Abstract

E-Learning solutions face challenges that are leading a group of researchers to doubt the efficiency of such an experience. Challenges include lack of adaptation in the e-Learning process. Service Oriented Architecture (SOA) - as a design pattern presenting systems as collection of reusable services that can be exposed and consumed on the Internet with standard interfaces - has many advantages that can be achieved on technical, managerial and implementation aspects. It can be useful in integrating adaptive and intelligent features in e-Learning systems.

However, utilizing SOA in e-Learning faces challenges. Those challenges can be categorized into two categories: pedagogical and technical. Pedagogical challenges are related to the activities and the learning path of the e-Learning process itself. Technical challenges are related to the way system architects design and build e-Learning systems. Optimization is a continuous process that happens iteratively and recursively to achieve better:

- Addressing and understanding the problems in hand
- Presenting different proposed solutions
- Optimizing the selected solution
- Applying the optimized and enhanced solution
- Evaluating the applied solution

Dissertation addresses pedagogical and technical challenges facing the e-Learning process and presents an Adaptive e-Learning Model as a solution to the highlighted problems. Pedagogical solutions include new adaptive features presented to: students based on their learning preferences, and to instructors to empower them through e-Learning. Technical solutions include optimizing newly presented features. Presented model uses SOA in integrating major e-Learning components together, side by side with adaptive and intelligent features. e-Learning Components include:

- Adaptive Learning Management System (LMS): includes
  - Student Learning Subsystem
  - Student Learning Profile Subsystem
- Quality Assurance and Accreditation Project (QAAP) Management System: includes
  - Course Specifications Module
  - Instructor Time Table Module

- Exam Management System: includes
  - Exam Data
  - Exam Application
- Learning Content Management System (LCMS): includes
  - Questions
  - Learning Objects (LOs)

Presented Adaptive e-Learning Model includes different intelligent services that use fuzzy logic as an intelligent technique to empower it. Presented Model proposes nine intelligent services utilized in different e-Learning functionalities. Intelligent services are grouped into two categories based on their aims: Instructor Services and Student Services. Instructor Intelligent Services are:

- Intelligent Learning Objects (LOs) Classifier: combines both supervised and non-supervised learning algorithms with fuzzy logic to classify LOs.
- Intelligent Online Lecture LOs Advisor: enables the Adaptive Online Lecture Model to present different pedagogical aspects via:
  - Recommending LOs based on students' learning preferences.
  - Involving students in the learning process from the very early beginning of the lecture.
  - Preparing for the next lecture, so students feel the lecture's adaptivity.
- Intelligent Student Performance Tracker: intelligently keeps track of students' learning profiles and preferences and verifies completeness.
- Intelligent Cheating Depressor: intelligently identifies students cheated during online assessments based on their history, consumed assessment duration, and scored marks.

Student Intelligent Services are:

- Intelligent Time-to-Learn Topic Calculation: guides the students to the time needed to learn topics. This service helps students come over the variance between the time they expect to learn, and the time they actually take to learn.
- Intelligent Study Plan Advisor: guides students through branching decisions in courses based on previous study plans, learning profiles and preferences of current students.

- Intelligent Agenda Study Time Planner: helps students identify study times and control interruptions to improve performance. It integrates with available activities to update students' calendar automatically.
- Intelligent Meeting Manager for Suspended Students: intelligently schedules a meeting with one of the instructors for suspended students.
- Intelligent LOs Recommender: intelligently recommends LOs to satisfy courses' prerequisites that are not fulfilled by students, and to suggest further readings for students based on their learning preferences.

Optimizing the presented SOA based Adaptive e-Learning Model and intelligent services is achieved on: Model level, Architectural Level, and Service level. Model level optimization included presenting new adaptive and intelligent features, and using them innovatively. Architectural level optimization included the shift from traditional methods of building SOA based e-Learning systems to decrease the granular level of services, and utilizing new Web services technologies. Service level Optimization is experienced through the optimization of Intelligent LOs Recommender, as it was the bottleneck of the presented Adaptive e-Learning Model identified during implementation and deployment.

Optimized Adaptive e-Learning Model and intelligent services are evaluated from three perspectives: User Satisfaction, Performance, and Information Retrieval. User Satisfaction is evaluated from both instructors and students points of view using surveys and reviews of the presented Adaptive e-Learning Models. Performance perspective of the presented model focuses on the effect of identifying the presented model's bottleneck through experimenting the system, and presenting a solution to overcome this bottleneck, optimizing the solution, and applying it. The performance bottleneck is identified at the Intelligent LOs Recommender service. Information Retrieval (IR) of the presented Adaptive e-Learning Model is an important aspect as the presented system has to handle large amounts of LOs. Presented system IR capabilities are measured by the three IR measures: Precision, Recall, and F-Measure. Presented Adaptive e-Learning system shows enhanced IR performance measures. The capability of Intelligent LOs Classifier on classifying different LOs was examined. Intelligent LOs Classifier shows high classification rates on testing set.