A Framework for Analyzing Course Contents in Learning Management Systems with Respect to Learning Styles

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Abstract: The harmony between the learning styles that a course supports and the actual learning styles of learners helps to magnify the efficiency of the learning process. The aim of this research is to present a framework for analyzing existing course contents in learning management systems and providing the teacher with information regarding how well the course supports different learning styles of students based on the Felder and Silverman's learning style model. This allows the teachers to be aware of the suitability of their courses for students with different learning styles and to improve their courses to support more learners. This paper introduces the design and the implementation of the framework.

Keywords: Course analyzer, learning management systems, learning styles

Introduction

In online learning, teachers build courses according to their teaching methods. Teaching methods vary. Some instructors lecture, others demonstrate or discuss; some focus on principles and others on applications; some emphasize memory and others understanding [1]. On the other hand, learners have different backgrounds, motivation and preferences in their own learning processes and web-based systems that ignore these differences have difficulty in meeting learners' needs effectively [2]. Therefore, when designing instructional material, it is important to accommodate elements that reflect individual differences in learning. One of these elements is learning styles. Understanding a student's particular learning style and how to best meet the needs of that learning style is essential to perform better. Clay and Orwig [3] defined learning style as a unique collection of individual skills and preferences that affects how a person perceives, gathers and processes information. Learning styles affect how a person learns, including also the aspects of how a person acts in a learning group, participates in learning activities, relates to others, and solves problems. Basically, a person's learning style is the method that best allows the person to gather and to understand knowledge in a specific manner. Once a learner's particular learning style is identified, it will be possible to identify ways in which the learning process can be improved [4]. There are many models about learning styles in literature such as Kolb [5], Dunn & Dunn [6], Honey & Mumford [7], and Myers-Briggs [8]. This research paper utilizes the Felder and Silverman's Learning Style Model (FSLSM) [1] because of its applicability to e-learning and compatibility to the principles of interactive learning systems design [9]. In this model, Felder and Silverman proposed four dimensions of learning styles (active/reflective, sensing/intuitive, visual/verbal, and sequential/global)

and teaching styles (active/passive, concrete/abstract, visual/verbal, and sequential/global), where each teaching style corresponds to (matches with) a learning style.

Many researchers have conducted research to detect the learners' learning styles and provide recommendations and adaptations for online courses based on learning styles. For example, Paredes & Rodríguez [10] presented a framework that collects explicit information about the students by means of the Index of Learning Styles (ILS) questionnaire developed by Felder and Soloman [11], adapts the course structure and sequencing to the student's profile and uses the implicit information gathered by the system during the course in order to dynamically modify the course structure and sequencing. Graf & Kinshuk [12] introduced a concept for enhancing learning management systems (LMSs) with adaptivity based on learning styles. They used the open source LMS Moodle as a prototype and developed an add-on that enables Moodle to automatically provide adaptive courses that fit to the learning styles of students. Mejía et al. [13] proposed an approach of an adaptation process that allows adjusting different types of resources to the user's preferences by means of the identification of the user's learning style in LMSs.

Our research is different from the previous research in that we focus on analyzing existing online courses and making teachers aware of how well those courses fit with diverse learning styles. Currently, LMSs contain tons of existing courses but very little attention is paid to how well these courses actually support learners. This research presents a framework to analyze existing course contents in learning management systems and provide the teachers with a visualization tool, which makes the teachers aware of the suitability of their courses for diverse learning styles. The aim is to help the teachers in improving their courses to support students with different learning styles. In the next section, the mechanism for analyzing course contents is presented; the framework architecture is illustrated in section 2. In section 3, the implementation of the framework is introduced, followed by the conclusions and the future plans of the research.

1. Course Analyzing Mechanism

Making teachers aware of how well their courses fit with diverse learning styles can help them in improving their courses to support students with different learning styles. Therefore, we propose a mechanism for analyzing existing courses in LMSs in order to infer which learning styles they currently support. The mechanism currently considers eleven types of learning objects (LOs), as listed below; however, from technical point of view, new types of LOs can easily be included in this mechanism, if required.

- *Commentaries:* provide learners with a brief overview of the section.
- *Content Objects:* are used to present the learning material.
- *Reflection Quizzes*: include one or more open-ended questions about the content.
- *Self-Assessment Tests*: include several close-ended questions about the content.
- *Discussion Forum Activities:* provide learners with the possibility to ask questions and discuss topics with their peers and the instructor.
- *Additional Reading Materials:* provide learners with additional sources for reading about the content.
- *Animations:* demonstrate the concepts of the course in an animated multimedia format.
- *Exercises:* provide learners with an area where they can practice the learned knowledge.
- *Examples:* illustrate the theoretical concepts in a concrete way.
- *Real-Life Applications:* demonstrate how the learned material can be related to and applied in real-life situations.
- *Conclusions*: summarize the learned content.

In order to use the proposed mechanism to analyze an existing course, this course only needs to fulfill two requirements. First, for the general structure of a course, it is assumed that a course consists of several units and a unit can (but does not have to) consist of several sections. Second, it is assumed that each section (or unit if no section exists) contains at least one content object which presents the learning material of this section.

A section normally starts with a commentary. Subsequently, there is an *area before content* (ABC) that may include a few LOs that aim at motivating the learners and making the section interesting for them. After this area, the content is presented. In the next area, namely *area after content* (AAC), different types of LOs may be presented. The conclusions of the section can exist either right after the last content object or at the end of the section. This mechanism recognizes how well a section of an existing course fits to each of the eight poles of FSLSM by calculating the average of three factors: the availability, the frequency and the sequence of the learning objects in that section, as illustrated below. Consequently, the results can be summarized for each unit and for the whole course.

Certain LO types can support diverse learning styles. The availability of types of LOs is considered as a factor to infer the learning styles that a section of the course fits well. It measures the existence of LO types in the section that can support each learning style in respect to all types of LOs that can support that learning style. The availability factor (Ava_{ls}) of a certain learning style (ls) is calculated using formula 1. On the other hand, the frequency factor ($Freq_{ls}$) measures the existence of LOs in the section that support each learning style with respect to the total number of LOs in that section, and is calculated as described in formula 2. The obtained values for both, the availability factor and the frequency factor, range from 0 to 1, where 1 indicates a strong suitability for the learning style and 0 means no support.

$$Ava_{ls} = \frac{(\#\ of\ existing\ LO\ types\ that\ support\ ls\ )}{(\#\ of\ LO\ types\ that\ support\ ls)} \qquad (1)$$

$$Freq_{ls} = \frac{(\#\ of\ existing\ LOs\ that\ support\ ls\ )}{(\#\ of\ existing\ LOs\ )} \qquad (2)$$

Not only the types but also the order and the position of the LOs affect the suitability of a course regarding different learning styles. The sequence factor measures the suitability of the sequence of LOs for different learning styles. It is calculated for each LO according to its type, location (ABC or AAC) and order. It is determined according to how much this object type in that place fits with each of the eight learning styles of FSLSM. The sequence factor (Seq_{ls}) is calculated using formula 3. In this formula, fls (LO) =1, if the LO is suitable for that learning style at that location, and fls (LO) =0 otherwise. The weight w represents how well the position of a learning object in AAC/ABC fits to the learning style, and n is the number of LOs in the section. This formula represented the weighted mean of fls(LO). Its value ranges from 0 to 1, where 1 indicates a strong suitability for the learning style and 0 means no support.

$$Seq_{ls} = \frac{\sum_{i=1}^{n} f_{ls}(LO_i) \times w_i}{\sum_{i=1}^{n} w_i} \quad , \ 0 < w \leq 1 \qquad (3)$$

2. Framework Architecture

The proposed framework is based on DeLeS tool [14]. DeLeS stands for "Detecting Learning Styles". It is developed to detect students' learning styles, in an automatic way, by using data from students' behavior in a course in a LMS. DeLeS is a standalone tool; it is developed to be used for any LMS. The tool consists of two components, the data extraction component and the calculation component. The data extraction component is responsible

for extracting the relevant data from the LMS database in order to calculate learning styles with respect to the four dimensions of FSLSM. Since one of the main aims of the tool is to be applicable for LMSs in general rather than only for one specific system, heterogeneity of database schemata in different LMSs is considered. The calculation component is responsible for calculating students' learning styles.

The proposed framework, for identifying how well a course fits to students' learning styles, extends the data extraction component to retrieve the existing course structure from the LMS database, and adds a new component, the course analyzer, that implements the mechanism described in the previous section. As shown in Figure 1, the data extraction component connects to the LMS database, keeps the tool generic for any LMS schema, and feeds the course analyzer with the raw data to apply the proposed mechanism. In addition, an internal database is implemented in order to facilitate a reliable way of storing and exchanging the data among the different components. Besides, the processing and visualization component retrieves the available information and supplies the teachers with a visualization tool through an interactive graphical user interface (GUI) in a way that supports the teachers to be aware of the suitability of their courses regarding different students' learning styles.

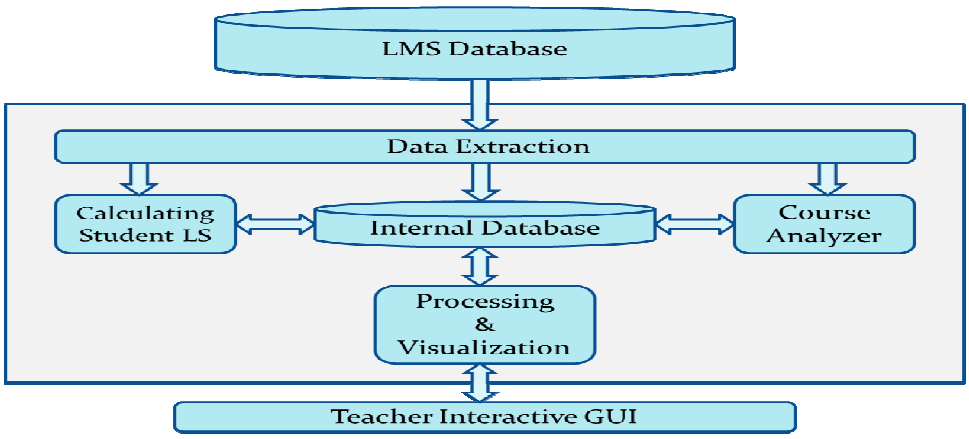

Figure 1. Framework Architecture

3. Framework Implementation

The framework is implemented as a client-server application. It is mainly developed using MySQL relational database management system and PHP scripting language. It is a stand-alone application that runs on the server side, connects to a LMS database (e.g., Moodle), extracts data, analyzes them, and provides the user (teacher) with an interactive graphical user interface that visualizes information about the suitability of the courses for students' learning styles. It allows the teacher to select one course from a list of existing courses in the LMS. Once a course is selected, a chart consisting of a set of bars is displayed. This chart shows how well the course and its sections fit with diverse learning styles.

4. Conclusions and Future Plans of the Research

This paper introduces the design and implementation of a framework for analyzing existing course contents in learning management systems and providing the teachers with information regarding the suitability of their courses for students' learning styles based on Felder and Silverman's learning styles model. The framework utilizes the proposed

mechanism for recognizing how well a course supports different learning styles by calculating three factors: the availability, the frequency and the sequence of learning objects in that course. It provides teachers with an interactive graphical user interface, which can be used to analyze each section of the course and to make teachers aware of the quality of their courses as well as how to improve the courses to support learners with different learning styles.

The future plans of the research includes extending the proposed mechanism to additionally provide teachers with recommendations on how to best extend their courses to support more students with different learning styles, and to fit the course to the current cohort of learners. Also, experiments with teachers are planned to evaluate the efficiency and user-friendliness of the framework.

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