A n Adaptive Learning Model Using Learner's Preference

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Abstract— **Several research of adaptive learning mainly focused on improving student learning achievements based on learning style, cognitive style or achievement. In this paper, an innovative learning approach is proposed by using the Myers-Briggs Type Indicator's (MBTI) personality dimensions. Based on the innovative approach, a framework for building an adaptive learning management system has been developed; moreover, an experiment was conducted to evaluate the performance of our approach. The result reveals the system effectiveness for which it appears that the proposed approach may be promising.**

Keywords-adaptive learning; learning style; teaching strategy; personalization; MBTI.

I. INTRODUCTION

Learning is defined as a process where knowledge is created through transformation of experience [3],[26]. The most common perceptions about learning include that it is a quantitative increase in knowledge or acquiring information of 'knowing a lot'; memorizing or storing information that can be reproduced; acquiring facts that can be reproduced; acquiring; interpreting and understanding reality in a different way [36], [37]. In e-learning systems, the one-size-fits-all approach has gained a great deal of attention in this area [41].

Adaptive learning may be defied as "the process of generating a unique learning experience for each learner based on the learner's personality, interests and performance in order to achieve goals such a learner academic improvement, learner satisfaction, effective learning process and so forth" [31], [38].

In fact, in response to individual needs, personalization in education not only facilitates students to learn better by using different strategies to create various learning experiences, but also teacher's designer's education needs in preparing or designing varied teaching or instructional packages. Each learner has a preference for a teaching style that allows him to learn better. Some one likes to listen and talk, others prefer to analyze a text, or simply using a visual medium. So to learn effectively, learners have to be aware of their preferences that make easy to manage its own way of learning. This information will enable the learner to improve the effectiveness of its approach to learning and to exploit its own resources.

Adaptive Hypermedia System (AHS) are systems that use user and concept models to provide a personalized version of the information for the end of user. Recent developments of the online learning are related to Adaptive educational Hypermedia Systems (AEHS). Adaptive Educational Hypermedia System (AEHS) are those that create a unique learning experience for each learner based on learner's knowledge, goals, learning style and so forth[13],[39].

Jungian based psychologists add that people's personality preferences influence the way they may or may not want to become more actively involved in their learning, as well as take responsibility for the self-direction and discipline. So we have to identify a person's individual learning style and then adapt instruction toward that person's strengths and preferences. It is commonly believed that most people prefer some kind of interacting with, taking in, and processing stimuli or information.

A lot of research works has been done about personality type, virtual learning system and learning but it's still very difficult to draw a definitive conclusion on the relationship between them. For example see [25], [11], [3], [21], [10], [8], [9] and [24]. In [1], authors designed an interface for computer learners appropriate for the type of their personality using MBTI test.

In this research, there are four strategies path to improve the content suit for individual learners. They are adaptive content, adaptive navigation, adaptive presentation and adaptive learning task.

In this paper we will suggest new strategies teaching on elearning context matching with learner's personality using the Myers-Briggs Type Indicator tools. In this purpose, we will apply our approach that may include the four strategy path, to implement a smart virtual learning which can give learner and also teacher a new positive educational experience.

II. BACKGROUND

The related studies about this research can be summarized under two sections; namely, the related studies about learning style and the related studies about MBTI and personality learners.

In the past decades, various issues concerning adaptive learning have attracted the attentions of researchers from the fields of computer science and education. In the meantime, various ways of measuring learning styles were proposed to assist instructors or educational researchers to more realize the characteristics of learners. In the following subsection, relevant studies addressing learning styles and the Myers-Briggs Type Indicator model are given.

A. Learning styles

In the work, [25] described the learning style as both a student characteristic and an instructional strategy. As an

instructional strategy, it informs the cognition, context and content of learning. It can also be defined as the way a person collects processes and organizes information.

There are many models of learning styles existing in literature. Individual learning styles differ, and these individual differences become even more important in the area of education. Learning style may be defined as "the attitudes and behaviours which determine an individual's preferred way of learning" [22]. The learning style provides educators an overview of the tendencies and preferences of the individual student [25]. Several studies show that students learn in different ways, depending upon many personal factors and everyone has a distinct learning style [30], [23]. Therefore, when an instructor's style matches a learner's learning style; this affects the learner's experience and ability to do well. Until today, a lot of research works has been done about learning styles and developed a good deal of learning style models but there does not seem to be any agreement of acceptance of any one theory [4]. There have been several models for defining and measuring learning styles, proposed, such as Kolb's questionnaire [26], honey's questionnaire [20], Keefe's questionnaire [25], MBTI's questionnaire (Myers, 9999). Felder and Solman proposed a psychometric questionnaire ILSQ [16].

Therefore, in this study, we adopted the Keefe's model as one the well-known source information for personalization.

B. Myers-Briggs Type Indicator model

The Myers-Briggs inventory is based on Carl Jung's theory of types, outlined in his 1921 work Psychological Types [3], [12], [13] and [26]. Jung's theory holds that human beings are either introverts or extraverts, and their behavior follows from these inborn psychological types. He also believed that people take in and process information different ways, based on their personality traits.

The Myers-Briggs Type Indicator reports a person's preferences on four scales, see Table I below:

TABLE I.   BASIC DEFINITION OF MBTI THE PREFERENCE

Preferences	Definition
Extraversion or Introversion	Where a person prefer to focus their attention
Sensing or Intuition	The way a person prefer to take in information
Thinking or Feeling	How a person deal with the external world
Judging or Perceiving	Where a person prefer to focus their attention

C. A Learner's clustering model

We all have an aspect of our personality which dominates or governs us. It gives direction to the personality and shapes our motives and goals. This is called the Dominant Process. There is an Auxiliary Process which should be the second in strength and is the necessary assistant to the dominant. The auxiliary takes care of the extraversion of the introvert and the introversion of the extravert. All four of these processes are

found in the middle two pairs of preferences, that is, the perceiving preferences which are either Sensing or Intuition and the judging preferences which are either Thinking or Feeling. If a person has a Dominant judging process, his Auxiliary process will be one of the perceiving ones. Conversely, a person with a Dominant perceiving process will have a judging preference for his Auxiliary process [26]. Using these combinations can reduce the number of 16 personality types to four. This is more manageable for planning teaching approach and monitoring learning engagement:

TABLE II.   LEARNER'S CLASSIFICATION BASED ON MBTI

Myers Briggs type	Dominant preferences
ISTJ, ISFJ, ESTP et ESFP	$\widehat{S}$
INFJ, INTJ, ENFP et ENTP	$\widehat{N}$
ISFP, INFP, ESFJ et ENFJ	$\widehat{F}$
ISTP, INTP, ESTJ et ENTJ	$\widehat{T}$

D. Adaptive teaching strategies

We define the teaching strategies as the ways of presenting instructional materials or conducting instructional activities. It will be designed in a way that learner are encouraged to observe, analyse, look for a solution and discover knowledge by themselves [5]. The main objective is to facilitate the learning process.

When learner enters the framework, described in section 3, for the first time, he's asked to take a learning style test based on MBTI's approach (for example ISEJ, ESTP, INTJ …), then he can belonging in one of the four classifications (see Table 2). Using learner traits based on Isabel Briggs Myers [3], [12], [13] and [26], we suggest below an adaptive learning style scenario for each learner's preference cluster (Fig. 1).
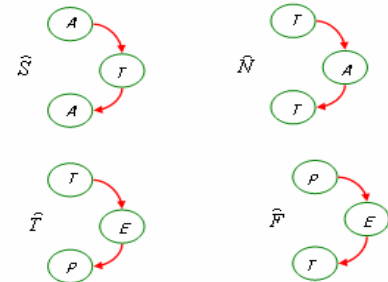

A : Application- T: Theory- E : Examples- P : Practical Exercises

Figure 1.   Adaptive taxonomy: LS dimensions and TS relationships

● *Teaching strategies for $\mathbb{S}$ cluster (TS1)*: it uses the Application-Theory-Application (ATA) approach. Teacher starts by presenting an Application. The students attempt to analyze and solve the problem without the benefit of the upcoming course's theory. Therefore, the teacher present the chapter's theory or ideas, and then applies it to the original application. Afterwards the teacher presents additional applications to make easy the learning process.

- *Teaching strategies for $\mathbb{N}$ cluster (TS2)*: it uses the approach Theory-Application-Theory (TAT). Teacher start by presenting the chapter's theory or idea before application related. The students attempt to analyze and solve the problem using the course's knowledge. The teacher can reuse the theory to facilitate the learning process. This approach is used for the traditional educational model.
- *Teaching strategies for $\mathbb{T}$ cluster (TS3)*: it uses Theory-Example- Practical exercises Approach (TEP). Teacher start by presenting the chapter's theory or idea before examples related. The students attempt to analyze and solve the practical exercises using the course's knowledge. Afterwards the teacher presents additional applications based logic and problem-solving.
- *Teaching strategies for $\mathbb{F}$ cluster (TS4):* it uses the opposite teaching of TS3. In fact, it uses Practical exercises, Example then Theory (PET). Teacher use case studies or learning based practical exercises. Therefore, the teacher presents the chapter's theory or ideas.

III.   SYSTEM ARCHITECTURE

The LearnFit framework is an Add-On to the popular Moodle Learning Management System to provide adaptivity learning experience. The tool is a web-based application having two tiers and has been implemented with PHP, MYSQL Server, CSS and AJAX on Linux environment. In fact, LearnFit consists of three parts:

a- Domain Model: Consist of concepts and the relations that exist between them. Typically the domain model gives a domain expert's view of domain.

b- Learner Model: Consists of relevant information about the user that is pertinent to the personalisation of the learning style

c- Pedagogical Model: includes two parts

- Adaptive Engine Model: Consists of set of rules or triggers for describing the runtime behaviour of the system as well as how the domain model relates to the user model to specify adaptation.

- Revised Strategy Model: Consists to determine whether a given resource is appropriate for a specific learning style or not.
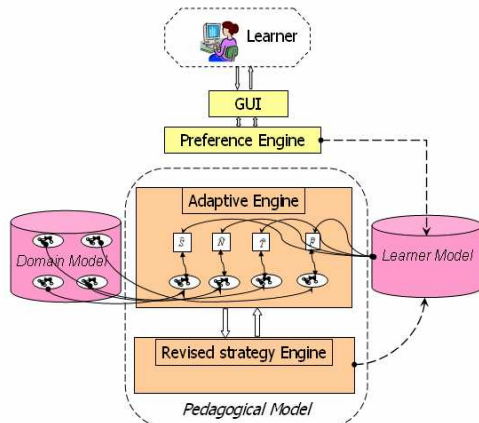

Figure 2.   Global System Architecture

For each individual student the system initialize the decision model generated from a set of rules that represents the matches between teaching style and the learner's personality using Bayesian Network (BN) [28]. This module uses a Dynamic Bayesian Network Classifiers DBN [7], [18] and [28] to classify 1 a teaching strategy as "appropriate" or "not appropriate" for the learner. To define the DBN's parameters we set the a priori distribution of the nodes representing the LS according to the score obtained by learner in the MBTI test (related module 1).

Our framework has three meta-models, in the following sub-sections, theses parts will be described.

A.   Learner Model

The model represents various learner characteristics (identity, preferences, etc…), which can be used to adapt the content and the teaching styles.

This component stores all user-related data, i.e. the users' profiles, including personal information, preferences. It enables the system to deliver customized instruction, on the basis of the individual student's, or the student group's, learning style [29]. For reasons of simplicity we consider only preferences to represent learner profiles since they are effective parameters in human activities such as learning [26].
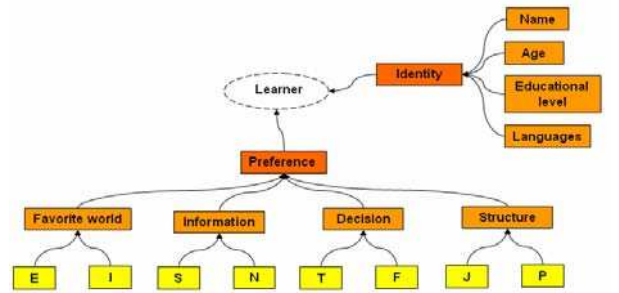

Figure 3.   Learner's profile

The learner ontology, $O_{learner} = \{O_{Identity}, O_{preference}\}$ is composed of two parts. The first part, $O_{Identity}$ represents a set of personal user profiles. They are name, age, education level, languages. The second part $O_{preference} = U$ describes a set of learning styles according MBTI tools defined as follows:

$$U = \left\{ u \in [0,1]^8 \, / \, u = (u_E, u_I, u_S, u_N, u_T, u_F, u_J, u_P) \right\} \quad (1)$$

Each component (u_i) is the priori probability of preference at i^{th} MBTI dimension. Using the MBTI questionnaire we may explicitly evaluate the U value for each learner on numerical values in an interval [0, 1] such that 0 indicates a minimal satisfaction and 1 indicates a maximal satisfaction. We will only consider the four types of dominant preference that are $\mathbb{S}$, $\mathbb{N}$, $\mathbb{T}$ and $\mathbb{F}$.

B.   Domain Model

This model describes all teaching styles (TS), given to the students by the teachers to facilitate a deeper understanding of

the information. The emphasis relies on the design, programming, elaboration and accomplishment of the learning content. Teaching strategies must be designed in a way that students are encouraged to observe, analyze, express an opinion, create a hypothesis, look for a solution and discover knowledge by themselves. Didactic teaching strategy for example refers to an organized and systematized sequence of activities and resources that teachers use while teaching [18].

Each Learning style LS can be associated with a teaching strategy (TSi):

$$V = \{TS_1, TS_2, TS_3,..., TS_m\} \quad (2)$$

Teaching strategies hold a one-to-one relationship with the learning styles. There can be one teaching strategy that accommodates one learning style.

C. Pedagogical Model

This model describes the structure of the information content of the application. It consists of concepts and concept relationships. A concept is an abstract representation of an information item from the application domain. The domain ontology of the system is based on the notion of learning goals that the learner can select and study, and provides learners with a plurality of learning activities and resources

A learning goal corresponds to a topic of the domain knowledge, which can be recognized and selected even by a novice learner. Each goal is associated with a subset of concepts of the domain knowledge, which formulates a conceptual structure that represents all the concepts of a goal and their relationships [27].

Each concept can be associated with appropriate learning objects (LOi):

$$W = \{LO_1, LO_2, LO_3, LO_4,..., LO_n\} \quad (3)$$

Otherwise a concept can be also represented by a tree of learning object where sections constitute the components (Child) of learning scenarios, each section can be composed of subsection that can also be composed of more specific learning objects like pedagogical resources and/or pedagogical activities.

IV. EXPERIMENT SYSTEM

We have set up experimentation to compare our system with a classical one, by measuring the student understanding after learning process. Participants were drawn from a pool (n= 48) of 2nd year undergraduate computer science students. The participants had to study the course "php advanced" designed in four ways S, N, T and F's strategy.

In the first counter, the system asked students to fill out the MBTI's questionnaire and according the result, adaptive instructional strategies will be achieved. This psychological questionnaire maps a set of many questions representing learning preferences and styles. Figure 4 provided MBTI questionnaire results:
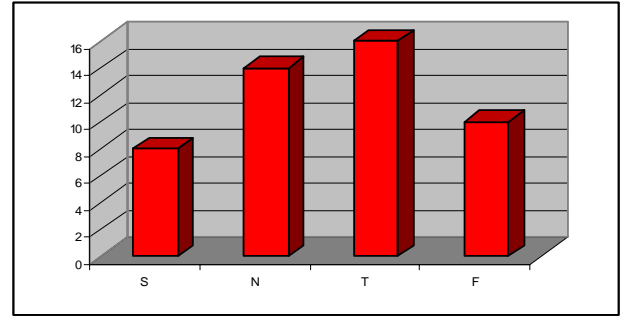

Figure 4. MBTI questionnaire results

Students work with our framework, then they answered about our learning environment. Figure 5 depicts the students' general impression:
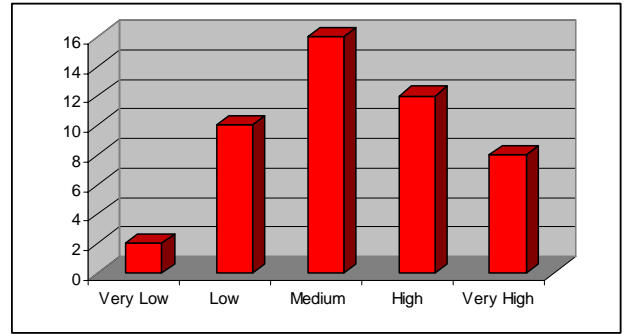

Figure 5. Overall impression of instructional strategies and experiments

Results show that participants are satisfied of learning environment based on learner's personality and considered the implementation of adaptive instructional strategies useful for adaptive educational. The full results of this experimentation will be published in the next work.

V. DISCUSSION AND CONCLUSION

The issues concerning personalization in learning process have been widely discussed in the past decades and remain the focus of attention of many researchers to day.

In this paper, we propose an adaptive learning platform, which takes the learner's personality into consideration. In this paper another approach has been presented. In this model some modules for personality recognition and selecting an appropriate teaching strategy for learner's personality, we considered to develop interaction with the learner. The first result show that placing the learner beside an appropriate learning style matching with learner's preference in online distance learning education lead to improvement and makes the virtual learning environment more enjoyable. To evaluate the innovative approach, an experiment was conducted to collect the students' impression about our system. The results shows that learners are satisfied and considered the implementation of adaptive instructional strategies useful for adaptive educational. Although the innovative approach presented in this article has demonstrated is benefits, it also depicted the limitation of actual application. The major difficulty is to develop four

versions of the same course to meet the personalisation of learning process. Finally, the evaluation results show that students understood the process and liked being involved in it, in spite the fact that it was not a simple task. For further work, we also aim to compare the learning outcome of our approach with a classical "one size fit all" approach.

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