Design of an Intelligent Agent for Personalization of Moodle Contents

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Abstract. This paper presents the architecture of an Intelligent Learning Management System (ILMS) applied to Moodle. Specifically, we present the design and implementation of an agent that select the teaching strategy according to the student's learning style. The chosen teaching strategy is used to filter the learning objects that are displayed to the students.

Keywords. Intelligent Learning Management System, teaching strategy, learning style, personalization content.

1   Introduction

Today, it is clear that the use of information and communication technology in the process of teaching and learning has increased in schools and universities. This has led to the creation of Intelligent Tutoring Systems (ITS). An ITS is a software system that aims to guide students in their learning and/or training process in a personalized way. To achieve its objective, the ITS should model the teaching process, the expert's knowledge, the student understanding on that domain, and achieve communication between these elements. However, most of these systems are not designed to show the material to the students according to their preferences, nor are they designed to diagnose whether the student has developed the competences of the subject that will be taught. One exception is the architecture proposed by [1], which integrates the concept of learning styles, as well as competency-based education in the basic architecture of an ITS.

Also, there are other systems called Learning Management Systems (LMS), which are platforms where teachers can create and manage courses. However, according to [2], these systems don't allow the learner to get a personalized learning experience. Considering this problem, in this paper we apply the ITS architecture proposed by [1] to create an Intelligent Learning Management System (ILMS) applied to the LMS Moodle [3]. This proposal seeks to enhance the features of Moodle and provides a

personalized learning to the student. The design and implementation of an intelligent agent that chooses a teaching strategy according to the student's learning style is presented. This strategy will be used to select the content that will be displayed to the student.

This paper is structured as follows: section 2 describes the concepts related to learning styles. Section 3 presents the proposed architecture. Section 4 describes the design and implementation of the agent. Section 5 presents conclusions.

2   Learning Styles

According to [4], the idea that each person learns differently from others, allows us to find more suitable ways to facilitate their learning. However, we must be careful not to "label" the people, because the learning styles, although relatively stable, can change depending on the situation in which the person is.

In [4], the concept of "learning style" is defined as the fact that each person uses their own methods or strategies to learn. Although the strategies vary depending on what the person wants to learn, each person tends to develop certain preferences or global trends, trends that define their style of learning. Table1 shows some learning styles that have been considered in the implementation of tutoring systems to adapt their teaching environments to users.

Table 1. Learning styles implemented in ITS.

Models of Learning styles	Works
Felder and Silverman model	Hernández [5], Caviedes [6], Cataldi [7]
Gardner's Multiple Intelligences	Cataldi [7]
VARK of Neil Fleming.	Araújo [8] and Peter [2]

Table 2. Example of Teaching-learning strategies for the VARK model.

Learning Style	Teaching-Learning Strategies
Visual	▪ Pictures, Videos, and/or Posters.
Aural	▪ Discuss topics with your teachers.
	▪ Explain new ideas to other people.
	▪ Use a tape recorder.
Read / Write	▪ Dictionaries, Textbooks, Notes.
Kinesthetic	▪ Field tours.
	▪ Applications.
	▪ Trial and error.

In this work the VARK Model [9] was the learning style used and implemented in Moodle. This model is a tool to find out the preferences of persons when they process information. This model takes its name from the initials of the four learning styles that it considers: Visual, Aural, Read/Write and Kinesthetic. Table 2 shows some of the Neil Fleming proposals for teaching-learning strategies for each learning style. The

learning style is detected by a process that applies a questionnaire to determine the student's dominant learning style, this process is described in [10].

3 Architecture

This section presents an Intelligent Learning Management System (ILMS) applied to the LMS Moodle based on the integration of the concept of learning styles and competency-based education in the basic architecture of an ITS (see Figure 1). The concept of learning style is implemented in the process called "selector agent of teaching-learning strategies" and the concept of competencies in the process called "diagnostic of competencies". Both processes were integrated in the tutor module.
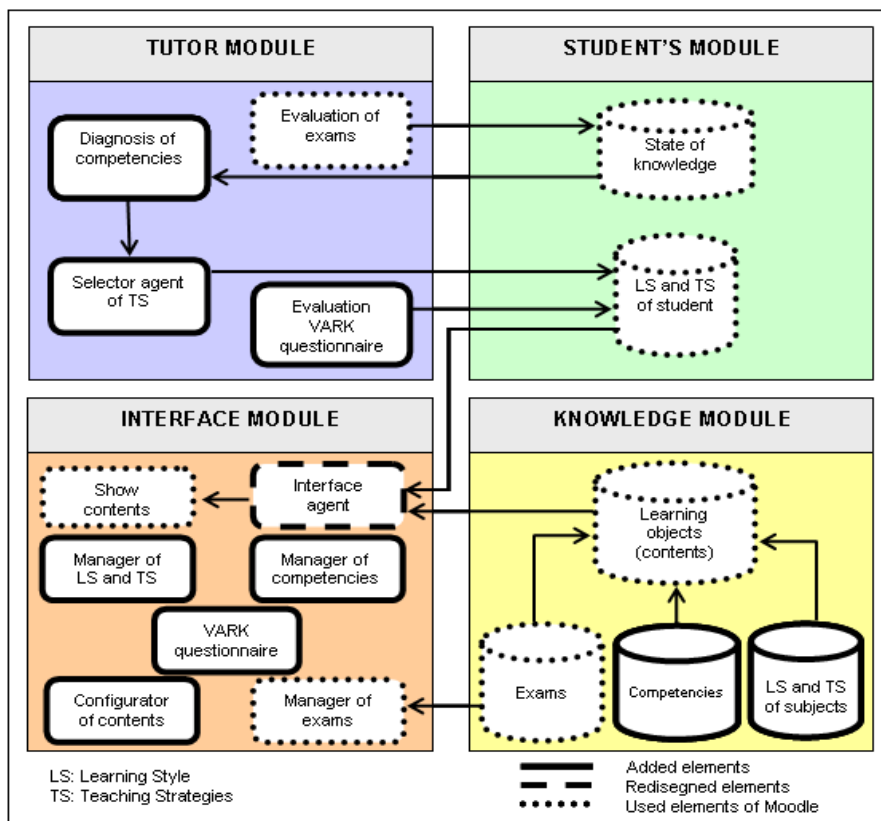

Fig. 1. Architecture of an Intelligent Learning Management System.

The modules of the architecture are related as follows: the *knowledge module* stores the contents to be taught, which are displayed via the *interface module*. The interface module displays the contents designed according to the learning style and the current teaching strategy for the student, this information is consulted in the

student module. The student module is updated by the tutor module, which is responsible for evaluating the performance of the student and diagnosing the competencies that students possess. If the student receives a diagnosis of unsatisfactory competence, the *tutor module* updates the teaching strategy and/or if necessary also the student's learning style, stored in student module, through the selector agent.

The execution of the selector agent depends on the result obtained by the process of diagnosis of competencies. That is, when a student does not meet the standard of competence established, the diagnostic process will execute selector agent. The purpose of the selector agent is to reinforce student learning, by selecting a teaching strategy that goes according to the current learning style of the student. When the teaching strategy is chosen, the interface agent uses this strategy to filter the learning objects developed for the current learning style and teaching strategy of the student that will be shown. This paper only describes the design and implementation of the selector agent.

4   Design and Implementation of the Selector Agent in Moodle

The selector agent is responsible for selecting the teaching strategy according to the current learning style of the student; it is used to filter the learning objects that will be displayed. When all teaching strategies related to the current learning style of the student have been used, the selector agent will be able to change their current style.
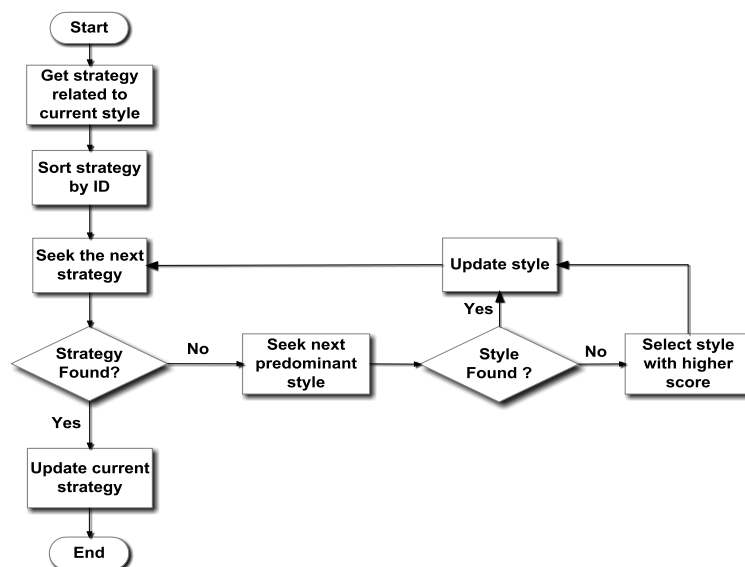

Fig. 2. Flowchart of the selector agent.

This change is performed according to the scores obtained by the student in the VARK questionnaire, choosing the next predominant learning style. When this action is performed on different occasions, and all learning styles have been used, then the selector agent will assign the style with the highest score as current learning style. After changing the current student's learning style, the agent updates the current teaching strategy (see Figure 2).

Below the implementation of the selection agent in Moodle is presented:

1. When the selector agent is executed, the first step is to perform a query to the database to get all teaching strategies that are related to the current learning style of the student. The current learning style of the student is loaded into memory in the object *$USER->Estiloactual*. When the query is performing, the strategies are ordered according to their identifier (see Figure 3).

```
$rs_Estrategia = get_recordset_sql("SELECT Distinct msee.EstrategiaId
                                    FROM mdl_Scorms_ee msee, mdl_Estrategias me
                                    WHERE (msee.EstrategiaId = me.Id) and
                                          msee.CursoId = $Curso and
                                          msee.EstiloId = $USER->Estiloactual
                                    ORDER BY msee.EstrategiaId");
```

Fig. 3. Query to get teaching strategies.

2. Once the strategies associated with student's current style have been obtained, the strategy that has an ID greater than the ID of the current strategy is chosen. The current strategy ID is loaded into memory in the object *$USER->EstrategiaActual*. When a strategy satisfies this condition, it is set as the current strategy (see Figure 4).

```
while ($row = rs_fetch_next_record($rs_Estrategia)) {

    if ($USER->EstrategiaActual < $row->EstrategiaId){
        $estrategia_id = $row->EstrategiaId;
        $Encontrado = 1;

        break;
    }
}

rs_close($rs_Estrategia);
```

Fig. 4. Code to search the new teaching strategy.

3. When a strategy that satisfies the condition is not found, this means that all strategies have been used. So, the selector agent will be able to change the current learning style of the student, according to the scores obtained by the student in the

VARK questionnaire, choosing the learning style that has the following lower score compared with the current style score.

4. Subsequent to the selection of the new style, we proceed to select the ID of the first strategy associated with the new style, which must being associated with some materials (see Figure 5). This strategy will be set as the current.

```
$estrategia_id = get_field_sql("SELECT Distinct msee.EstrategiaId
                            FROM mdl_Scorms_ee msee, mdl_Estrategias me
                            WHERE (msee.EstrategiaId = me.Id) and
                                  msee.CursoId = $Curso and
                                  msee.EstiloId = $estilo_id
                            ORDER BY msee.EstrategiaId");
```

Fig. 5. Code to select a teaching strategy related with the new learning style.

5. After the selector agent made the change of learning style and/or teaching strategy, this information is updated in three different places: 1) in the *EstiloActual* and *EstrategiaActual* fields contained in the *mdl_user_info_data* table, 2) in the *mdl_historial_agenteselector* table which stores the history of changes realized by the selector agent in the style and strategy and 3) in the *$USER* object.

With these three updates, the selector agent function ends. Now, the next process is filtering the contents showed to the student through the interface agent, considering that contents are designed for the current style and strategy for the student.

5   Conclusions

This paper describes the modifications made to basic architecture of an ITS incorporating the concept of learning styles and competency-based education. This architecture is applied to the LMS Moodle in order to create an Intelligent Learning Management System (ILMS).

In particular, we describe the design and implementation of the processing performed by the selector agent to choose a teaching strategy according to the student's learning style. Supporting it with the idea expressed in [3], which states that students learn more effectively when they are taught according to their learning style.

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