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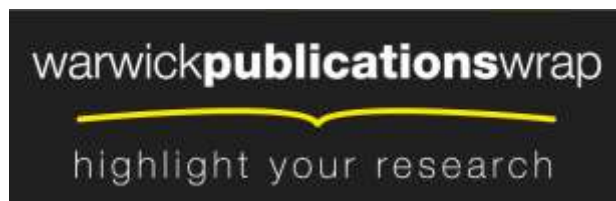
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# To Support Adaptivity in Agent-Based Learning Systems – The Use of Learning Objects and Learning Style

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## Abstract

*Few intelligent learning systems exist which are dynamic and able to provide personalized learning materials to satisfy individual students' requirements. We have developed an agent-based learning system that incorporates learning objects to facilitate personalization, and is based on a learning style theory as the pedagogic foundation for adaptivity. In this paper, we present our novel approach to the incorporation of learning style theory and learning objects, and evaluation indicates that the approach is able to provide personalized learning materials and improve the adaptivity in learning systems.*

## 1. Introduction

The issues of how to support adaptivity in learning systems, and provide students with personalized learning materials, can be partially solved by providing student-centred, self-paced, highly interactive learning materials and introducing automatic and dynamically adaptive learning methods. To achieve these methods, new delivery mechanisms are required, including online, open and distance learning [1]. Agent technology is a promising approach for addressing the challenges of modern day education [2]. However, although some agent-based learning systems exist, many of them lack a robust pedagogic foundation to support adaptivity. We have developed a multi-agent based integrated learning system architecture [3] that is student-centred, adaptive and dynamic. In contrast to other agent-based learning systems, learning style schemes form the pedagogic foundation for adaptivity and the use of learning objects facilitate personalization.

There are many strategies and standards for designing and categorising learning objects, but research into incorporating real learning objects with

learning style schemes into education systems is rare. Learning style theory addresses the issue of adaptivity, and learning objects address the issue of decomposition of learning materials to meet the requirement of personalization. How to incorporate learning style theory into agent-based learning systems is still a research question, and the appropriate granularity of learning object classification is also under investigation. One of the contributions of our research is how our proposed multi-agent learning system addresses these questions.

## 2. The Use of Learning Objects and Learning Style

In our multi-agent based learning system, one of five agents, the Learning Object Agent, is responsible for incorporating the learning style scheme and the learning objects. The learning style theory we have adopted in the system is the Felder-Silverman Learning Style Model, for reasons described in [4].

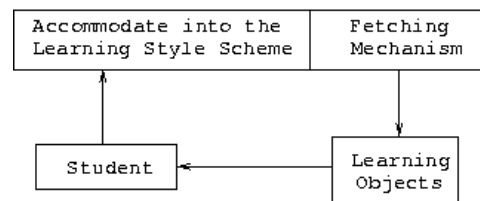


Figure 1. Overview

A repository provides the learning objects in the Learning Object Agent. In order to deliver the learning objects according to different learning styles, the implementation and evaluation has been divided into three parts: accommodating students into the learning style scheme, categorizing learning objects according to the learning style scheme, and delivering Learning Objects. From a highly abstract level, an overview of the system can be laid out as in Figure 1.

The system locates the student's learning style preference into the learning style space, and also stores each student's current learning style (which may change over time), and the style attributes of each learning object, as co-ordinates in the four-dimensional space. The system will then search the repository of learning objects, to fetch appropriate learning objects with similar (but not necessarily identical) dimensional descriptions. These are supported by agent technology to realize the algorithm and implement the process. The objects are then presented to the student, and the subsequent interactions between the student and these learning objects may be used to modify the learning style attributes recorded for a student.

The incorporation of learning objects and learning style, which we have used in our system, is able to dynamically organise and deliver learning materials to satisfy individual learning requirements, and agent technology gives dynamic support. For a more extensive technical discussion, we refer to [4].

### 3. The Multi-Agent Education System

Agent technology has been used in education systems to facilitate autonomy and adaptivity, decoupled from the pedagogic foundations of the system (for more information, refer to [4]). Each such system emphasizes a particular aspect, such as training, group work, or human resources requirement. Each has its individual ways of organizing the learning materials, and few have considered the effect of different learning styles or the adoption of learning objects.

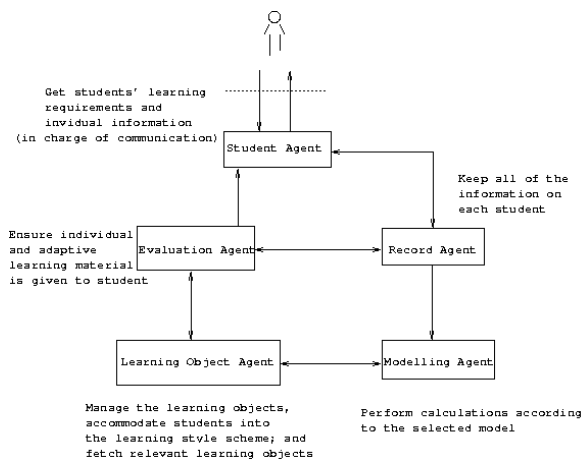


Figure 2. System Architecture

Our proposed multi-agent based pedagogic system is functionally constructed by five agents, as shown in

Figure 2, and comprises the Student Agent, the Record Agent, the Modelling Agent, the Learning Object Agent, and the Evaluation Agent. Each agent is designed to satisfy a certain functional requirement to actualize the service purpose of the education system, namely to provide dynamic and adaptive learning materials to individual users.

The Student Agent is responsible for communicating with students; the Record Agent maintains information about each student; the Modelling Agent creates models of students' skills and learning objectives; the Learning Object Agent manages the set of learning objects; and the Evaluation Agent ensures that learning objects are presented in individual and adaptive learning paths to each individual student.

### 4. Conclusions and Future Work

We have described the use of learning objects and learning style in an agent-based learning system to enhance adaptivity. At the conceptual level, personalization and adaptivity are achieved by the use of learning style schemes to tailor the presentation of learning objects to individual students. Conversely, at the practical level, this adaptivity is achieved by providing a set of agents that use a combination of pre-built and acquired knowledge to determine the learning styles and learning objects that are appropriate for individual students. In contrast to other agent-based learning systems, learning style schemes form the pedagogic foundation for adaptivity and the use of learning objects facilitate the personalization. Future work includes evaluation of the functions of agents, and the evaluation of the system effectiveness and efficiency.

### 5. References

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