Students’ Satisfaction in Learning Style-Based Adaptation

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Abstract— Initiatives based on learning style adaptation are often marked by a lack of experimental evaluation of their efficacy in general and of student satisfaction in particular. A high level of satisfaction can increase the motivation of students, their engagement and experience, and therefore improve their learning. This paper is concerned with the investigation of the effect of adaptation based on learning style on students’ satisfaction. An adaptive approach, which involves the construction of personalised learning paths based on learning style, was implemented in an adaptive e-learning system. A controlled experiment in this learning environment was conducted with sixty undergraduate students to evaluate their level of satisfaction with the system. The results indicate that the students were generally satisfied with their learning experience. It can be concluded that adaptation of learning content according to learning style can improve student satisfaction and enhance their experience and motivation.

Keywords— adaptive e-learning; learning style; information perception; student satisfaction; experimental evaluation

I. INTRODUCTION

Although traditional e-learning systems may provide useful learning environments, they suffer from several limitations. They usually do not take into account the characteristics of the students such as their knowledge, skills, abilities and learning style. They provide a fixed sequence and presentation of learning material and ignore the different needs of different students. This may lead to the dissatisfaction and frustration of the students with their learning process, and may be reflected in the quality and the effectiveness of learning.

Enhancing traditional e-learning systems through adaptation can address these limitations. Adaptive e-learning systems (AESs) personalise the presentation of learning material and adapt the course content and sequence based upon the students’ characteristics [5, 6]. Among the student characteristics, learning style is recognised as an important factor in learning [1, 10]. Students process, manipulate and acquire information in different ways according to their different learning styles [9].

Several AESs based on learning style that apply different adaptive methods and techniques have been deployed [11, 12]. For example, an intelligent human-like agent is built in the eTeacher system to suggest personalised content according to an inferred learning style profile of each student [12]. The INSPIRE system provides some adaptivity features according to the learning style of students - such as link annotation and direct-guidance [11].

Although there have been numerous attempts to incorporate learning style in AESs, learning style-based adaptation is still a debated issue [1, 5]. The way in which to provide adaptation based on learning style is not always apparent. Furthermore, the learning efficacy and satisfaction of students when adapting learning material according to learning style is still unclear despite extensive research [1]. There is also a lack of studies that are based on well-designed and robust experimental evaluations [1, 4, 5].

Students’ satisfaction plays an important role in learning as it increases their engagement, motivation and experience [1, 2]. This paper presents the results of an investigation into the impact of learning style-based adaptation on students’ satisfaction. An AES that constructs personalised learning paths based on learning style is implemented. It mainly takes into account the information perception dimension of learning style as a basis to provide adaptation. This dimension has received the least attention in published research [1, 6]. Additionally, a controlled experimental evaluation is conducted to measure the student satisfaction.

This paper is structured as follows. Section II covers the learning style background. Section III presents the learning style-based adaptation. Section IV details the experimental evaluation, and Section V offers the results. Section VI concludes the paper with pointers for future work.

II. LEARNING STYLE

A. Introduction

Learning style is defined as a composite of affective and cognitive factors that specify the student perception and interaction behaviour in the learning environment [10]. A large number of learning style models and frameworks have been proposed [7]; however, the Felder-Silverman model is the most widely used and accepted model for online learning, especially in science and engineering education [1]. It provides a complete description of each of its dimension, and each dimension is associated with a teaching style. The Felder-Silverman learning style model is comprised of four dimensions as follows [9]: (1) information processing (active-reflective), (2) input modality (visual-verbal), (3) information understanding (sequential-global) and (4) information perception (sensory-intuitive).

The information processing dimension can be implicitly supported by interactive and hypermedia systems and by collaborative learning features [14]. The input modality
dimension has been a subject of extensive research, and no significant effect has been reported [4]. The information understanding dimension seems to be more related to the design of system interfaces; its learning effectiveness may be limited [4]. The information perception dimension of learning style is discussed in the next section because of its importance and relevance to this work.

B. Information Perception Style

The information perception style (sensory/intuitive) is one of the most important factors that should be taken into account in instruction [8]. This style is also correlated with various behavioural tendencies, learning styles, management styles and even with career aptitudes and preferences [9]. However, it has rarely been incorporated and evaluated as a single dimension in AESs [1, 6]. This situation warrants a study of its use as a basis to provide adaptation and of its potential effect on students’ satisfaction.

The information perception dimension of learning style concerns the appropriate type, presentation and order of information to be perceived by individual students. It classifies students into two categories: sensory and intuitive. Felder and Silverman define sensing and intuition as follows: “Sensing involves observing, gathering data through the senses; intuition involves indirect perception by way of the unconscious—speculation, imagination, hunches. Everyone uses both faculties, but most people tend to favour one over the other.” [9]. Sensory students favour data, facts, real-world examples and experimentalisations; intuitive students prefer principles, theories and mathematical models. Sensory students may perform better with concrete information; intuitive students may benefit more from abstract concepts.

III. LEARNING STYLE-BASED ADAPTATION

A specific approach to adaptivity based on the information perception style is proposed. An AES constructs personalised learning paths through the sequencing of learning objects (LOs) [3]. The system represents the course structure at two levels. Level one consists of a number of learning units. A learning unit focuses on a single sub-subject of the course. Each learning unit is comprised of interrelated LOs. Each LO is annotated based on its type as an “abstract” or “concrete” object according to the teaching style that corresponds to the information perception style [9].

The system generates personalised learning paths for sensory and intuitive students. They are mainly constructed within each learning unit. The sensory students study first “concrete” LOs related to each learning unit, and then they interact with “abstract” LOs (i.e., concrete-to-abstract). Conversely, the intuitive students interact with “abstract” LOs first, and then they study “concrete” LOs (i.e., abstract-to-concrete). Concrete LOs include real-world examples, exercises and practical tools. Abstract LOs involve concepts, theories, mathematical models and principles. Fig. 1 presents an example of an abstract LO as provided by the system.

This approach is, to some extent, generic and can be adapted to any learning domain because of the simple, yet effective annotation of LOs and generation of learning paths.

![Mathematical Notation of Private-key encryption](image)

A. Introduction

A controlled experiment was conducted at university level in a computer laboratory in order to evaluate the proposed approach in terms of students’ satisfaction. Each experimental session lasted for about 60-75 minutes.

Two experimental conditions were put forward. In the first condition, the system matches the sequence of LOs according to the information perception style (the matched condition). In the second condition, it provides a mismatched sequence of LOs (the mismatched condition).

B. Data Collection

Two data collection tools were used in the experiment. The learning style was identified by the Index of Learning Style1 (ILS) questionnaire [9]. A subset of the questionnaire containing 11 questions related to the information perception style was used; this style is the basis of adaptation in the AES. Student satisfaction was measured by the conceptualisation of e-learner satisfaction (ELS) tool [13]. Three components of the tool were taken into account: the system interface, the learning content and the system personalisation. These components are assessed through 13 questions measured on a 7-point Likert scale with anchors ranging from “strongly disagree” to “strongly agree”. An example related to satisfaction with the system interface in the ELS tool is ‘the e-learning system is easy to use’ [13].

1 http://www.engr.ncsu.edu/learningstyles/ilsweb.html
C. Procedure

Participants were invited to access the system via an Internet browser, enter personal information and complete the 11 questions of the Index of Learning Style questionnaire [9]. The participants were randomly assigned to either the matched condition or the mismatched condition. The participants studied two learning units on information security: private-key encryption and key-management protocols. Each learning unit is made up of a combination of concrete and abstract LOs, generated by the system as a customised sequence according to the assigned condition of the participant. At the end of the learning process, the participant completed the satisfaction questionnaire [13].

V. RESULTS

Sixty (60) undergraduate students took part in the experiment. Twenty-nine (29) students were assigned to the matched condition, and thirty-one (31) students to the mismatched condition. In the experiment, 72% of the participants were sensory students and 28% were intuitive students. All the students completed the experiment successfully.

Based on the analysis of the student satisfaction questionnaire, the group in the matched condition (M=6.17), which was provided with personalised learning paths based on their information perception style, achieved higher general satisfaction scores than those in the mismatched case (M=5.35).

Table I summarises the results of the students’ satisfaction. In a more refined analysis of the satisfaction in terms of system interface, learning content and system personalisation, it was found that the participants in the matched condition achieved higher satisfaction mean scores than those in the mismatched condition.

The system provides the same interface layout and the same learning content for both experimental groups. The difference is the customised sequence of LOs. However, the satisfaction scores related to these components in the matched condition were significantly better than in the mismatched condition.

The results indicate that students are more satisfied when an AES provides adaptation according to their learning style. It can be inferred that adaptation can enhance the motivation and engagement of the students [1, 2]. The results suggest also that the information perception style should be incorporated in adaptive e-learning systems in order to enhance the motivation and experience of students.

VI. CONCLUSION AND FUTURE WORK

An investigation into student satisfaction with learning provision in an adaptive e-learning system was presented in this paper. The adaptivity approach involved the construction of personalised learning paths according to learning style. The approach was validated by an experimental evaluation which was conducted with sixty students. The results indicate an adequate level of satisfaction with the system and the learning material.

This work is part of a wider investigation into learning style-based adaptation and students’ satisfaction. The proposed system will be extended to incorporate the knowledge level of students besides their learning style. A long-term experimental evaluation that measures the satisfaction and perception of students, with more learning objects and with a large number of participants is currently being carried out.

REFERENCES