

Chapter Two

e-Learning Pedagogical and Technical Problems

2.1 Introduction

Current Learning Model Paradigm faces many pedagogical and technical challenges. Pedagogically, Educational psychologists agree that students differ in the ways they learn and very few teachers can adapt learning to each student in the typical large classes. Computer-based learning systems are criticized by many researchers for their limited ranges and adaptability of teaching actions compared to rich tactics and strategies employed by human expert teachers. Many universities in the developing countries, started to adopt e-Learning by modifying network infrastructure, establishing new labs, providing internet connection, and purchasing different tools for creating e-Learning courses and using different LMSs. However, these modifications and supplement were not enough to ensure successful e-Learning outcomes because other important elements for e-Learning success were missing such as flexibility of the system, adaptability towards students' needs, reusability of learning objects, interoperability between LMSs, effective and official design of e-content. SOA as a design pattern that has achieved technical advantages in integration, interoperability, and many other aspects faces performance challenges that can be enhanced.

This chapter presents Pedagogical problems, and the Technical problems, facing e-Learning opening the door for closely identifying the problems in hands, and beginning the road for Optimizing SOA to Support e-Learning with adaptive and intelligent features.

2.2 Pedagogical Problems

E-Learning can be thought of as the learning process created by interaction with digitally delivered content, services, and support. E-Learning involves intensive usage of Information and Communication Technology to serve, facilitate, and revolutionize the learning process [1-3]. Learning methods include traditional learning “face-to-face”, distance learning “complete asynchronous time and place learning delivery; mainly online”, and blended learning “learning that combines instruction lead learning with online learning activities leading to reduced classroom contact hours”. Blended learning has the potential to increase student learning while lowering attend rates compared to equivalent fully online courses [4]. Blended learning is the learning paradigm that attempts to optimize both traditional learning and distance learning advantages, potentials, and benefits while eliminating both learning paradigms shortages and challenges. When compared to traditional learning paradigm, blended learning is found to be consistent with the values of traditional learning paradigm adopted in almost all higher education learning institutions for decades, and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences [5].

Learning Management System (LMS) is the software that automates the administration of education. LMS registers students, tracks courses in a catalogue, records data from learners, and provides reports to management. LMS is typically designed to handle courses by multiple publishers and providers. It usually doesn't include its own authoring capabilities; instead it focuses on managing courses created by a variety of other learning resources. Prototypical LMS is presented in [6]. Technology and the great advancement in recent Web 2.0 and informal learning methods allowed the existence of complete education programs and courses to be presented online.

This part reviews the different adaptive and intelligent e-Learning systems proposed over a long e-Learning research era, highlighting the maturity of adaptive and intelligent features and the e-Learning researchers attempt to introduce services based e-Learning systems in order to overcome many of the e-Learning challenges, like reusability, scalability, integration, and interoperability. This chapter concludes with the need to present a new learning model that attempts to use the best of what was presented before, and avoid all the challenges and mistakes.

Current Blended Learning Model Paradigm faces many pedagogical challenges. Today's technologies advance by decades technologies used in teaching and education less than decade ago. However, a number of recent articles have commented that science education is no better today than it was fifty years ago. The National Assessment of Education Progress (NAEP) shows that in most areas today's students are achieving at about the same levels as students tested in 1971 [7]. This pedagogical issue is the result of:

- The attempt to use whatever technology currently available or becomes available in the near future without pedagogically considering student or the learning process.
- Allowing technology to stand against the learning process, because no matter what advancement we have achieved, technology is still limiting our ambitions.
- The poor evaluation that is available for many of the innovations. Most of the required evaluations are either inadequate or doesn't exist at all.

Alfred Bork et al. argue that some of the reasons why technology has not led to improvements in learning globally are [7]:

- Grabbing Onto Each New Technology: The belief that each new technology will enhance learning needs more arguments about efficiency than just belief.

- **Failure to Continue Successful Development:** funders often prefer to look for something new rather than follow up on successful approaches because they want to make a mark by being in the forefront. Funders want to make a statement, and following up on someone else's work doesn't provide them with the credit or "name" they desire.

Pedagogically, most training methods and technologies produce, at best, "trained novices". That is, they introduce facts and concepts to students, present them with relatively simple questions to test this new knowledge, and provide them with a few opportunities to practice using this knowledge in exercise or scenarios. However, becoming proficient requires extensive proactive solving realistically complex problems in wide range situations, combined with coaching and feedback from managers, more experienced peers, or other types of experts [8].

Most evaluations of today's presented technologies in the learning model focus on technology aspects of the solution while ignoring the pedagogical aspect; almost at all. The result of using technology, particularly computers, in learning has so far not been impressive. A variety of studies and opinions have questioned the use of technology to improve learning. Although it has been many years since computers have begun to be used in learning environments, there is little improvement in learning, with or without technology. Although the use of technology in learning shows no significant difference, that is, computer learning is no better than traditional instruction, learners have been provided with the convenience of any time, any place learning. Students' understand and retention improves when students learn by experience. Technologies such as collaboration, interactivity, modeling, simulation, virtual reality interfaces, and gaming will help students experience the skill being taught, but they have not helped students that far yet [7]. Besides, students lack

of awareness of different e-Learning technologies stand up against the presentation of effective e-Learning model.

Adaptive learning for students with many different backgrounds, learning styles, and interest is almost a must. Educational psychologists by and large agree that students differ greatly in the ways they learn and very few teachers or professors can adapt learning to each student in the typical large classes, the costs associated with delivering different instruction for varied learning styles is prohibitive [7]. Benjamin Bloom (1984) showed twenty-seven years ago, as reported in his 2 sigma paper, that almost all students can learn to the mastery level, given the right learning environment [9]. In Bloom's experiments, the most successful learning strategy was tutoring. Adaptive e-Learning that is supported with intelligent techniques and methods is one of the ways to support tutoring in e-Learning, and so it is believed that it will be the way to solve many of the limitations and today's e-Learning challenges.

2.3 Adaptive and Intelligent e-Learning Systems

Computer-based learning systems are criticized by many researchers for their limited ranges and adaptability of teaching actions compared to rich tactics and strategies employed by human expert teachers [10]. Many universities in the developing countries, started to adopt e-Learning by modifying their network infrastructure, establishing new labs, providing internet connection, and purchasing different tools for creating e-Learning courses and using different LMSs. However, these modifications and supplement were not enough to ensure successful e-Learning outcomes because other important elements for e-Learning success were missing such as flexibility of the system, adaptability towards students' needs, reusability of learning objects, interoperability between different LMSs, effective and official design of e-Content [11].

Adaptive e-Learning systems would be a good solution for better e-Learning. The absolute majority of Web-enhanced courses rely on LMS because they are powerful integrated systems that support a number of teachers and students' needs. Though LMSs look surprising, indeed for every function that a typical LMS perform there is an Adaptive Web Based Educational System (AWBES) that can do it much better [12]. Adaptivity is the ability to modify e-Learning lessons using different parameters and a set of predefined rules. Researchers differentiate slightly between adaptivity and adaptability by thinking about adaptability as the possibility for learners to personalize an e-Learning lesson by themselves. These two approaches go from machine centered (adaptivity) to learner centered (adaptability). In practice, it is quite difficult to isolate one from the other due to their close relationship [13, 14]. Adaptive e-Learning is often meant to be new or in an early development stage [10]. Adaptive e-Learning system is the environment of software modules, which comprises a set of features for adaptivity and adaptability [15].

Important factors for adapting to student needs and desires include [7]:

- **Each student should move at a unique pace:** Given all the variations between students' backgrounds, interests, and abilities, it is highly desirable to allow each student to move at a unique pace in the learning units.
- **Adaptation should be very frequent:** Changes based on occasional exams are inadequate. Learning activities should adapt to each student on a moment-by-moment basis. Students should feel that the adaptive program is responding to them as individuals.
- **Each student should be successful in learning:** a major advantage of adaptive variable placing is that the students can continue to learn in a given area until they have learned the material. Almost all learners can succeed and achieve mastery, but some learners need more time and more practice than others.

- **When something is successfully learned, the learner should move on:** Often in classroom learning, after a student has learned something, the class continues working on the topic, boring the student. This will not occur in a fully adaptive learning environment.
- **No one should be taught something he already knows:** By assuring learner competencies, avoiding unneeded instruction, and moving each student forward when ready, students are expected to achieve a major reduction of learning time, but this cannot be verified empirically until there are full range of computer-based adaptive learning units.

The provision of static learning material will not meet the requirements of students. Adaptive e-Learning enables personalizing learning process to individual learners via adapting some parameters; like identifying, analyzing and monitoring relevant aspects of instructions, such as different velocities, paths, or strategies of learning. Performance improvements within the learning process can be gained via adaptive e-Learning systems [15]. Adaptation and personalization will improve the learning process; therefore, a paradigm shift from the consumption of static learning contents to well tailor and highly personalized learning sessions is needed.

2.3.1 Adaptive e-Learning Approaches

Four main approaches which are used to give a historical overview of adaptive e-Learning can be identified [10]:

- **Macro-Adaptive Approach:** Addresses adaptation of instructions on a macro-level by allowing different alternatives in selecting a few main components such as learning objectives, levels of detail, and delivery system. In this approach, instructional alternatives are selected mostly on basis of the student's learning goals, general abilities, and achievement levels in the curriculum structure.

- **Aptitude-Treatment Interaction (ATI) Approach:** This approach treats adaptation of instructional strategies to specific student's characteristics. This strategy proposes different types of instructions or even different media types for different students. The most important classes of learner characteristics can be summarized with the following ones: intellectual abilities, cognitive styles, learning styles, prior knowledge, anxiety, achievement motivation, and self-efficiency. One aspect of the ATI approach is the user's control over the learning process according to the abilities of the students by giving them full or partial control over the style of the instruction or the way through the course. Level of control can be one of three levels: complete independence, partial control within a given task, and fixed tasks with control of pace.
- **Micro-Adaptive Approach:** Addresses adaptation of instructions by diagnosing the student's specific learning needs during instruction and providing instructional prescriptions for these needs. Researchers have attempted to establish micro-adaptive instructional models using on-task rather than pre-task measures. Monitoring the user's behavior and performance, such as response errors, and response latencies can be used for optimizing instructional treatments and sequences on very refined scale [15].
- **Constructivistic-Collaborative Approach:** Follows the constructivist pedagogical approach. An important element of this approach is the usage of collaborative technologies which are considered often an essential component of e-Learning. Adaptive system enables learning by focusing on how knowledge is learned and should consider the context, learning activities, cognitive structures of the content, and the time extension. Some new adaptive e-Learning systems take account of students' motivational factors combining the instructional plan with a "motivational" plan.

Over the last decades, various types of adaptation systems and possible areas for their applicability have been identified, thus leading to the emergence of

specialized research fields, like Adaptive Hypermedia Systems (AEHS), Computer Aided Instruction (CAI), Computer Managed Instruction (CMI), Recommender Systems, Intelligent Tutoring Systems (ITS), Personalized Systems of Instruction (PSI), and many others. Adaptive multimedia systems as an improved learning environment is well documented in the research work of Christian Gutl et al. [15].

2.3.2 Intelligent e-Learning Systems

Artificial Intelligence (AI) utilizes programming algorithms to simulate thought processes and reasoning that produce behavior similar to humans. A successful implementation of AI could be tested using a Turing Test approach, in which a human interacts with an interface that could have either a human or computer on the other end. The test is considered successful if the human is unable to determine whether there is a computer or a human on the other end. The applications of AI within e-Learning can produce the potential of creating realistic environments with which students can interact. The student essentially would interact with the intelligent agents which in turn perceive changes in the simulated environment. The intelligent agents would then communicate perceived changes in the environment back to the student who then makes decisions based upon their own perceptions of the environment [16].

Current learning technologies can help create trained novices more efficiently, but they are really not up to the job of creating true experts. For example, multimedia Computer Based Training (CBT) systems are good at presenting information and then testing factual recall using multiple choice or fill-in-the blank questions. However, traditional CBT systems are incapable of providing intelligent, individualized coaching, performance assessment, and feedback students need to acquire deep expertise [8].

Employing the state-of-the-art AI technology in current e-Learning systems can bring personalized, adaptive, and intelligent services to both students and educators. Most of the AI applications have not yet been expanded to or adopted in widely used e-Learning systems, especially open-source systems such as Moodle and Sakai. Current intelligent LMS systems are still in their early stage, while AI applications need to handle some problems or to be modified before applying them into the LMS systems, and AI technology needs to be brought to open source communities [17].

2.4 Utilizing Service Oriented Architecture in e-Learning Systems

Service Oriented Architecture (SOA) is a design pattern that presents IT infrastructure and information systems architecture as loosely coupled, fine granular services that can address system requirements once they are presented either by adding new services or modifying existing ones. SOA also addresses enterprises information systems' inefficiency by enhancing reusability, thus theoretically, shortening information systems development time and effort required. Besides reusability, interoperability and integration are other main driving forces for adopting SOA in e-Learning systems. W3C defines Service as 'A Component capable of performing a task'. Service is 'A vehicle by which a consumer's need or want is satisfied according to a negotiated contract (implicit or explicit) which includes Service Agreement, Function Offered and so on'. SOA is the design pattern that utilizes services concept to achieve architectural advantages. W3C defines SOA as 'A set of components which can be invoked, and whose interface descriptions can be published and discovered'. This definition can be expanded to include the science, art and practice of building applications, so SOA can be defined as 'The policies, practices, frameworks that enable application functionality to be provided and consumed as sets of services published at a granularity relevant to the service consumer. Services can be

invoked, published and discovered, and are abstracted away from the implementation using a single, standards based form of interface' [18].

2.4.1 Web services as main SOA enabler

Web services are applications that use standard transports, encodings, and protocols to exchange information [19]. A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. W3C defines Web service as “A software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a format that machines can process (specifically WSDL), Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with XML serialization in conjunction with other Web-related standards” [20]. Web service can also be defined as ‘A programmatic interface to a capability that is in conformance with Wsnn protocols’. Wsnn protocols are present efforts in the W3C and more recently in OASIS to reach a Web service maturity model. Wsnn protocols include WSDL, SOAP, and XML [21]. SOAP is a lightweight protocol intended for exchanging structured information in a decentralized, distributed environment [22]. XML solves a key technology requirement that appears in many places. By offering a standard, flexible and inherently extensible data format, XML significantly reduces the burden of deploying the many technologies needed to ensure the success of Web services [23]. Web services is a general framework that expedites the sharing of heterogeneous data and software resources dispersed on the internet. The standard-based resource sharing and platform-neutral characteristics of Web services have motivated many organizations to apply the technology in diverse areas, such as supply chain management, virtual enterprise, homeland defense, and e-business [24].

2.4.2 SOA and e-Learning Systems

Integration, interoperability, scalability, and reusability are the main axis that SOA based e-Learning researchers attempt to address, solve, and enhance in e-Learning systems. Though some researchers ignored the pedagogical features of e-Learning systems, others considered those features as the main motivator of adopting SOA in e-Learning. e-Learning is moving from passive to active; because the learner is getting more involved with the learning experience [25]. Besides, technology emerging from the adaptive hypermedia, semantic web, mobility and distributed computing communities are being widely employed in online learning, and steps toward Service-Oriented e-Learning platforms need to be taken. LMSs can be classified into three generations: First Generation “Monolithic”, Second Generation “Modular”, Third Generation “Service-Oriented”. First generation focused on presenting learning content without tracking learner activities. Second generation enhanced the learning process but cannot stand handling new technologies, interoperability and integration between evolving systems like third generation shall do. Interoperability needs to be on control basis not just on data basis. Service-Oriented LMS include adaptive hypermedia and semantic web.

2.4.2.1 Moodle and Web services

Research work that focuses on “assignment” modules based on Moodle and the steps to enrich it with Web services is presented in [26]. It is argued that Web services is important and required in integrating different Moodle(s) resources; especially assignments, and to provide the capability for more than one instructor to be working on the same course. Instructor can search for the best assignment within different Moodle(s) instances and retrieve it. PHP based SOAP Web services to integrate best with Moodle is presented. There is no evaluation presented at his research, however it presents a utilization of UML in

describing Web services specifications. Though the research work title includes SOA, the common misuse of Web services as SOA is clear in this research. Web services are main SOA enabler, however SOA is not just Web services.

2.4.2.2 Services based e-Learning Systems and Reusability

One of the good utilization of SOA in e-Learning is presented by [27] to address the reusability capabilities provided by SOA. It is argued that instead of building an e-Learning system from scratch, it can be assembled by choosing the required functionalities from a set of Web services related to e-Learning. Study results in a set of Web services for the e-Learning domain. In the abovementioned study, there are different points of strength and weaknesses. The main functionalities of typical e-Learning systems are built using Web services. The strength of this approach is reusability and interoperability. Developing a new e-Learning system will involve assembling the required Web services. The e-Learning system can be developed and run on different hardware and software platforms. However, the disadvantage of this approach is if the server that hosts the Web services is off-line, the e-Learning system which depends on these Web services will not be operational. Another important feature of this study is the use of rubrics in guiding the instructor to evaluate subjective assessment. Rubrics improve consistency in the evaluation of students' work especially when there is a large number of student and multiple instructors are involved in the evaluation. Another good point of the proposed research is the commitment to E-Learning Framework (ELF) and e-Learning standards as depicted in the architecture presented at the study.

However and to repeat from almost all services based LMSs, SOA is not Web services. There is no indication of implementation at all, and so evaluation was not mentioned. It is really rare to find evaluation for SOA based e-Learning systems. SOA adoption in e-Learning systems is new to some extent.

2.4.2.3 Services based e-Learning Systems and Scalability

Another SOA based framework for e-Learning Systems is presented by [28]. Scalability issues of educational institutions are discussed and SOA based e-Learning framework to address scalability capabilities of SOA is presented. This research handles the educational institutions incapability of maintaining large scalable LMSs by grouping LMSs services (based on Advanced Distributed Learning “ADL” Seven services) into local and global groups. Local services group which constitutes the “Local LMS” are provided and maintained internally while other services can be spread over the internet. ADL modularize LMS into seven services: Tracking, Delivery, Learner Profile, Course, Sequencing, Content Management, and Testing/Assessment. It is argued that tracking and delivery services shall compose local LMS while rest of the services can be spread globally. Authors argue that maintaining learning material might exhaust educational institution resources, so Local LMS will not store learning material, however it will acquire it from different places.

Though proposed framework combined content with course services to be almost one service, and though they did not mention Assessment/Test service at all, they still presented a SOA based e-Learning framework that included modifications to the Original ADL LMS model to fit with the research objective.

2.4.2.4 Services based e-Learning Systems and Integration

Web services oriented framework for e-Learning systems aimed at providing a flexible integration model in which all the learning components and applications are well defined, effectively discovered, and loosely connected through using Web services as the main system component to achieve that objective is presented in [29]. However, it argues that there is a need for a standard mechanism for supporting complete automation through all aspects of end-to-

end learning process that includes finding suitable learning components or learning management services, getting information about their services and invoking their services. Though automation of complete end-to-end learning process might seem to be a goal to achieve, doubts about the effectiveness of such a learning approach is under questions. Arguments that prove the efficiency and effectiveness of pure e-Learning programs are not completely confirmed. There is a need of human tutor to support blended learning (at least at some level of the learning process). This research did not include any details about evaluation of the proposed work. Experience proved that SOA is not just Web services.

Another SOA based e-Learning research project is the one presented in [30] that presents a SOA based Course Management System (CMS) to address different integration challenges. One of the critical limitations of a newly established educational institution is the lack of available well prepared courses. It is more applicable to use widely available courses that might be higher in quality than preparing new courses. Current CMSs do not exploit courses shareability. To address this shortage, a CMS is presented to highlight automated discovering and importing of courses maintained and managed by external CMSs. Proposed CMS architecture utilizes SOA as a design pattern to integrate different CMSs on service level. Proposed CMS consists of two layers: Presentation layer and Service Layer. Presentation layer is responsible for interacting with user either via displaying information or receiving user inputs. Service layer contains core system services. Service layer is divided into three sub layers: orchestration layer, application services layer, and agents layer. Orchestration layer holds business logic required by system processes. Application services layer contains set of stateless services that are capable of performing certain tasks. Agents layer presents the suggested required software agents to serve the overall system. Suggested agents are: Discoverer, Ranker, Tracker, and Analyzer

software agents. Integration between software agents and Web services is achieved by utilizing SOA. Proposed CMS facilitates integration between different CMS in order to share resources of educational institutions.

Other SOA based e-Learning research projects that concern integration is the one presented in [31]. It is argued that Web services have drawn the attention of learning technology researchers and practitioners, e.g., for decentralized, integrated support of Web-service-based agents, for contract-based provision and discovery of distributed Reusable Learning Object (RLO) repositories, or for enhancing the functionality and interoperability of existing learning technology applications, to mention a few. All of these approaches employ Web services to increase extensibility and flexibility of existing solutions and to foster standards-driven development, dissemination, and usage of desired functionality. They present an open, standards-based learning technology architecture that uses distributed Web services to support a broad variety of blended learning scenarios. This project addresses blended learning where; according to the author, not much projects address efficiently.

2.4.2.5 Services based e-Learning Systems and Interoperability

“Scalable Adapter” design pattern constitutes a software architecture that can be used to create interoperability between differently targeted educational tools. The key idea behind the pattern is to add a small “data adapter” to each learning environment. The adapters can then access arbitrary (scalable) parts of the data of “their” learning environment and exchange this data with other adapters. These changes are not costly and usually easy to create since the existing systems do not have to be changed but merely need to be extended. This design pattern is used mainly to provide interoperability features between different e-Learning tools used in educational institutions. Advantages of this design pattern are many and three different case studies presented in this research.

However, integrating different applications on data level has never been the appropriate solution for all system integration problems.

Interoperability approach based on data is presented in [32]. There are driving forces for applying that approach, include: easier exchange of data, reduced development time, and reduced maintenance costs. Architects and programmers do not have to change current already running systems; instead they need to add new adapters that connect systems together. However, connecting systems together via adapters is not “always” the optimum solution. Data based interoperability lacks application logic interoperability and might stand as an obstacle against Business Processes adoption within educational institutions. However, data based interoperability cannot be ignored.

Another SOA based interoperability research project is the one presented by [33]. This research project presents a SOA based Assessment Management System (AMS) to address Mobile Assessment as one of the e-Learning activities. Mobile Learning (M-Learning) is an approach to e-Learning that utilizes mobile devices and is strongly recommended to be enabled by LMS. Assessment is one of the learning activities that can be achieved electronically and via mobile devices. Mobile assessment refers to the capability of conducting assessments via mobile devices. Mobile assessment relies on external services that are not part of the LMS. Providing interoperability between different external systems and services to be virtually part of the educational institution LMS is one of integration and interoperability challenges. Authors presented an extension to the SOA based LMS developed in the faculty of computers and information systems at Mansoura University to address mobile assessment. Proposed architecture consists of two layers: Interface layer, and Service layer. Interface layer interacts with instructors, learners, and business managers via human interface (portals), and with external organization services via machine interface (Web services). Service layer

contains core LMS services and has three sub layers: Orchestration, Application Services, and Agents layer. Orchestration layer holds business logic presented by system processes as executable services. Application Services layer contains set of stateless Web services that are capable of performing certain tasks related to system entities. Agents' layer presents the suggested required software agents to serve the overall system. Agents' layer presents Tracker software agent; which is responsible of tracking students' non-conducted assessments and taking appropriate actions to inform them.

Other interoperability approach that acts on “service basis” is presented by [34]. Importance of standards and its role in interoperability between different applications is highlighted. Also, they argue that layering is one of the patterns that are important while considering e-Learning solutions. Also, LMSs' future tendency is to be service-oriented. In this scenario, LMSs are based on modular components and they can support different services that do not stick to a specific platform. They envision that the ideal scenario is one in which all the different educational services can be interoperable among different LMSs; and in which the entire design of different LMS courses can be done off-line (outside of LMSs) in an easy way for teachers without high technological knowledge using proper authoring tools' and next these courses can be imported within the different LMSs.

Infrastructure layer represents the final resources of an institution, such as file systems or databases. The Common Services are services that are used by several educational applications, such as authorization or authentication. The Educational Services are specific educational modules like assessment or Course Management. Finally, the Educational Applications are the applications a user directly interacts with and these educational applications can use the implemented educational and common services. The IMS Abstract Framework architecture is very similar to the defined by Open Knowledge Initiative (OKI),

and a perfect relationship among layers of both architectures can be established. Both architectures capture the strong importance of LMS services. Besides interoperability, Reusability of courses, services, and all materials is a main motivator of researchers to highlight the importance of layering and standards to achieve interoperability and reusability between different educational systems.

2.4.2.6 Services based e-Learning Systems and XML

e-Learning framework based on the design and implementation of a middleware is presented in [35]. Authors ought to adopt technologies that are standardized and widely deployed in both e-Learning systems and network infrastructure layers. The general architecture of the e-Learning management scheme is based on the configurable component-based middleware architecture for deploying e-Learning services. Each component has one or more agents, which maintain a local XML-based Management Information Base (MIB), and communicate with manager residing at the service or session management component. The agent communicates with the middleware via a light protocol such as SOAP. Another research project that utilizes XML in e-Learning is the one presented by [36]. E-Learning platform with the required functions to provide information to everyone in anytime and at anywhere is proposed.

2.5 Technical Problems with Services based e-Learning Systems

SOA utilization from different researchers' perspectives leads to different SOA based e-Learning systems architectures. From full SOA functionalities architectures to just Web services enabled architectures are available by different researchers. SOA based e-Learning systems frameworks are available; without much evaluation and further analysis of points of strength and weaknesses. Architectures that tend to support fully automated learning process and architectures that tend to support blended learning are available. SOA based systems that support point-to-point integration and interoperability, and

architectures that support Middleware based integration and interoperability also exist. Each approach has its own points of strength and points of weakness. Point-to-point integration enhances performance. On the other hand, middleware based architectures are more flexible, scalable, and fault tolerant. Evaluation of utilizing SOA in e-Learning systems need to be more studied to highlight advantages and shortages of utilizing SOA in e-Learning, and still SOA based architectures vary a lot from a research project to another.

2.5.1 Evaluation of Utilizing SOA in integrating e-Learning Systems

To help universities achieve their goals, it is important to align managerial functionalities side by side with educational aspects. Universities consume University Management Information Systems (UMIS) to handle managerial aspects as they do with Learning Management Systems (LMS) to achieve learning objectives. UMIS advances LMS by decades and has reached stable and mature consistency level. LMS is the newly acquired solution in Universities; compared to UMIS, and so adopting LMSs in universities can be achieved via three different deployment approaches.

This part presents the current situation at Mansoura University; Egypt, presents integration as the most suitable solution, and evaluates three different implementation techniques: Dynamic Query, Stored Procedure, and Web services. Evaluation concludes that though SOA enhanced many different aspects of both UMIS and LMS; and consequently university overall. It is not recommended to adopt SOA via Web services as the building unit of the system, but as the interdisciplinary interface between systems. Mansoura University runs its in house developed UMIS for more than a decade right now. UMIS has reached a stable and well mature state when compared to the newly introduced LMS in the university. To adopt LMS functionalities in the University; without making LMS and UMIS isolated islands, there are three deployment approaches to choose from:

- Approach One (LMS replaces UMIS): University will replace its UMIS with LMS that will perform both educational and managerial functions. Challenges are: UMIS has been customized to fit University rules and regulations and it is not easy to let it go simply, importing current data into LMS might be a challenge, and there is a risk of system inconvenience especially if LMS failed to provide managerial functionalities as UMIS.
- Approach Two (UMIS takes over LMS): University will add learning functionalities to current UMIS. Though this approach overcomes shortages of previous one but still has some challenges to manage, like time to develop and add the new features while university can make use of advanced features available right now via LMS providers, and dealing with emerging standards.
- Approach Three (Integrate UMIS and LMS): Neither LMS will replace UMIS nor UMIS will take over LMS. Both UMIS and LMS will exist and interoperate to enable university to achieve its managerial and educational tasks in efficient and effective manner. This alternative avoids all challenges presented in alternatives one and two. It avoids replacing UMIS risks, and provides flexibility to change LMS without affecting UMIS, and provides an immediate solution to make use of current available LMS functionalities.

Approach three presents the most suitable solution to the current situation with technical challenges to integrate different information systems side by side while keeping in mind that different information systems require different information presentation for the same entity. Student is an example of the entities that require different information presentations. Student data required by UMIS differ than student learning profile needed by LMS. UMIS student record includes data like ID, Social Security Number (SSN), name, age, gender, address (street, city, country), email, username, password, Date of Birth (DOB), faculty, year, department while LMS student profile include data like a detailed records of what students have already learned at the level of learning objects, a

learning preferences profile, and a development portfolio of transferable skills, a history of student interactions with tutors. Figure 2.1 presents the current scenario in Mansoura University; where users can be classified into UMIS users; to handle non-educational activities, and LMS users; to handle educational activities. To generate a detailed report of the courses and the learning contents, the user has to go through UMIS to generate the courses IDs and LMS to acquire the learning content. UMIS and LMS are isolated islands connected only via users. The assessment experience by Faculty of Computers and Information Sciences in Mansoura University; <http://www.m-assessment.info> highlighted many of the challenges exist in the University. Assessment Management System (AMS) team asked students to register explicitly for the AMS; and that is not accepted. A single-student registration is a must to satisfy all learning interactions with the University. Figure 2.2 presents the proposed solution where a Service Layer shall be added in the middle area between UMIS, LMS, and users. Middle layer facilitates integration between different systems via Web services. Web services are relatively a new technology that have received wide acceptance as an important implementation of SOA. Middle layer can provide portal(s) to unify users' interaction with different systems.

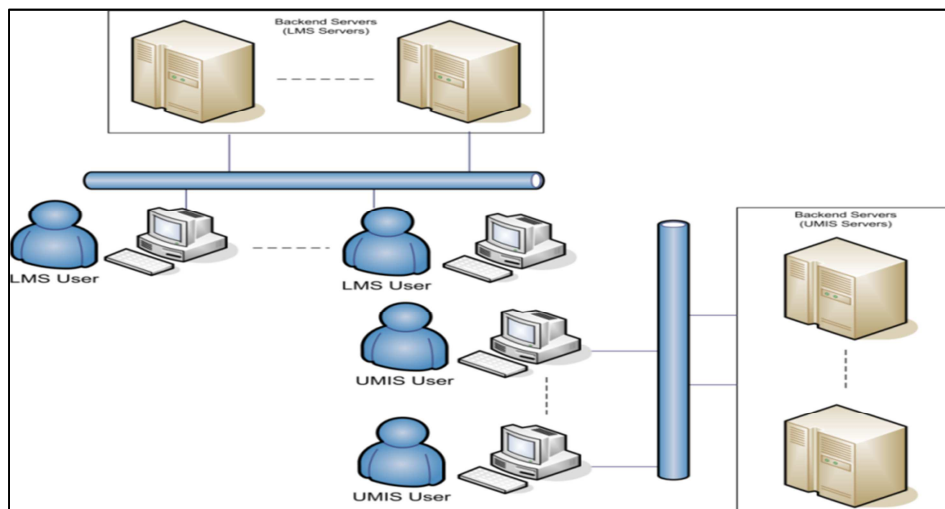
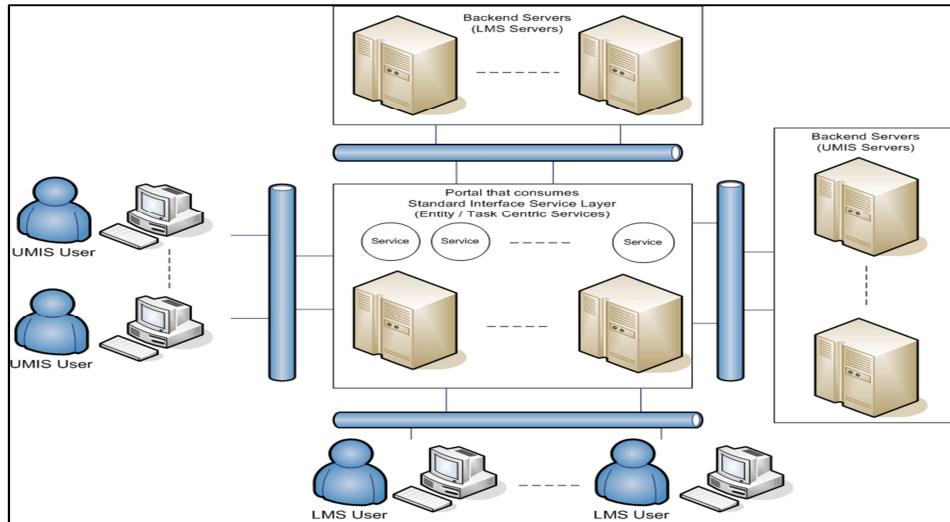


Figure 2.1: Current Scenario (Isolated UMIS and LMS integrated via users)



**Figure 2.2: Proposed Solution Presenting a Service Layer
as Intermediary between UMIS, LMS, and Users**

It is evaluator's responsibility to determine the most valuable architectural aspects to be considered in the evaluation process. Information systems quality parameters evaluated in this chapter are: Network Performance, User Perceived Performance, Integration and Interoperability, and Reusability. SOA enhances system overall security, replace ability, testability, and both hardware and software scalability.

2.5.2 Technical Evaluation Quality Parameters

Quality parameters like performance, integration and interoperability, compliance, security, maintainability, analyzability, decomposability and modularity, testability, portability via replaceability and scalability, simplicity, modifiability, and reusability shall be addressed. A Comparative performance analysis study is presented to test SOA based systems user-perceived performance against non-SOA based systems.

2.5.2.1 Network Performance

SOA based systems relies heavily on messaging. It is clear that SOA based applications need to add extra headers to manage requests and responses in standard format. Header can be classified into two Static Header and Dynamic

header. Static header is added once for every time the service is invoked while Dynamic header is added for every record contained within request or response message. By analyzing data in the request and response messages, it is noticeable that there are three data categories:

- **Static Header:** This header occurs once for each service invocation no matter how many records in the request. There are 463 characters for one of the test headers.
- **Dynamic Header (XML Tags):** Those tags are the overload of requests and responses. Those tags are named by developer, so they are not static every time, but in the same test message there is 179 characters.
- **Actual Data:** Those are the record details to be inserted after invoking the Web service.

Added extra headers differs according to the no. of records to be handled, and differs from an application to another (because the header used to represent an author might be different from the one used to represent a book) so network performance differs from an application to another. It is the system architect responsibility to decrease the transferred data over the network to the maximum extent (so decrease network delay) because it is noticeable that headers needed by SOA cannot be neglected easily.

2.5.2.2 User Perceived Performance

Web services are the main SOA enabler. It is expected that utilizing Web services within an application will affect User Perceived Performance. In order to understand the extent to which Web services affect User Perceived Performance, three different Library Management Systems (LIS) were implemented tested against the same data samples.

The three different LISs are Parameterized Query based LIS, Stored Procedures based LIS, and Services based LIS. While Parameterized Query based LIS SQL statements exist within the web pages and accesses database directly, Stored Procedures LIS highlights the separation between data layer and application layer by the presence of Stored Procedures as a middle layer in-between the portal and the databases. The Portal consumes stored procedures to access the databases. The services based LIS presents the services layer in between the portal and database layer to present a standard based interface layer that consumes stored procedures and available for portals. Services based LIS presented the highest arithmetic mean and mode values while Stored Procedure based LIS were the best for the insert operation. From the presented performance analysis and after evaluation of the three LISs, it is clear that the time consumed to perform the same operations using the services based LIS exceeds the time consumed to perform the same operation using either the stored procedure LIS, or the parameterized query one.

2.5.2.3 Integration and Interoperability

Systems can share their effects within a single operation via service level integration. Assessment Management System (AMS) did not have to access Student Affairs Information System database tables to retrieve and update student table data; instead, it just invoked the Update_Student service exposed. AMS includes a Take Assessment Process that needs interoperability between AMS and external systems as presented in [33]. Without this interoperability, Mobile assessment would not have taken place at all. SOA utilization in the system gave the system capability to expose standard interfaces that act like sockets to be plugged in to connect systems.

2.5.2.4 Reusability

Reusability is achieved in the proposed architecture on two levels: Internal and External. Internal reusability distinguished the application capability to use the implemented service more than once without modification. This happened with the Update functionality, where it consumed Delete and Insert functions. Services were not written every time. External Reusability refers to the external systems that consumed the exposed internal services to achieve functionalities. CMS shared services with AMS and UMIS, and that reusability distinguished the advantages of SOA.

2.6 Summary

Mansoura University runs its in house developed University Management Information System (UMIS) for more than a decade. UMIS has reached mature state compared to the newly introduced LMS. To adopt LMS functionalities in the University without making LMS and UMIS isolated, both need to interoperate to enable university achieve managerial and educational tasks. Comparative performance study was conducted to test SOA based systems performance against non-SOA based systems. Technical Challenges include:

- SOA based systems rely heavily on messaging and add extra headers to manage requests and responses in standard format. Headers sizes differ according to the number of records to be handled, and differ from application to another, so network performance differs. However, the comparative study yielded the fact that network delay is highly affected by the header size.
- Three different Library Management Systems were implemented and tested against the same data samples. The three different systems are Parameterized Query based, Stored Procedures based, and Services based. Services based System faced serious challenges in performance when compared to other two systems.