Faculty of Information and Communication Technology

MULTI LAYER FEED FORWARD ARTIFICIAL NEURAL NETWORK FOR LEARNING STYLES IDENTIFICATION

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DECLARATION

I declare that this thesis entitled "Multi Layer Feed Forward Artificial Neural Network for Learning Style Identification" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : ……

Name : Bilal Luqman Bayasut

Date : ……

APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature : ……

Supervisor Name : Dr. Gede Pramudya Ananta

Date : ……

DEDICATION

"*To my beloved mother Afifah Bin Thalib*"

"*To my beloved wife Dalilah Ali Salim Marfadi"*

"To my beloved uncles, Fahim Bin Thalib and Fahmi Bin Thalib"

ABSTRACT

Accommodating learning styles in adaptive educational hypermedia system (AEHS) may lead to an increased effectiveness and efficiency of the learning process as well as teacher and learner satisfaction. The premise is that a fact that learning in the classroom is less efficient, when teachers will not be able to get insight of each of the student's learning style; hence, they won't be able to adapt their teaching strategies to match with the student's learning style. In order to get an insight of the student's learning style in AEHS, the system must be able to recognize the learning styles of the students. Current methods for recognizing learning styles are less efficient, where questionnaires will lead to tedium and disturbance at learning processes. Thus, this study developed the learning styles based AEHS that utilized Multi Layer Feed-Forward Artificial Neural Network (MLFF) which was used to identify student's learning styles in real-time. The automatic and real-time learning styles identification was done by analyzing the student's browsing behavior while they are learning through the proposed AEHS. The system then adaptively presents the learning content that matches with the students' learning styles by the means of fragment sorting and adaptive annotation technique. At the end of the study, the data triangulation was done to test if incorporating learning styles in learning environments can impact the student achievement. It was done by asking the student to answer the mini quiz after they were using the proposed AEHS with adaptive feature was activated. This study also focused on analysis of the existence of the relationship between the frequencies of students' click on learning components with their staying time on those particular learning components. The result showed that the proposed MLFF performed well in identifying the students' learning styles in real-time. Moreover, the analyzed student's browsing behavior revealed that there was a relationship between the frequencies of the students' click on learning components with their staying time on those particular components. Furthermore, after the student's learnt through the proposed AEHS with adaptive feature activated and answered the mini quiz result; most of them could achieve the perfect score. In this case, the mini quiz result showed that incorporating learning styles into learning environment may affect and increase student's achievements.

ABSTRAK

Penyesuaian gaya pembelajaran dalam adaptive educational hypermedia system (AEHS) boleh membawa kepada peningkatan keberkesanan dan kecekapan proses pembelajaran disamping memberi kepuasan kepada guru dan pelajar. Sebenarnya pembelajaran didalam kelas kurang berkesan kerana guru tidak tahu gaya pembelajaran pelajarnya. Oleh yang demikian itu, guru tidak dapat menyesuaikan strategi pengajaran mereka untuk dipadankan dengan gaya pembelajaran pelajar. Dalam usaha untuk mendapatkan gaya pembelajaran pelajar, system AEHS akan mengenalpasti gaya pembelajaran pelajar tersebut. Sehingga kini, cara untuk mengenalpasti gaya pembelajaran kurang efisien, dimana hasil soal seldik mendapati gaya pemebelajaran membawa kepada kebosanan dan ganguan semasa proses pembelajaran berlangsung. Oleh itu, kajian ini mengembangkan gaya pembelajaran berdasarkan AEHS yang menggunakan Multi Layer Feed-Forward Artificial Neural Network (MLFF) untuk mengenal pasti gaya pembelajaran pelajar. Proses pengecaman gaya pembelajaran pelajar secara automatik dan real time dilakukan dengan cara menganalisis tingkah laku pelajar semasa melayari sistem yang dicadangkan semasa mereka belajar. Sistem tersebut kemudian secara adaptif membentangkan kandungan pembelajaran yang sepadan dengan gaya pembelajaran pelajar dengan cara-cara penyusunan serpihan dan teknik anotasi adaptif. Pada akhir kajian ini, triangulation technique telah dilakukan untuk menguji jika menggabungkan gaya pembelajaran dalam persekitaran pembelajaran boleh memberi kesan kepada pencapaian pelajar. Ianya dilakukan dengan meminta pelajar untuk menjawab mini kuiz selepas mereka menggunakan sistem hipermedia adaptif yang berasaskan pendidikan yang telah dicadangkan dengan ciri adaptif digunakan. Kajian ini juga memberi tumpuan kepada analisis kewujudan hubungan antara kekerapan klik pelajar terhadap komponen pembelajaran dengan masa yang diambil oleh mereka pada komponen-komponen pembelajaran tertentu. Hasilnya menunjukkan bahawa MLFF berprestasi baik dalam mengenal pasti gaya pembelajaran pelajar dalam real time. Selain itu, data tingkah laku pelajar dalam melayari sistem yang telah dianalsis, mendedahkan bahawa terdapat hubungan antara kekerapan klik pelajar terhadap komponen pembelajaran dengan masa yang diambil oleh mereka pada komponen-komponen tersebut. Tambahan pula, selepas pelajar itu belajar melalui sistem yang dicadangkan dengan ciri adaptif yang diaktifkan dan menjawab soalan mini kuiz, kebanyakan mereka boleh mencapai skor yang sempurna. Dalam kes ini, hasil mini kuiz menunjukan penggabungan gaya pembelajaran ke dalam persekitaran pembelajaran boleh memberi kesan dan meningkatkan pencapaian pelajar.

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LIST OF ABBREVIATIONS

AEHS	Adaptive Educational Hypermedia System
MLFF	Multi-Layer Feed Forward Neural Network
ANN	Artificial Neural Network
VARK	Visual, Aural, Read/Write, Kinesthetic
AHS	Adaptive Hypermedia System
AHAM	Adaptive Hypermedia Application Model
DM	Domain Model
UM	User Model
AM	Adaptation Model
GM	Goal and Constrain Model
PM	Presentation Model
XML	Extensible Markup Language
ITS	Intelligent Tutoring System
LS	Learning Styles
ULSM	Unified Learning Styles Model
SF	Selection Frequency of Component
FC	Frequency of Student's Click on Component
SR	Selection Ratio of Component
FCA	Frequency of Student's Click on All Components
AST	Average Staying Time of Component
TST	Total Staying Time of Component

SRC	Selection Ratio of Content Link Type
FCT	Frequency of Student's Click on Content Link Type
FCAT	Frequency of Student's Click on All Content Link Types
ESD	Embedded Support Devices
FL	Foreign Language
SL	Second Language
WYSIWYG	What You See is What You Get

LIST OF PUBLICATIONS

The following articles are published during my master study:

Journal

Bayasut, B., Pramudya, G. and Basiron, H., 2014. The Application of Multi Layer Feed Forward Artificial Neural Network for Learning Style Identification. *Advance Science Letters*, 20 (10), pp.2180-2183. doi:10.1166/asl.2014.5660.

Proceedings

Bayasut, B. L., Pramudya, G., & Basiron, H., 2013. The Review of Adaptive Educational Hypermedia System Based on Learning Style. *In Colloquium on Active Learning UTeM* (p. 4). Melaka, Malaysia.

Bayasut, B. L., Gede, P., & Halizah, B., 2013. ULUL-ILM : The Design of Web-Based Adaptive Educational Hypermedia System Based on Learning Style. *In 13th International Conference on Intelligent Systems Design and Applications (ISDA)*. Kuala Lumpur:IEEE.
Retrieved from http://www.mirlabs.net/isda13/proceedings/html/paper38.xml

CHAPTER 1

INTRODUCTION

1.0 Background

Adaptive educational hypermedia systems (AEHS) promise the individualized learning experience for every needs of each student (Brusilovsky, 2001). The rationale behind them is to investigate the individual preference of students (in terms of goals, knowledge level, cognitive abilities, learning styles, etc.) with the ability of Adaptivity of the system for the benefit to the student, leading to an increased learning performance and satisfaction.

Creating an adaptive learning system that meets student's requirements can be challenging since students learn with not only different needs, but also different learning characteristics (Lo et al., 2012). One of the characteristics is the fact that people have different approaches in learning, namely that individuals perceive and process information in very different ways which can be defined as learning styles (Popescu et al., 2009). For instance, some learners like to study by seeing (visual learning style) and they remember best what they see. Others like to study by listening (aural learning style), and so they remember best what they hear. And others prefer doing some experiments (kinesthetic learning style) rather than merely reading chemistry books and they remember best what they do. While others like to study by reading (read/write learning style), and so they remember best what they read (Popescu et al., 2009).

Moreover, The researches in pedagogy area have shown that different learners learn in different ways (Coffield et al., 2004). If each learner has their own learning style and is given the learning materials presented according to the particular learning style, the learner will not only learn better but will effectively develop the given information into deeper understanding. Thus, the educational systems that adapt their presentation based on the needs of the learner are intended to improve efficiency and the effectiveness of the learning process.

However, less attention has been paid in AEHS that accommodate learning styles. This may be caused by the lack of the experimental justification of testing the validity of learning styles applied to education. According to Pashler et al. (2009), There are very few studies have even used an experimental methodology capable of testing the validity of learning styles applied to education.

In fact, based on the learning styles theory, the variation in the student's learning styles is an important concern for crafting the AEHS (Lo et al., 2012). Moreover, Felder & Silverman (1988) stated that the student with a dominant preference for a specific learning styles may have difficulties in learning, if the teaching strategy does not match with their learning styles.

Many prototype had been developed in the field of AEHS that incorporates learning styles such as WELSA (Popescu, 2010), AHA! (Bra et al., 2007), MOT (Ghali and Cristea, 2009), APeLs (John Canavan, 2004), iWeaver (Wolf, 2002), INSPIRE (Papanikolaou and Grigoriadou, 2003). However, most of the systems have a traditional way of modeling the student, let say by giving questionnaire or survey to the student in order to figure out their prior knowledge, learning goal, learning preferences, or learning styles. In fact, this way of acquiring student's information is less efficient as it might not motivate them to answer the questions and it might lead to cumbersome (Ghazarian and Noorhosseini, 2010).

Moreover, it is not that feasible to ask student about their learning styles while they are learning (Akbulut and Cardak, 2012). Another argument from Akbulut & Cardak (2012) is that the students will be less motivated to respond to questionnaires since they were obviously long, boring and time-consuming (Akbulut and Cardak, 2012). Based on those drawbacks, researchers had tried to minimize the number of questions to diagnose learning style, but still students do not always take the time to complete questionnaires carefully (Latham et al., 2010).

Another research have been done to improve the efficiency of modeling the user through the questionnaire, by analyzing the student's browsing behavior and then applies the rule-based technique to determine the students' learning styles (Stash, 2007). However, another problem occurs when the student learns different content which rule-based failed to handle. It is because the rule-based will fail if the new domain is different from its' preprogrammed rules in the previous domain. As it is known the students have different approaches in learning, namely that individuals perceive and process information in very different ways. Besides, they do not only learn differently, but they also learn different content in different learning styles (Nish, 2011). This means that when a student learns mathematics he / she may has a kinesthetic learning style, while when he / she learn history, he / she may has an aural learning style (Popescu et al., 2009).

In fact, rule-based technique has it's own drawbacks in acquiring student's learning styles. Let say, the behavior of a rule-based system tends to degrade abruptly whenever the knowledge base is incomplete or not detailed enough or when operating at the borders of its expertise (Lombardi et al., 2011). It means that when the domain (learning content) is changed or not exist in the corresponding pre-programmed rules, which cause the rule-based will fail. Therefore, the challenge is to define the dynamic student's characteristics that constitute the base for the system's adaptation to each individual student's needs.

These characteristics include knowledge and skills, errors and misconceptions, learning styles and preferences, affective and cognitive factors, meta-cognitive factors, and Knowledge (Chrysafiadi and Virvou, 2013).

Previous researches have done to improve and automate the user modeling or the attempt of recognizing the student's cognitive styles, learning goals, preference by utilizing the machine learning techniques. One of the techniques is MLFF (Multi Layer Feed-Forward Artificial Neural Network). The MLFF was used because of its ability to generalize and learn from specific examples, ability to be quickly updated with extra parameters, and speed in execution and also perform well in classification tasks, making them ideal for real time applications. In fact, the MLFF was adopted because the task of identifying students' characteristics including students' learning styles is similar to character recognition in that they both involve the classification features from a potentially infinite numbers of possible inputs (Castellano, 2001; J.-J. Lo and Shu, 2005; Mullier, 1999).

This research is also motivated by the lack of the experimental evaluation to assess the impact of incorporating learning styles in AEHS towards student's achievement (Mustafa & Sharif, 2011; Mulwa et al., 2011). Another researcher also mentioned about this lack of empirical evidence and experimental evaluation in AEHS. Let say, Brown et al., (2009), studied that out of ten AEHS that utilize learning styles, six systems did not seem to have published any quantitative evaluations. This statement is supported by Mulwa et al., (2010) who stated that more research and publications are required in the area of AEHS. As a matter of fact, The feasibility of the incorporating learning style in AEHS has been questioned, since there is the existence of several empirically untested models of AEHS based on learning style (Akbulut and Cardak, 2012). In addition, Pashler et al., (2009) stated in their writing titled "Learning Styles Concepts and Evidence" that "at

present, there is no adequate evidence base to justify incorporating learning styles assessments into general educational practice". Hence, this research is also aimed to provide the assessment of the students' impact on achievement by using our proposed AEHS framework. Those facts also justify the second problem statement this thesis.

Considering some drawbacks and problems above, this research aims to provide the AEHS framework that can recognize the students' learning styles in real-time by applying Multi-Layer Feed-Forward Artificial Neural Network (MLFF) as well as presents the learning contents that match with those identified students' learning styles. This research also provides the experimental evaluation to assess the impact of incorporating learning styles in our proposed AEHS toward student's achievement.

1.1 Problem Statements

As it is already described in the background section, the problem statements in this research can be listed below:

1) Current methods for identifying learning styles are less efficient, where issuing questionnaires while the students are studying were used, which lead to tedium and disturbance at learning processes (Ghazarian & Noorhosseini, 2010; Ortigosa et al., 2010; Akbulut & Cardak, 2012).
2) Current studies are lack of the experimental evaluation to assess the impact of AEHS towards student's achievement. (Brown et al., 2009; Mulwa et al., 2010; Mustafa & Sharif, 2011; Mulwa et al., 2011). Moreover, Akbulut & Cardak (2012) stated in his review journal paper that the majority of studies proposed framework or model for adaptivity whereas few studies addressed the effectiveness of learning style-based AEH. Means that the majority of the study is only concerned with the framework development and for getting the assessment of the effectiveness of learning style-based AEH.

1.2 Research Question

Based on the research background and problem statements above, the research questions can be defined as follows:

1) What kind of components, methods, techniques, and models needed to develop AEHS incorporated with students' learning styles identification technique?
2) What is the accuracy of the proposed learning style identification technique in identifying students' learning styles?