 2014). The automatic detection of learning styles is important in educational systems and has benefits over traditional approaches (Phobun &

Vicheanpanya, 2010). There are a few benefits by utilizing the automatic learning style approach. The first benefit is that the approach do not require additional effort from students. The second approach is that the approach is free of uncertainty. The third benefit is that this approach uses real data to detect students' learning styles which ensure and enhance accuracy. Lastly, this approach can recognize and update the change of students' learning preferences which is very convenient. (Dung & Florea, 2012b).

**Figure 1. Traditional identification of learning styles and automatic detection of learning styles**



### e-Learning

e-Learning is an abbreviation for Electronic Learning. e-Learning can be defined as a transfer of learning resources through any electronic media which includes internet, intranet/extranet, satellite broadcast, audio/video tape, interactive TV, CD-ROM, and computer-based training (CBT) (Hanson, 2006 ; Savidis, Grammenos, & Stephanidis, 2007; Surjono, 2011). e-Learning includes the use of a number of technological tools that can be applied in numerous contexts (Savidis, et al., 2007). Content is delivered via the internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. It can be self-paced or instructor-led and includes media in the form of text, image, animation, streaming video and audio (Ghadirli & Rastgarpour, 2012).

A common theme that is explored in e-Learning literature is on how technology plays a vital role in changing the learning paradigm, which resulted in a faster and highly efficient process of acquiring knowledge. (Adam & Tatnall, 2008). But most of the e-Learning systems have ignored individual differences that exist in learners such as ability, background, goal, knowledge foundation and learning style (Surjono, 2014; Yarandi, et al., 2013). To overcome this constraint and to increase effectiveness of learning, learning pathways should be adapted to a student's requirements and needs (Qutechate, et al., 2013). Adaptive e-Learning will try to solve these difficulties by changing the material of learning in order to suit to each learner.

### Learning Styles

In a learning environment each learner will have different requirements and specific learning style (Dunn, Dunn, & Freeley, 1984; Felder & Silverman, 1988; Kolb, 1984; Surjono, 2014). Learning style is the way how learners remember, process and express information in different ways and the differences approaches to the learning environment (Gilakjani, 2012). Learning styles can be defined in many ways, depending upon one's perspective. Learning style can be defined as individual preferences of learning and differences in students' learning and considered as one of the factors influencing a learner's achievement (Dung & Florea, 2012b; Feldman, et al., 2014; Özyurt, et al., 2013). Many

research showed that knowing learning styles of individuals will assist their learning process and can influence the effectiveness and students' achievements (Dinçol, Temel, Oskay, Erdoğan, & Yılmaz, 2011; Khandaghi & Farasat, 2011; Surjono, 2014). There are various models of learning styles from the literature and almost seventy-one (71) different learning style models have been stated such as Felder-Silverman, Dunn & Dunn, Kolb, Honey and Murnford, and VAK (Visual, Aural and Kinesthetic)(Özyurt, et al., 2013; Surjono, 2014). Some models, such as Kolb's model and VARK model, are commonly used as theory foundation in learning technology studies(Chih-Kai, Tsung-Yen, & Wen-Lin, 2012).

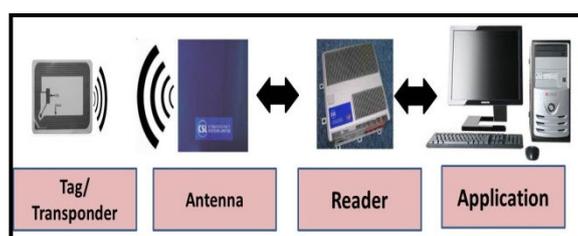
According to the Malaysia's Ministry of Education , there are two learning style models that are commonly used; Dunn & Dunn and VAK (Othman & Amiruddin, 2010). VAK theory is now a favourite because of its applicability and compatibility to the principles of interactive learning systems design. It is straightforward, and the results from this theory can be easily understood (Fardon, 2013). According to VAK learning style, learners who learn visually learn best by seeing and thinking from what is in the pictures. For these learners, pictures, flow diagrams and videos are the best learning materials. Auditory learners learn best by listening. For these learners, audible lectures are considered the best learning material. Kinesthetic learners are those who learn best by feeling and executing given tasks . Example of a suitable learning material for these learners are computer games, interactive animations and practical hands-on experiences (Gilakjani, 2012; Özyurt, Özyurt, Baki, Güven, & Karal, 2012; Surjono, 2011). The main purpose of selecting VAK learning style for our system is the reason that this learning style is suitable for structural characteristics of topics in creating the content for the system. It can be applied to e-Learning approaches that are represented using different types of media channel for all learning modalities. For example, words and images can be presented for visual aspect while sound explanation and spoken words can be presented for auditory aspect. Similarly, in kinesthetic, interactive animation can be presented.

### **Learning Disability**

In Malaysia, children with learning disabilities are categorised as special needs children. The Malaysia's Ministry of Education categorised special needs into three sub-categories which are; those who are visually handicapped, or partially or fully deaf, or suffering from the disability to learn (HJ, SK, & PJ, 2010). According to The National Joint Committee on Learning Disabilities (NJCLD) (Sulaiman, Baki, & Rahman, 2011), the term 'learning disability' is defined as "a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities". These children may not be the same and portrays different types of learning difficulties. Comparing to other disabilities, such as blindness, vision and motor impairments, a learning disability does not become immediately apparent in daily life (Savidis, et al., 2007). Children with learning disabilities can be successful if they are provided the correct and consistent assistance. Many of these children are barred from educational opportunities and are not be able to complete primary education (Laabidi, Jemni, Jemni Ben Ayed, Ben Brahim, & Ben Jemaa, 2014). Generally, people with disabilities face a wider range of obstacles which include access to information, education and a lack of job opportunities.

Nevertheless, modern technology can be a great tool for students with disabilities to improve their quality of life and complete their education. Many research over the last 30 years have shown that technology plays an important role in specific disadvantaged groups such as the blind, those with movement disabilities and LD (Beacham & Alty, 2006),(Adam & Tatnall, 2008),(POLAT, ADIGUZEL, & AKGUN, 2012). e-Learning and RFID emerge as the answer to fulfil that learning needs (Brahim, Jemaa, Jemni, & Laabidi, 2013). Radio Frequency Identification (RFID) is a wireless communication technology that has been around since World War II. This technology has been successfully applied to various fields such as transportation, distribution , retail, logistics, supply chain and telemedicine (de la Guía, Lozano, & Penichet, 2013). However, the electronic tags have been too expensive and too limited to be practical for many commercial applications, RFID technology was forgotten for many years. But now the price of electronic tags is gradually decreasing which allows RFID technology to be widely applicable and become acceptable depending on application used (Huang, Chuang, Chang, & Sandnes, 2007). RFID is the term used for technology that uses radio waves to identify items automatically. Figure 2 shows the RFID system component. There are tag/transponder, antenna, reader and application. This interesting technology has been applied in many areas, and now it can be beneficial for the education system.

Figure 2. RFID system component



### A Concept for Detection Learning Styles

The method to automatically identify the learning styles is based on the attributes used such as personality factors, behavioural factors and time. Many studies propose the automatic detection learning style to avoid calculating the wrong answers and to save student’s time in filling in a questionnaire (Ahmad, Tasir, Kasim, & Sahat, 2013; Dung & Florea, 2012b; Surjono, 2014). Some studies use data-driven approach (DDA) and literature-based approach (LBA) to identify learning styles in automatic approach (Ahmad, et al., 2013; Khan, Graf, Weippl, & Tjoa, 2010; Kolekar, Pai, & Pai, 2014). Table 1 shows the summary of data-driven and literature-based approach.

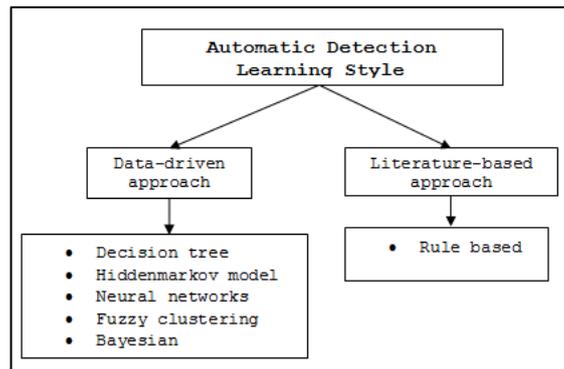
TABLE 1: SUMMARY OF DATA-DRIVEN AND LITERATURE-BASED APPROACH.

DATA-DRIVEN
Uses sample data in order to build a model for identifying learning styles from the behavior of learners
Advantage: the model can be very accurate due to the use of real data
Disadvantage: the approach strictly depends on the available data and is developed for specific systems

LITERATURE-BASED
Uses the behavior of students in order to get hints about their learning style preferences then applies a rule-based method to calculate LSs from the number of matching hints
Advantage: generic and applicable for data gathered from any course
Disadvantage: might have problems in estimating the importance of the different hints

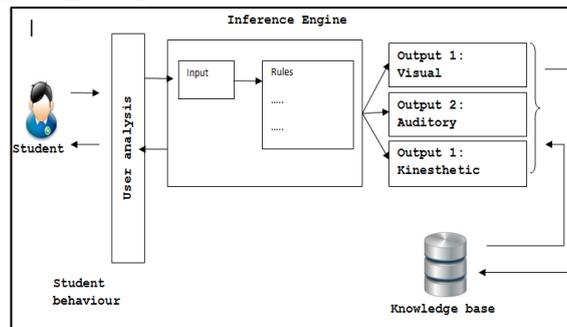
Data-driven method is focused on building a model that imitates the Inventory Learning Style (ILS) questionnaire and uses sample data to develop a model for identifying learning styles from the behavior of learners (Dung & Florea, 2012b). The techniques that use data-driven approach are decision trees, hidden markov model, neural networks, fuzzy clustering and bayesian networks (Ahmad, et al., 2013; Sabine Graf & Viola, 2009). Literature-based is an approach for identifying learning style based on behavior of learners (Ahmad, et al., 2013; S. Graf, et al., 2008). This approach applies a simple rule-based technique to calculate learning style from the number of matching hints. A method using this approach was proposed by Graf et al. (Sabine Graf & Liu, 2008). Generally, the idea of the detection learning style can be simplified as Figure 3 shows.

Figure 3. Idea of detection learning style



The architecture of VAK Learning Style is divided into two components which are inference engine and knowledge base as shown in Figure 4. The detection activities begin with user's registration then the student use the learning. The results of this exercise will determine the initial learner preferences visual or auditory or kinesthetic based on the number of visits and the time spent on learning object. Lastly, the resulting explanation and recommendations on a material content module are given based on learning style preferences.

Figure 4. VAK learning style architecture



### Learning Styles Estimation

Literature-based method is used to estimate learning styles automatically. Predictable time spent on each learning object,  $Time_{predictible}$ , is determined. The time that a learner actually spent on each learning object,  $Time_{spent}$ , is recorded. For example, if  $Time_{predictible}$  of a visual learning object is 30 second. After a period of time X, sums of  $Time_{spent}$  for three learning style elements of the learner is calculated. Then, the ratios of time (RT) are found out as the formula in equation (1).

$$(1) \quad RT_{LS} = \frac{\sum Time_{spent}}{\sum Time_{predictible}}$$

To calculate the ratio of number\_ visit, RVLS, number of learning object visited and total of learning object each learning style element are computed using the formula as equation (2).

$$(2) \quad RV_{LS\_element} = \frac{\sum Ex_{visit}}{\sum Ex}$$

Finally, the average ratios are calculated as the formula in equation (3).

$$(3) \quad R_{avg} = \frac{(RT + RV)}{2}$$

Then learning style is estimated based on the simple rule as shown in Table 2:

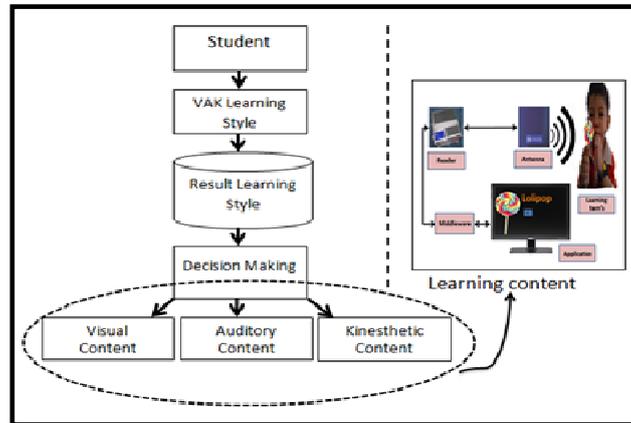
TABLE 2. SIMPLE RULE

$R_{avg}$	LS
0 – 0.3	Weak
0.3 – 0.7	Moderate
0.7 – 1	Strong

### Proposed Approach

In this study, an adaptive e-Learning integrated with RFID technology was proposed based on learning style of a learner using VAK learning style. This study focuses on LD children to improve their learning performance. Based on the VAK learning style, different contents will be prepared according to these three styles that are offered to the student. This system also connects the digital and physical world by providing a platform for LD children to select tangible object and receive computer-based multimedia instructions. By using RFID technology, children only need to explore, select items, and simply move them over the RFID reader. A different content which will be automatically launched is prepared according to these three styles that are offered to the student to achieve greater impact on the learning process. The overall architecture of this system is shown in Figure 5. This system will be designed as an adaptive e-Learning environment where the content will be based on VAK learning style and is supported with RFID technology.

Figure 5. Architecture of system



### Conclusion and Future Work

This paper proposed a model for an adaptive e-Learning which is able to model the learning style of learners using the VAK learning style with RFID technology. By analysing real behaviour patterns of students during interaction with the system, 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. Children learn the content that is appropriate to their own learning styles via this system. It is possible to say that this system provides a fully individualized environment for learners. In summary, the system offers what learners need. It creates a promise to significantly improve the result of learning. Indeed, it provides a great opportunity in improving the quality for learners to acquire knowledge faster and in a more flexible manner, by assisting learners to study in “the best way”. For future works, we will carry on with the development of a prototype to validate the proposed system and the efficiency of the method.

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