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An SOA Framework for Web-based E-learning Systems:

A case of Adult Learners

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PROJECT REPORT

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Declaration

This project, as presented in this report, is my original work and has not been presented for a degree in any other university.

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This report has been submitted as partial fulfillment of the requirements of Master of Science in Distributed Computing Technology of the University of Nairobi with my approval as the University Supervisor.

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Acknowledgement

Abstract

Web-based e-learning systems have allowed many learners to study and learn anywhere and anytime. Currently we have a large number of adult learners choosing to pursue their postgraduate degrees in order to enhance their work skills, fulfill their employer requirements, and to get a certificate. These adult learners are mostly working professionals whom because of their busy schedules choose to enroll their programs on e-learning environments. The e-learning environments that are used to instruct these adult learners are the same ones that are used to instruct children and do not obviously support diverse learning activities that may be suitable for adult learners.

The review of literature indicated that adults are experienced, self-directed and are independent thinkers in their learning and they seek to learn from and about their social and work environments and the roles they play there as opposed to young leaners. Learning by being guided by others is therefore unfitting in adult education environments.

This study used two methods to collect data: system analysis and survey. The e-learning environment through which learners engaged their learning was investigated in order to understand the context of the present study environment and to provide the context for the design of the model for adult learners. The survey carried out was used to obtain information concerning the current status of e-learning systems put in place to support learning in colleges and Universities and describe what adult learners feel in regard to their motivation and satisfaction in self-directed learning. The results from survey indicated that the design of the current e-learning system in use is majorly used to deliver content to the students and does not provide an environment through which adults' experiences as a great resource can be utilized. This also limits the adult learners to engage in a self-directed learning process.

To make use of the adult learners' experiences, a dedicated learning model based on SOA, and intended to make learning process collaborative while allowing the learners use their experiences in publishing articles within an e-learning system and to allow them share what they learn was developed. The SOA framework was able to deliver a remote service into a web-based LMS; in this case Moodle so that it can be internally utilized by the adult learners in accessing content from other systems as services. Wordpress blogging functionality was employed in the SOA and used to demonstrate how adult learners can collaborate and interact together and at the same time

be able to socially construct knowledge and content that is shared and accessed by learners in the same course.

An evaluation was designed to validate the SOA framework's relevance. The purpose of the evaluation was to establish whether the adult learners' characteristics as identified in this study were incorporated in the SOA framework so as to enhance the motivation and satisfaction of adult students in the learning process. Two methods were used to carry the evaluation process for the framework developed. A survey carried out by the study participants and an analysis from the system views/logs.

The participants in involved in the evaluation process were required to first carry out Abstract Task (AT) inspection on the framework before responding to the questions in the questionnaires distributed online to each inspector. The analysis from the evaluation process was adequate enough to give a clear effect of using the SOA framework when compared to the initial survey carried out on the current e-learning systems which the learners used in their learning. The system views/logs collected from the system were used by the researcher to establish the students' exchanges and access of remote objects/content. The views analyzed from the system logs demonstrated that there increased number of exchanges between the adult learners who collaborated in their learning. This system views and results from the survey positively demonstrated that the satisfaction and motivation of adult learners increased by the implementation of the SOA framework.

Finally, it can be concluded that when adult learners, who engage in web-based e-learning, are provided with a learning environment which allows them to collaborate interactively, they feel motivated to learn and this leads to their satisfaction. This way, their experience is exploited and brought to the center of the learning process.

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List of Abbreviations

HTTP – Hyper Text Transfer Protocol

IBM-International Business Machine

ICT-Information Communication Technology

IMS LTI - Instructional Management Systems - Learning Tool Interoperability

MOODLE – Modular Object-Oriented Dynamic Learning Environment

SOAP – Simple Object Access Protocol

SOA- Service Oriented Architecture

UDDI – Universal Description, Discovery & Integration

WSDL – Web Service Description Language

XML – Extensible Mark-Up Language

CHAPTER 1 : INTRODUCTION

The Information Communication and Web 2.0 technologies have drastically changed the way people learn. The web-based e-learning systems have allowed many learners to study and learn anywhere and anytime. Few years ago, people could only study once, get their certificates and would not go back for further their studies. Things have changed. Even after acquiring first degrees, adult learners still go back to institutions of higher learning to continue with their education in order to enhance their work skills, fulfill their employer requirements, and to get a certificate. These adult learners are mostly working professionals whom because of their busy schedules choose to enroll their programs on e-learning environments.

The e-learning environments that are used to instruct these adult learners are the same ones that are used to instruct children. Knowles (1996) argues that adults should not be treated the same way as children when it comes to learning. He argues that maturity affects how adults learn and take in information. Adults are independent, experienced and self-directed when it comes to learning. If they are treated the same way as children, they feel intimidated and that their independence and experience in the knowledge gained is never appreciated or acknowledged.

Pedagogy is not as useful in an adult learning environment because it does not utilize the learner's capabilities, experiences and adult learning characteristics (Cercone 2008; Billington 2000). Andragogy is geared for the adult learner who knows how to learn and is motivated to learn. There is a need for e-learning systems for adult learners where the learners' experiences are also incorporated in the learning process and not just what the instructor determines.

Cook (2003) asserts that researchers with expertise in education or information communications technologies have not applied their findings to the adult learners. She argues that this has resulted in teaching methods and strategies that are ineffective in teaching and instructing the adult learners. This means that for computers and related technologies to be important and relevant to adult learners, adult educators and instructors need to develop new models, strategies and understandings of computer facilitated learning systems i.e. adult e-learning systems.

The researcher in this study introduces the concept of andragogy as an important learning theory which may hold some interesting clues to how e-learning and adult learning could merge together in a practical environment so as to enhance adult learning process for their satisfaction. The andragogical theory puts much emphasis on the learner's ability to self-direct their learning.

Malcolm Knowles (1968) introduced the theory of adult learning, andragogy, in direct contrast to the then known term pedagogy which involves teaching and learning of children. Knowles highlighted the lack of information about helping adults learn. As Knowles puts it; andragogy is the art and science of helping adults learns.

This study investigated adult learners in e-learning environments, in which learners go through instructional materials delivered via the Web at their own pace with no or minimal interaction with an instructor with the aim of recommending a framework based on Service-oriented technologies that will allow greater flexibility in supporting and enhancing adult learning experience.

This research focuses on how to implement the Moodle Learning Management Systems to provide a reliable, flexible, and collaborative learning environment, which can be widely adopted in the e-learning community for adult learners. This was meant to increase motivation and satisfaction for adult learners when learning through the web as compared to the current undesirable e-learning systems that are also used by pedagogy class of learners.

1.1 Definitions of terms

1. Adult Learners

(Knowles 1980) defined adults as those who perform roles associated with adults by one's culture i.e. workers, spouses, parents and perceive themselves to be responsible for their own lives. Adult learners therefore are adults who are engaged in learning in various instructional settings. More precisely, adult learners in this study included adult students in formal education, attending accredited educational institutions e.g., a post graduate degree program as well as working adults who participate in workplace learning in a variety of work settings.

2. Web based e-Learning

This study investigates adult learners who engage their study through e-learning environments where learners go through instructional materials through the Web. In this study therefore, web-based e-learning can be defined as a form of instruction in which the learner goes through instruction delivered via the Web (Kim 2009 & Ismail et al. 2010). Self-directed e-learning for this study can be defined as an learning process in which an individual takes on the responsibility for his/her learning process by identifying their learning needs, setting goals, finding resources,

implementing strategies, and evaluating their results. Here there is little interaction between student and instructors (Conlan et al. 2003).

1.2 Problem Statement

The existing learning design models for adult learners are mostly built on pedagogical principles and are more appropriate for younger learners. These traditional learning management systems do not obviously support diverse learning activities that may be suitable for adult learners. The wealth of real-life experiences that adult learners possess is a great resource that can be utilized for their learning. These experiences cannot be utilized in the current e-learning environments, which are only used to deliver information to the learners. Adult learners needs an environment that can enable them to be involved in the construction of their own course content, giving then the freedom to make use of the experiences that they possess (Jun 2004 & Jun 2005). Despite this fact, instructors for adult learners are still using the pedagogical model of instruction for both children and adults. Bichelmeyer (2005) also argues that to this end e-learning for adult learners has been presented as though it only involves only one type of educational experience as it only provides learners with information they need with less emphasis on the learning process itself.

This researcher focused on developing a design model of e-learning systems based on the theory of andragogy as an alternative model of instruction to enhance learning for working adults and adult learners.

1.3 Research Objectives

The main aim of this study was to design and develop an SOA framework that incorporates the adult learners' characteristics in an e-learning system so as to increase their motivation through web-based e-learning. To achieve this, the following objective guided the researcher.

1. To identify adult learners' characteristics that can be exploited and employed in the design of an e-learning systems that satisfies their learning process.
2. To design SOA framework for Web-based e-learning for adult learners, that provides an environment for collaboration and self-directed learning.
3. To evaluate framework developed for its collaborative and learner-centeredness learning features.

1.4 Research Questions

To achieve the above objectives, the researcher sought answers to the following questions.

1. Do adult learners have unique learning characteristics on which the e-learning process can be tailored so as to produce the best results for adult learners?
2. If so, what is the best way to tailor and enhance e-learning satisfaction to adults?

1.5 Justification

Pedagogy may not be useful in an adult learning environment because it does not utilize the learner's capabilities, experiences and adult learning characteristics (Cercone 2008). Andragogy is geared for the adult learner who knows how to learn and are self- motivated to learn. There is a need for e-learning systems for adult learners where the learners' experiences are incorporated in the learning process and not just what the instructor determines.

The absence of a design model that would do for andragogical learners what the current learning environment achieves within a pedagogical class of learners is what motivates the researcher. The design model will include collaboration process which will enhance communication, coordination and interaction amongst learners and instructors to help adults convert knowledge and enhance cognition and change their behaviors towards e-learning.

This research, therefore, is an effort to inform and guide the development of e-learning model design for adult learners. To achieve this goal it was important to investigate how adult learners navigate their online learning experiences.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

The literature review in this study sought to review the topics that are closely related to teaching using web-based e-learning systems to the adult learners. This included an overview of the theory of adult learning, methods of learning and teaching adults and the motivations underlying adult learning and the e-learning technologies that enhances e-learning on adult students.

2.2 Theoretical review

2.1.1 Theory of Adult Learning

This study investigated the issues underlying adult learners who participate in self-directed e-learning. Adult learners are those who perform roles associated with adults by one's culture e.g., workers, spouses, parents and perceive themselves to be responsible for their own lives (Kim 2009). In this study, adult learners are adult students in formal education who study for the award of accredited certificates e.g. a postgraduate degree.

Knowles (1980) the father of andragogy introduced the term andragogy to explain the distinction between the learning need of adult learners as opposed to those of children. Knowles argues that adults are self-motivated to learn and should actively be involved in the learning process. They also bring into the learning process their adverse experience from their professional field of work.

According to Knowles, adults have moved from being dependent upon others as children, to being independent thinkers as adults. Learning by being guided by others is therefore unfitting in adult education environments. Knowles argues that adults are self-directed in their learning and they seek to learn from and about their social and work environments and the roles they play there. Therefore, adult learning process must be different from the pedagogical procedures used to educate children.

Adult learners are experienced and self-directed: andragogy is the activating or enabling environment that best supports self-directed learning. Traditional learning management systems do not obviously support diverse learning activities that may be suitable for adult learners. If the design of the software environment encourages a pattern of use that imitates traditional teacher-

student roles there is little incentive for adult learners to adopt e-learning in "continuing education".

According to Knowles, andragogy rests on four crucial assumptions about adult learners and how they differ from child learners. Andragogy assumes that, as people mature (1) their self-concept moves from dependence to self-direction, (2) their growing reservoir of experience begins to serve as a resource for learning, (3) their readiness to learn becomes oriented increasingly toward the developmental tasks of their social roles, and (4) they begin to want to apply what they have learned right away to life's real challenges. Adults' orientation towards learning shifts from one of subject centeredness to one of problem centeredness.

Malcolm Knowles the father of Andragogy saw this in terms of identifying the characteristics of adult learners as opposed to children as learners. He made five assumptions listed below (Knowles 1984):

1. **Self-concept**: As a person matures his self-concept moves from one of being a dependent personality toward one of being a self-directed human being
2. **Experience**: As a person matures he accumulates a growing reservoir of experience that becomes an increasing resource for learning.
3. **Readiness to learn.** As a person matures his readiness to learn becomes oriented increasingly to the developmental tasks of his social roles.
4. **Orientation to learning**. As a person matures his time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly his orientation toward learning shifts from one of subject centeredness to one of problem centeredness.
5. **Motivation to learn**: As a person matures the motivation to learn is internal

Having the above assumptions the following inferred principles were useful in the construction of e-learning systems for adult learning:

- Adult learners know why they are learning and are able to relate what they learn to their own lives and experiences.
- Adult learners are self-motivated and keen to learn something new based on the experiences that they have gathered. Learning should focus on problem solving rather than being content-based.

- The collaboration process which involves communication, coordination and interaction amongst themselves and instructors can help adults convert knowledge, enhance cognition and change their behaviors towards learning.

The review of andragogy theory indicates that adult learners are characterized by a great experience and self-directed learning (Holton 2010). E-learning systems, therefore, should enable learners go through instructional materials delivered via the Web at their own pace with no or minimal interaction with an instructor and be involved in content creation. This theory also implies that adult learning should therefore emphasize on knowledge construction by learner actively exploring and discovering for. The e-learning framework proposed in this study focus on collaborative learning environment and the employment of the experiences of these students in knowledge/content exploration.

Adult learners possess more life and domain specific knowledge, different motivations to learn, and more available resources than young learners (Bichelmeyer 2005 & Huang 2002). Basing on this assumption, and adult learners' characteristic of self-directedness and experiences, the web-based system for e-learning described in this study allows adult learners to use this reservoir on experience and to be involved in the creation of content for learning.

Table 2.1: Summary of Assumptions about adult learners compared to younger learners

Summary of Assumptions about Adult Learners (Bichelmeyer 2005)		
About	**Pedagogical**	**Andragogical**
Concept of Leaner	Dependent personality	Increasingly self-directed
Learner's experience	To build on more than used as a resource	Rich resource for learning by self and to others
Readiness to learn	Uniform by age-level and curriculum	Develops from life task- or problem-centered
Orientation to learning	Subject-centered	Task- or problem- centered
Motivation	By external reward and punishment	By internal incentives, curiosity

The understanding of this theory of adult learning and computer-supported learning leads to an acceptance that adult learners seek interaction and collaboration within any learning environment and the experience that they possess can be utilized in content creation through the use of web services enabling them to access content from remote systems.

The experiences that the adult learners possess, which is a great resource can only be tapped into the learning process in the e-learning environments used by adult learners if only they contain features that allow learners to (Wang 2003):

a) Find the content they need

b) Collaborate/Discuss questions with other students within course

c) Access the shared content from e-learning community

d) Discuss questions with your instructors

e) Share what they learn with the learning community

f) Learn the content they need

g) Choose what they want to learn

h) Control the learning progress

2.1.2 E-learning and Adult Learning

E-learning in the context of this study can be defined as learning that is facilitated by using computer-related technologies. Stand-alone computers and all they offer, such as internet access, are probably the most prominent of these technologies (Conlan et al. 2003). Distance and individual self-directed learning is core to this study.

Many researchers and practitioners in e-learning believe that stimulating learner motivation is one of the critical factors for creating a successful online learning environment (Hofmann, 2003). The findings from this study were subjected to analysis and then used for the design of SOA Framework for adult e-learning environments that may help increase learner motivation at the same time utilizing the reservoir of experiences that these adult learners possess.

Bichelmeyer (2005) argues that an e-learning system that addresses the needs of adult learners through interaction, engagement, and activities requires a range of highly sophisticated software. The use of SOA and web services is likely to enhance the adult learners' experiences when the exchange of information is encouraged, and there are opportunities for rehearsal, feedback,

application, and transfer. This can only take place if these services will be oriented in the current e-learning systems before being adopted for adult learning. Through service orientation, e-learning tools will help create space for interaction, collaboration and thinking to occur in educative ways hence enhancing the functionality of e-learning systems used by the andragogical class.

The IMS content packaging specification makes it possible to store chunks of material in a standard format which can be re-used in different systems, without having to convert the material into new formats (Dougiamas 2004). The presence of large amounts of resources available outside the learning management system can now be utilized by the LMS through the use of the LTI application tools. This application allows access of remotely stored content to be viewed within e-learning management systems.

According to the characteristics of adult learning, an e-learning system must be based on student-centered learning, and learning technologies should allow greater flexibility in supporting and enhancing learning experience. The following section exposes how Service Oriented technologies can be used to build e-learning environment suitable for adult learning.

2.1.3 Service Oriented Architecture

Service Oriented Architecture (SOA) is a description of how different parts of the system interact and communicate to achieve a desired result. It is "*an interconnected set of services which in its basic form is a message-based interaction between software agents, each accessible through standard interfaces and messaging protocol*" (Luthria & Rabhi 2009). SOA is implemented through the use of web services (MacLennan & Van Belle 2014).

A service-oriented architecture is essentially a collection of services which communicate with each other by involving either simple data passing or it could involve two or more services coordinating some activity.

Service Oriented Architecture utilizes services as the basic constructs to support the development of rapid, low-cost and easy composition of web-based applications that allow communication and exchange of services even in heterogeneous environments. Through SOA, services cooperate and allow services over a network to be assembled to carry out a specified function with little effort.
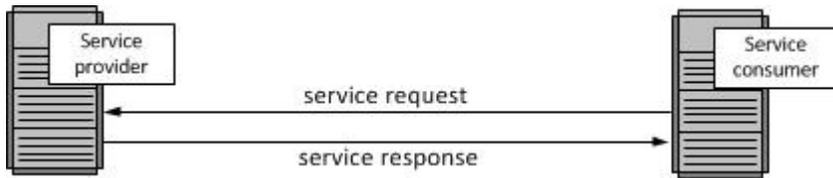
Figure 2.1: Basic Service-Oriented Architecture (Douglas, 2014)

A service Oriented Architecture broadly comprises of three components; Service providers, service consumers and registries that help service consumers to find services that are published. Services providers publishes their services descriptions in registries or discovery agencies and makes them available for clients or consumers (Luthria & Rabhi 2009). In its simplest form, an SOA could be described as shown in figure 2 below which details how a service is provided and consumed (Douglas, 2014):

- The Web Services Description Language (WSDL) is used for the specification of Web Services. A service provider describes its service using WSDL. This definition is published to a repository of services. The repository could use Universal Description, Discovery, and Integration (UDDI). Other forms of directories could also be used.
- A service consumer issues one or more queries to the repository to locate a service and determine how to communicate with that service.
- Part of the WSDL provided by the service provider is passed to the service consumer. This tells the service consumer whether the requests and responses are for the service provider.
- The service consumer uses the WSDL to send a request to the service provider.
- The service provider provides the expected response to the service consumer.
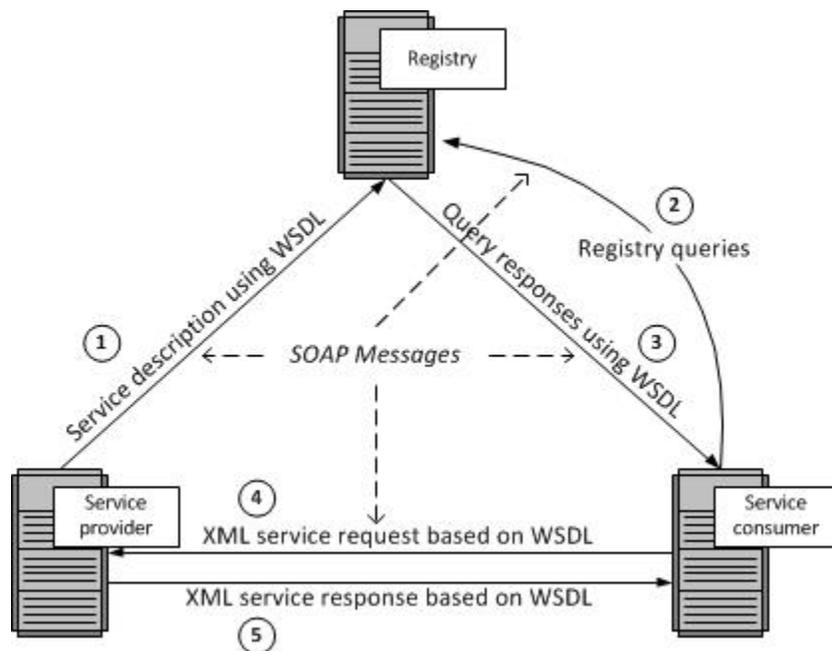
Figure 2.2: How a service is provided and consumed (Douglas, 2014)

The communication between the three components is done through messages SOAP (SOAP Simple Object Access Protocol). SOAP uses the HTTP to provide envelops in sending the web services between providers and consumers.

The service provider and service consumer, in this study however, communicates through the use of a consumer key and a shared secret which allow any message to be passed between the two systems. The messages are signed using the Oath protocol for secure API authorization.

A number of SOA e-learning frameworks have been developed. These frameworks include the NSDL and IMS DRI (Eduardo M. D. & Paulo N, 2012) and OKI-Model as summarized by Leal & Queirós (2011). Scott (2003) also describes an SOA framework that integrates different systems of an institution that occupy vertical positions e.g. VLE, Library Management System and Student Records (MIS). The framework integrates the components of different systems in an institution in order to reduce replication/overlapping of functions.

The SOA framework uses Web services to integrate different components systems so as to improve interoperability among different components as show in the diagram below:

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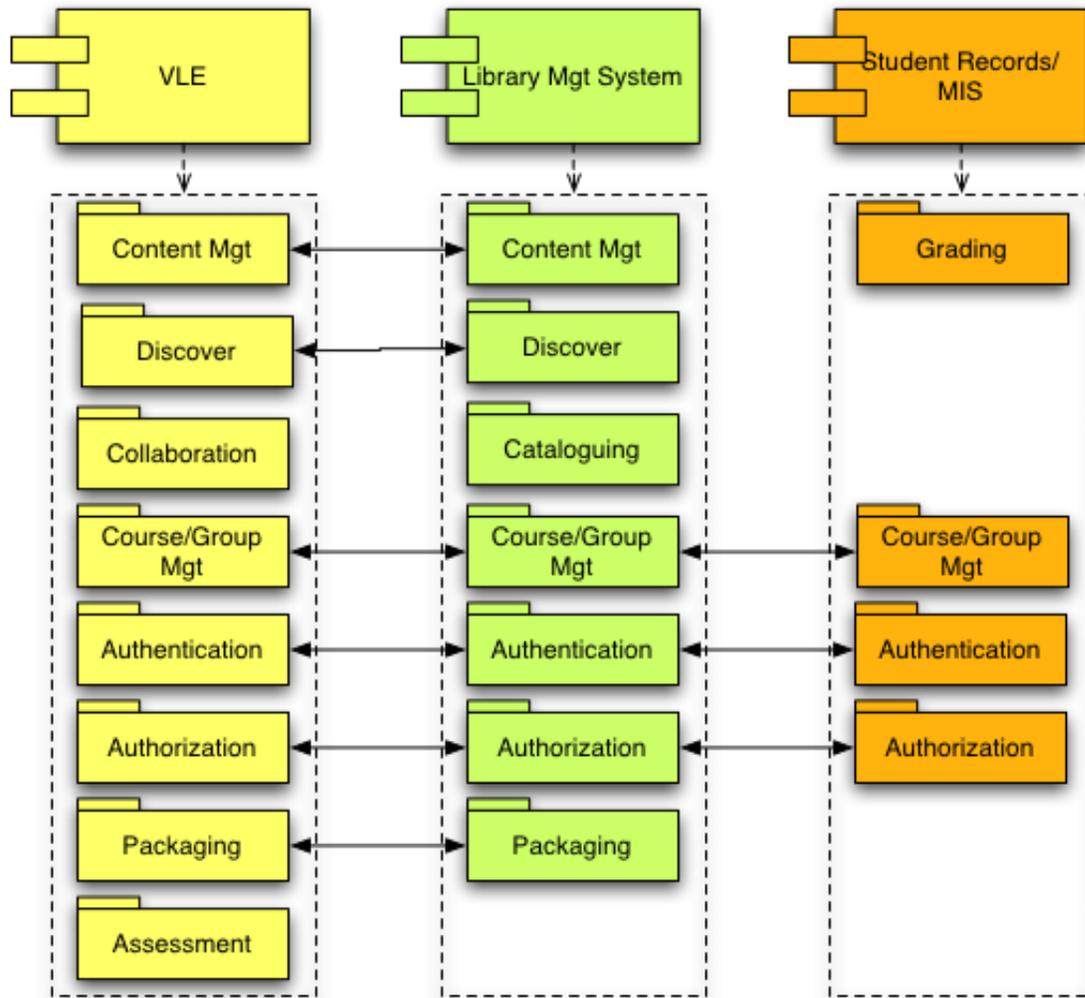
Figure 2.3: Components of different systems integrated through SOA and Web Services

2.1.4 Web Services

"*A web service is a software system designed to support* **interoperable** *machine-to-machine interaction over a* **network**. *It has an interface described in a machine-processable format called WSDL. Other systems interact with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards.*"(Alonso & Casati 2005)

A service is a function that is well-defined, self-contained, and does not depend on the context or state of other services. The basic service-oriented architecture contains a service consumer that sends a service request message to a service provider. The service provider returns a response message to the service consumer. The request and subsequent response connections are defined

in some way that is understandable to both the service consumer and service provider (Douglas, 2014).

Web services and SOAs should not be confused. While Web services are defined as a system function that is well defined, self-contained, and does not depend on the context or state of other services, Service Oriented Architecture provides a framework or an infrastructure through which web services interact and communicate to each other (Luthria & Rabhi 2009).

The importance of utilizing SOA in e-learning systems includes integration, interoperability, scalability, and reusability (MacLennan & Van Belle 2014). Interaction, knowledge building and collaboration features of e-Learning systems cannot be ignored and it is necessity that they be considered in the adoption of SOA in adult e-Learning systems. The attributes of web services that include reusability, composability, discoverability and loose coupling (MacLennan & Van Belle 2014; Luthria & Rabhi 2009) extends the importance of employing SOA in e-learning systems to allow integration of different systems to communicate and utilize the services (Papazoglou et al. 2008) they contain from each other.

There are a number of disparate systems outside the LMSs that provide tutorials and/or exercises useful for learning. These systems expose these resources as web services and can be utilized within LMSs through the framework proposed in this study. These web services include;

1. **Repository of learning objects based on web services which in the context of this study refer to** reusable content components for education and training.

2. **Application Programming Interfaces**: There are a number of programs written and stored on various applications as learning objects and may be accessed through APIs that are exposed as set of related web services that can be accessed through different protocols. This when brought close to students through the framework discussed in this study allows students to access written programs that are executed within the LMSs and enables students to solve complex programming exercises without having to install the API on their machines and even allow collaboration and grading during and after the programming exercises (Leal & Queirós 2011)

3. **Evaluation engines.** There are a number of evaluation engines that provide electronic quizzes, computer-scored homework assignments, and practice exams. The quizzes through the help of the SOA framework can be brought within the LMS and be a great resource for students' learning. They are presented as web services. An example of this is

the ChemVantage which is a service tool provider works within an LMS to perform site authentication, new account provisioning, and returns student assignment scores to the LMS grade book automatically.

The SOA framework developed through this study is embedded in an LMS to allow for the access the above named web services. The communication between the Service Oriented LMS (service consumer) and the other web based systems (service providers) is through message passing through the OAuth protocol which uses HTTP POST requests in its transport layer as discussed in Chapter four.

SOA allows heterogeneous systems to interoperate seamlessly. This is enabled through integration and use of web services that enables efficient and flexible combination of resources to optimize operation across and beyond the boundaries of an organization allowing processes and information to transcend organizational boundaries despite the existence of multiple and heterogeneous platforms and protocols over the World Wide Web (Papazoglou et al. 2008).

The SOA framework discussed in this study will enhance adult learning while taking consideration of the adult learning theory principles and the data collection results as proposed in the methodology of the research. The framework will help adult learners employ the great reservoirs of experiences gained through professional work skills and knowledge in content construction as well as provision of services that will allow for opportunities for rehearsal, feedback, application, and transfer. The interaction and collaboration services will be oriented in the current e-learning systems so as to be fit for adult learning.

Through service orientation, e-learning tools create space for interaction, collaboration and thinking to occur in educative ways hence enhancing the functionality of e-learning for adult learners. These actions in e-learning make the adult students more motivated to continue engaging in e-learning because they can more readily access support when it is needed.

The communications between the LMS and the other systems exposes their functions as web services even when the systems involved are heterogeneous (Leal & Queirós 2011). Leal and Queiros (2011) argues that a revolutionary standard that seeks to support many LMSs is the IMS LTI which provides uniform standard specification for LMSs to allow remote content to be integrated into e-learning environments.

2.1.5 Moodle LMS

Moodle is an on-line learning management system (LMS) that can be used to complement face-to-face class lectures, or deliver a course completely on-line (Dougiamas 2004). Understanding the tools provided by Moodle LMS was essential to the development of the framework in this study. The function of these tools includes content creation, learner's activities and various communication processes that specifically are in accordance with the Web 2.0 technologies (Maram 2008).

The researcher chose Moodle because;

1. Moodle is a free and open source system an organized documentation which makes it possible for developers to be able to connect to one another in the development process.
2. The Moodle LMS was designed and developed using a social constructionist pedagogy principle. This constructivism philosophy that Moodle LMS employs, allows people actively construct new knowledge as they interact with their environments. It allows everything that learners read, see, hear, feel, and/or touch to be tested against their prior knowledge and if it is viable within their mental world, it forms new knowledge that learners to carry with them. This Philosophy actually allows knowledge to be strengthened if learners can use it successfully in their wider environment (Maram 2008 & Holton 2010).

This confirms with the theory of adults learners that they are not memory banks which passively absorb information, or transmitted to them by reading something or listening to instructors but by being engaged and involved in the construction of the knowledge.

Additionally, Moodle uses a social constructivism principle that extends constructivism into social settings which allows for a group of learners to collaboratively construct knowledge for and from one another. This philosophy is also in harmony with the characteristic of adult learners who learn by sharing information from one another.

When Moodle LMS is well utilized and enhanced its potential is discovered which is greater than just creation of activities. Moodle enriches the learning experience by ensuring that the learner is actively engaged while constructing the meaning within the activity. The researcher keeps this philosophy in mind together with the principles of adult learners during the design of the design model for adult learners. The model will focus on the importance of autonomy for the adult students and their experiences to construct content in learning process.

CHAPTER 3 : METHODOLOGY

3.1 Overview

This study used an approach that involved the following procedure. First, an existing pedagogical-based eLearning system based at one of the leading public University in Kenya was investigated on the extent to which it implemented the adult learners' characteristics. Second, a survey (on a sample set of 228) to establish the motivational level of the adult students who were carrying their studies through e-learning was done. The results from the investigation and survey led to the development of a framework describing the principles of adult learners that need to be incorporated in an SOA framework. An andragogical-based e-learning framework that runs on an SOA model was developed from the adult learners' principles framework (Figure 1).

A prototype based on the andragogy based eLearning framework was then developed and was used in a simulated Moodle-based LMS. This prototype was used to validate the proposed SOA framework. A sample comprising of 58 students was used in the validation process.

A survey together with system investigation/analysis were carried out in order to obtain information concerning the current status of e-learning systems put in place to support learning in colleges and Universities, and describe what adult learners feel in regard to their motivation and satisfaction in self-directed learning. The data collected from the investigation of the current eLearning environment was to triangulate the data obtained from the survey study that followed. Triangulation enhances the reliability of a research study by obtaining data from multiple sources and/or employing multiple methods to obtain data (Creswell, 1999 & Merriam, 1998).

3.2 Investigation of the current e-learning environment

The investigation of the e-learning environment was to help the researcher understand and describe the learning environment in which the study participants were engaged during their e-learning. It was important to investigate and describe the design and the suitability of the e-learning environment to the adult learners who were engaged in this study. The main objective of this was mainly to understand the context of the present study environment and to provide the context for the design of the model for adult learners as discussed in the problem statement of this study.

3.3 Study Survey

The researcher explored and determined what is supposed to comprise of the e-learning systems that the adult learners/students use in the web-based e-learning. The survey was used to obtain information that lead to the design of the model based on SOA framework for adult learning as identified in the problem definition and literature review of this study.

The research design included a survey about the adult learners' characteristics. This survey provided for opportunities for the researcher to model the adult learners' characteristics in a design that will enhance adult learners' motivation in engaging in self-directed e-learning.

3.2.1 Instrument design

The tool that was used mainly was questionnaires that targeted the adult learners in one of the leading Universities in Kenya. The questionnaire consisted of 3 parts which is Part I, Part II and Part III (see appendix B (ii)). Part I focused on the respondent's demographic and personal background such as gender, age, and type of program engaged in. It was crucial that those who were involved were adult learners i.e. had at least attended the four years in regular degree program as well as working adults who participate in workplace learning in a variety of work settings. Age was also another factor in consideration. Part II questions consisted of factors related to the satisfaction for adult learners who engage their learning through e-learning environment. Part III of the questionnaire mainly centered on establishing the whether the adult learning characteristics were taken care of during and in the design of the e-learning environment which they were already using.

3.2.2 Population and Sampling

The population for study consisted of adult learners who have taken e-learning course. The sample (of 228 adult learners) for this study was drawn from students who are based at one of the leading public University in Kenya and were pursuing postgraduate degrees through distance and open learning and therefore match the characterization of adult learners as described in the previous chapter.

3.2.3 Data collection and analysis

The data presented in this study was collected from two sources as explained in the methodology overview i.e. investigation of an existing pedagogical-based eLearning system and a survey that was conducted with adult students who used the e-learning environment based at one of the leading public University in Kenya. Data from the questionnaires was subjected to statistical

analysis using SPSS. SPSS was preferred to other tools used in statistical analysis because it has more benefits of reproducibility, simplifying repetitive tasks, and handling complex data manipulations and analyses. It also has a rich set of capabilities for every stage of the analytical process and one is able to choose from a broad range of tools, tests and techniques so that one can quickly and confidently perform any type of analysis.

Based on the results from the system analysis and the analysis of data from the survey conducted, the researcher was able to construct a model that used to implements SOA in the e-learning systems for adult learning.

3.3 Analysis and Design

As explained in chapter 3, the study was carried out using two research designs. The result from the designs is discussed below.

3.4 Findings from the investigation of the current e-learning environment

The investigation was done on the e-learning portal that the students were using with the objective of answering the listed items in (Appendix B (i)).

Table 3.1: Analysis results from the e-learning environment

1: **What tools does the system provide for teachers to present their ideas/information to students?**
Creating a course: Content is be uploaded to the course and activities added in the order that students will use them. Instructor presentation tools: Resources (content), forums, quizzes, assignments and chat are the main tools that an instructor can include in the course created. The resource module contains HTML pages and other documents. Student presentation tools: Contains all the above except for the **resources tool which is utilized by instructors/teachers only**. This should be changed to allow students to build up course collections and include a filespace for them to take their materials from other systems.
2: **What tools does the system provide for students to articulate their opinions and ideas to teachers and other students in the learning community?**
The Moodle LMS employed as the e-learning environment provides does not provide for

discussion and chat amongst the students. For communications however, the students use their emails to communicate amongst themselves.

3: Can learners access external content while still in the course to supplement what the instructor provides?

Forums and journal entries are set by the instructor to allow for private thoughts about the course. This is however is only left to the instructors to express using the tools provided. Because of security reasons, the system does not allow students to upload/import external content in the learning environment.

4: Interaction of students and teachers inside the course

The basic tools provided for students' interaction only include chats and forums. The course instructors also uses students email addresses to deliver course materials including tutorials initially not included in the course module.

The information from this analysis helped the researcher to gain a picture of what parts of the e-learning system were currently covered as per the assumptions of adult learning theory so as to establish what was supposed to be included in the design model proposed in this study.

It was established that the e-learning environment used to instruct study participants who are adult learners is the same one used to instruct the undergraduate students. Grounded on the pedagogy principle, the e-learning system is used especially to deliver content to the learners. Knowles (1996) argues that adults should not be treated the same way as children when it comes to learning. He argues that maturity affects how adults learn and take in information. Adults are independent, experienced and self-directed when it comes to learning. If they are treated the same way as children, they feel intimidated and that their independence and experience in the knowledge gained is never appreciated or acknowledged.

The learning environment does not utilize the learner's capabilities, experiences and adult learning characteristics (Cercone 2008; Billington 2000).

The experiences that the adult learners possess, which is a great resource can only be tapped into the learning process in the e-learning environments used by adult learners if only they contain features that allow learners to (Wang 2003):

   a) Find the content they need

b) Collaborate/Discuss questions with other students within course

c) Access the shared content from e-learning community

d) Share what they learn with the learning community

e) Learn the content they need

f) Choose what they want to learn

g) Control the learning progress

From the analysis of the e-learning environment used by the adult learners, it can be concluded that the learning environment in use was designed to support a model of teaching and learning that was only based on information/content transmission from instructor to learners and little consideration is given to the activities that the learners themselves might engage in.

A good e-learning environment for adult learners should encourage teaching and learning by improved collaboration and interactivity among students through the use of computer mediated technologies (Ismail et al. 2010) with the freedom that they can also enhance the learning process through a guided incorporation of the rich experience they possess in the learning process.

3.5 Findings from the study Survey

The reason for carrying out the survey was to obtain information concerning the current status of e-learning systems put in place to support learning in colleges and Universities, and describe what adult learners feel in regard to their motivation and satisfaction in self-directed learning.

The respondents who participated in the survey are learners who are pursuing their postgraduate studies. Majority of the participants belong to the age group between 25 – 34 and 35 – 44 which represents 54% and 36% respectively.

From the analysis, 94.5% of the number who were involved in the research displayed the characteristics of an adult learner i.e. 79% are married, playing a role of a parent/spouse and had accomplished the undergraduate student period of four years of traditional college/university learning, 42% of whom are employed as working professionals. When asked for the reason for enrolling for the e-learning course only 4% indicated that their main reason was to receive a certificate, while 96% indicated that they enrolled in the e-learning course in order to develop and enhance their skills. This analysis agrees with what Knowles defined who an adult learner is (Knowles 1996).

Table 3.2: Survey Participants' Background Information

ITEM		FREQUENCY	PERCENTAGE
Age group	24 or younger	0	0
	25-34	123	54
	35-44	80	36
	45-54	23	10
	55 or older	0	0
	Total	**226**	**100**
Gender	Male	156	69
	Female	70	31
	Total	**226**	**100**
Marital Status	Married	178	79
	Single	48	21
	Total	**226**	**100**
Academic Status	Student-Undergraduate	12	5
	Student-Graduate	119	53
	Working Professional	95	42
	Total	**226**	**100**
Motivation for taking e-learning course	For personal development	111	49
	To enhance my job skills	107	47
	To receive a certificate	0	0
	To complete mandatory training or class assignment	8	4
	Total	**226**	**100**
Reason for choosing e-learning	Classroom training did not fit my schedule.	118	28
	Classroom training was not available	40	10
	Convenience of online learning	123	29
	Flexibility of self-paced learning	107	25
	Cost less than taking classroom instruction	36	8
	Total	**424**	**100**

Part II of the study explored the satisfaction of their learning process through e-learning. When asked about the frequency of their interaction with an instructor, a majority of those surveyed responded that they occasionally had interactions while they took the e-learning course. In particular, 12% of the respondents indicated that they never had such interactions and 76% of those surveyed responded that they occasionally or seldom interacted with an instructor.

As Holton (2010) argues, 96% of the respondents indicates that they like learning on their own pace. This reflects that any learning environment should give the adult learners intellectual freedom, experimentation and creativity. When left to explore on their own, they feel that they are respected, more satisfied and motivated to engage in e-learning. Adult learners likes taking their own responsibility in their learning as they are independent and autonomous in their thinking (Kim 2009 & Ismail et al. 2010). Since students have their courses completely online and they must interact and complete assignments and coursework without meeting their instructors or peers or talking to them in real time, their motivation will only be maintained when they are involved in the learning process.

Table 3.3: Adult Learners' satisfaction in the use of e-learning environment in their learning

Statement (N=226)	SCALE	Frequency	Percentage
How often did you interact with an instructor or technical support staff while you took this course?	Very Frequently	4	2
	Frequently	24	11
	Occasionally	135	60
	Seldom	37	16
	Never	28	12
	Total	**226**	**100**
I liked being able to learn at my own pace	Strongly Agree/ Agree	216	96
	Strongly Disagree/ Disagree	10	4
	Undecided	0	0
	Total	**226**	**100**
This e-learning environment allows for academic feedback regularly/timely from the instructor	Strongly Agree/ Agree	108	48
	Strongly Disagree/ Disagree	87	38
	Undecided	31	14
	Total	**226**	**100**
Self-directed e-learning has been encouraged in this e-learning environment	Strongly Agree/ Agree	195	86
	Strongly Disagree/ Disagree	26	16

	Undecided	5	2
	Total	**226**	**100**
The e-learning system allows for collaboration among students & instructors	Strongly Agree/ Agree	75	33
	Strongly Disagree/ Disagree	136	60
	Undecided	15	7
	Total	**226**	**100**

The table below indicates the utilization of adult learners' experiences in the e-learning process. In the review of the theory of adult learning, it was identified that as online educational environment is increasingly being used by adults (Cercone 2008), there should be a design that is based on the needs of adult learners. The items used in this survey as identified by Billington (2000) helped the researcher to explore whether the adult learners characteristics were being utilized in the e-learning system they were using in their learning process.

Table 3.4: Utilization of Adult learning Characteristics in the e-learning system

Statement (N=226)	SCALE	Frequency	Percentage
The e-learning system provides many sources of learning materials for student exploration	Strongly Agree/ Agree	5	2
	Strongly Disagree/ Disagree	221	98
	Undecided	0	0
	Total	**226**	**100**
I believe that my abilities and previous experiences/ achievements have been acknowledged and respected in this e-learning course	Strongly Agree/ Agree	72	32
	Strongly Disagree/ Disagree	144	64
	Undecided	10	4
	Total	**226**	**100**
In this e-learning course I have been treated as an experienced adult where my opinions/contributions are listened to, honored and appreciated/respected	Strongly Agree/ Agree	76	34
	Strongly Disagree/ Disagree	129	57
	Undecided	21	9
	Total	**226**	**100**

This e-learning environment has promoted interaction with the instructor and between students	Strongly Agree/Agree	108	48
	Strongly Disagree/ Disagree	97	43
	Undecided	21	9
	Total	**226**	**100**
I would prefer to interact and share information with peers rather than to learn on my own in an e-learning course(s)	Strongly Agree/ Agree	184	81
	Strongly Disagree/ Disagree	15	7
	Undecided	27	12
	Total	**226**	**100**

When asked whether the current e-learning system contains more sources of information from which the adult learners explore, 98% disagreed with the statement. The e-learning environment through the system analysis carried out by the researcher before the survey also indicated that the course module in the LMS is only used to deliver content in HTML format to the learners. Additionally, the instructor occasionally sends the learners learning materials through their email addresses. When this is applied in the learning process the adult learners feel intimidated and are not motivated to learn.

In the question related to content in the e-learning environment which sought the adult learner's interaction and sharing of information with other colleagues, majority prefer to interact and share learning information with other students rather than studying on their own. Even though information sharing and interaction is also common to the pedagogical class, process of helping children learn, adult learners will feel more satisfied especially when they share what they have previously got from the professional skills earned. This can only be achieved especially through participating and contributing to proceedings of a lesson.

The analysis in table 5 above show that 144 respondents which is 64% of those involved in the survey indicated that their achievements and previous experiences were not utilized in the learning process. Cook (2003) asserts to this as she argues that researchers with expertise in education and information communications technologies have not applied their findings to the adult learners. Cook continues to argue that this has resulted in teaching methods and strategies that are ineffective in teaching and instructing the adult learners.

Of the adults who participated in this study 81% responded that they prefer interaction and collaboration with other students, as noted in the following comment by a participant who was a full-time working professional:

"Free interaction with other students and instructors and sufficient e-learning material provided"

In reading other comments, it is apparent that what matters to adult learners in the learning is the process.

"The university should subscribe for more materials and make them accessible anywhere through internet unlike current case where a student can down load such material only within the university library"

Adult learners possess characteristics that should be incorporated in their training. Experience, a great resource that can be tapped in the learning process and self-directedness, through which adult learners can participate in the learning process. These are special components in adult learning process which allow the learners pick and choose what they are only interested with.

3.6 Discussion of Results from the survey

Adult learners are working professionals and experts in their fields and possess experiences under which learning process should be based. These learners are skilled at self-directing their own learning and often seek learning when there is a particular need in the context of their field.

From the survey conducted in this study it is clear that the current design models are not suited for adult learners. The same environment is used for both andragogy and pedagogy classes.

To make use of the adult learners' experiences, a dedicated learning model, as proposed in this study should be adopted. This design model, based on SOA, is intended to make learning process collaborative while allowing the learners to use their experiences in publishing articles within an e-learning system and to allow them share what they learn. The published articles are subjected to thoughtful contributions from other faculty groups; informal-competency groups i.e. those who possess similar levels of confidence and experience in a particular field and other wider professional bodies of colleagues.

As identified by Rodrigues (2012) blogging, the method adopted by the researcher is this study, leads to transformative learning which is based on learners' experiences and encourages

reflection and free thinking leading improvement of knowledge. This will be utilized in the SOA framework discussed in as discussed in chapter six.

This creation of content through blogging exploits adult learners' experiences through social construction of knowledge within groups where problem solving and collaboration occurs. This framework is therefore meant to allow adult learners to see the reality of a context that they can relate to so that they can achieve the value of it in their own learning and context.

Additionally the review of the theory of andragogy clearly shows that the characteristics that stand out in regard to adult learners when contrasted to teaching children are experiential learning and self-regulation. These principles however are not utilized by the current e-learning systems.

To incorporate these adult learners' principles in e-learning systems especially used by adult learners, the framework includes the principles as indicated in the figure 3 below.
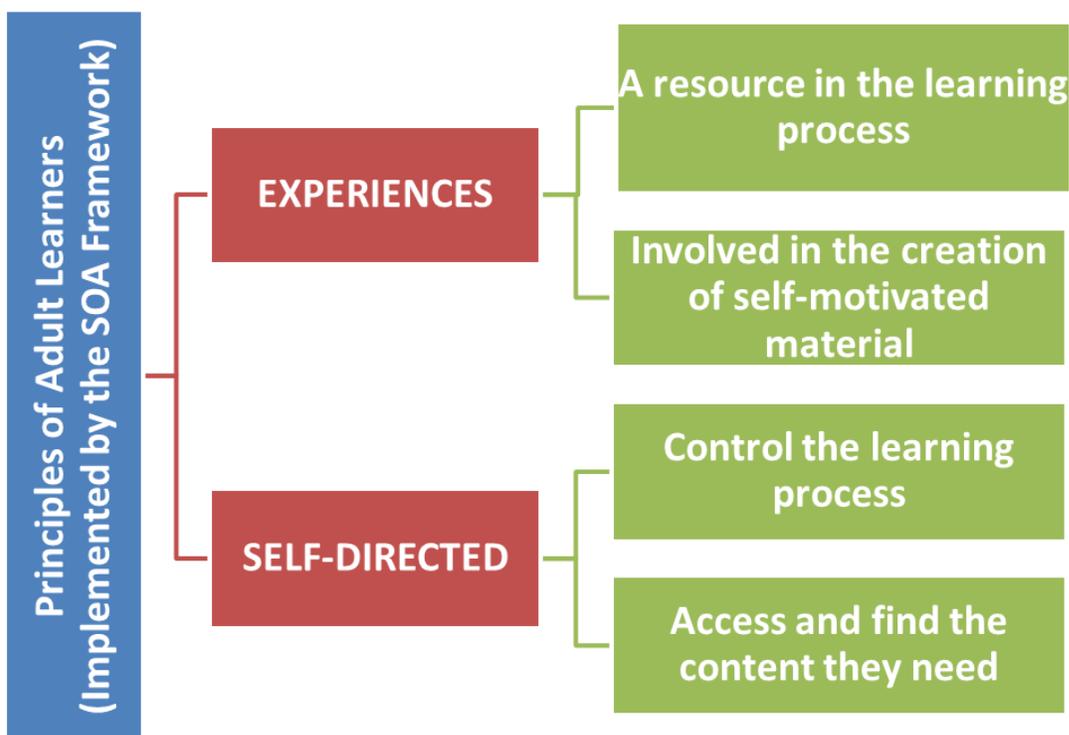

Figure 3.1: Principles of adult learners implemented by the SOA Framework

To implement the above principles in the SOA framework, the researcher includes the following in its design.

27

1. **Remote access to other resources while still in the LMS** – to make use of the resources outside the learning environment, which could otherwise be accessed by use of link outside the e-learning system. This allows the students to the following activities while promoting learner-centered learning process.

   a) Access the shared content from e-learning community

   b) Find the content they need

   c) Learn the content they need

   d) Choose what they want to learn

   e) Control the learning process

2. **Collaborative and Discussion forums** through **blogging and other tools like Wikis**– these are for open reflections and for sharing experiences and thoughts that also allow students to share what they learn with the learning community.

Blogging has been found to be useful and empowering learning tool for students of all ages and particularly for adult learners (Park & Lee, 2011). Blogs have always been used in informal adult learning. This study seeks to make blogging a formal tool in learning. Park (2011) argues that adult learner's experience could be well stimulated in blogging.

While allowing for both audio and video material to be posted, "*Blogs promote critical and analytical thinking and allow students to create content in ways not possible in traditional paper-and-pencil environments.*"(Johnson 2010)

These two components are at the core of the developing of the SOA framework for learning process on professional development and enhancement.

3.7 The SOA Framework Design

3.7.1 The SOA Framework Specifications & Design

This section focuses on the design of the framework that will deliver a remote service into a web-based LMS, in this case Moodle so that it can be internally utilized by the adult learners in accessing content from other services. This function will enable the service function to be utilized without necessarily developing the same remote system within the LMS.

Additionally the framework incorporates the use of Moodle Wiki plugin that will allow interaction and collaboration amongst learners and instructors in content construction.

3.7.2 The integration of Moodle LMS and Remote System Architecture

In this section the architecture of the SOA framework is described. The framework presented in this study enables the Moodle Course students while logged into the LMS to connect over to other remote tool, blog or another LMS and be automatically authenticated and allowing them proceed to use their experience in selecting the content they want in the Moodle course(s).
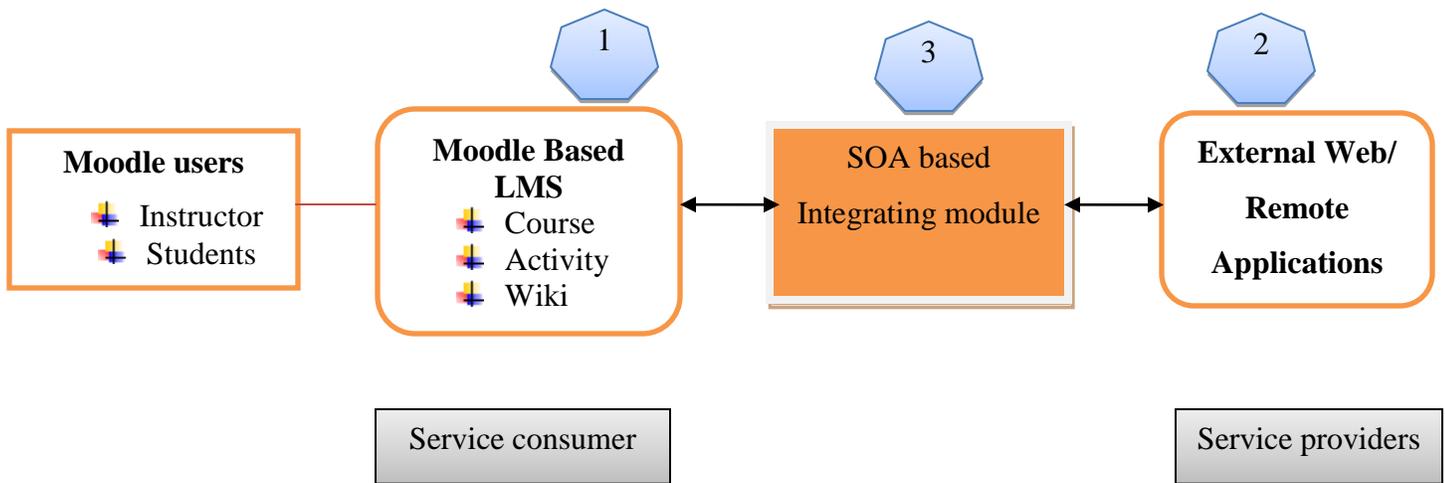
Figure 7: Context diagram of the SOA based integrating framework

The architecture comprises of three parts: Service Consumer - **Moodle LMS**, acting as the service consumer, and containing the users of the e-learning management systems. All authenticated users in the Moodle LMS are automatically authenticated in the external Web system which in this case is the service provider; **External Web/Remote Application**, acting as the service provider, it stores the remote content to be accessed by users of the LMS system upon clinking the Launch URL of the LTI integrator; **SOA based integrating module,** is the

application at the core of this architecture which provides an API between the service consumer (Moodle LMS) and service provider (remote application).

The **SOA based integrating module** is implemented through the use of IMS specification standards and allows embedding of the remote system in the LMS by assigning information in the launch process such as launch URL, shared key and the secret.

1. Service Consumer - Moodle LMS

Centrally, Moodle is a user management system. It also comprises of course areas where users are given roles and permissions, to access content resources and other activities in the learning process (Henrick 2012). These features were separated and treated as internal services in this study. These tools were separated from the other tools as they are able to allow the handling of content within the LMS and also from the remote system that was designed in this study. The activity module of Moodle provides access to an activity or a course from other systems using the External Tool capability. The LTI allows the Service consumer and the service provider which are two separate systems to seamlessly communicate without the users required again to authenticate themselves. Once they have been authenticated in the Service Consumer system, they need not to log on to access the content and resources in the Service Provider system

2. Service Provider - External System

The external system, in this case referred to as service provider, could be an online library, a public collection, a Learning Management System from another institution or a dedicated system which stores learning resources engine. Example is science, programming or mathematics engine that is constructed outside the Learning Management system and instead of having to make it work inside the LMS all that can be done is to implement the IMS LTI standard (IMS GLC, 2010) and provide connection details to those who want to use the resources or accessing content.

The SOA Framework Architecture

```
                    ┌─────────────────────┐
                    │ SOA based integrating│
                    │       module         │
                    │    (Repository)      │
                    └─────────────────────┘
```

Service queries   Service description
                                                      (user's context)

```
┌─────────────────────┐                    ┌─────────────────────┐
│  Moodle Based LMS    │◄──────────────────►│       Remote         │
│  (Service Consumer)  │                    │  systems/applications│
│                      │                    │  (Service Providers) │
└─────────────────────┘                    └─────────────────────┘
```

Service request
&
response messages

```
              ◄──────►┌─────────────────┐◄──────►
                      │   End Points    │
                      └─────────────────┘


              ◄──────►┌─────────────────┐◄──────►
                      │    Services     │
                      │   Contracts     │
                      └─────────────────┘
```
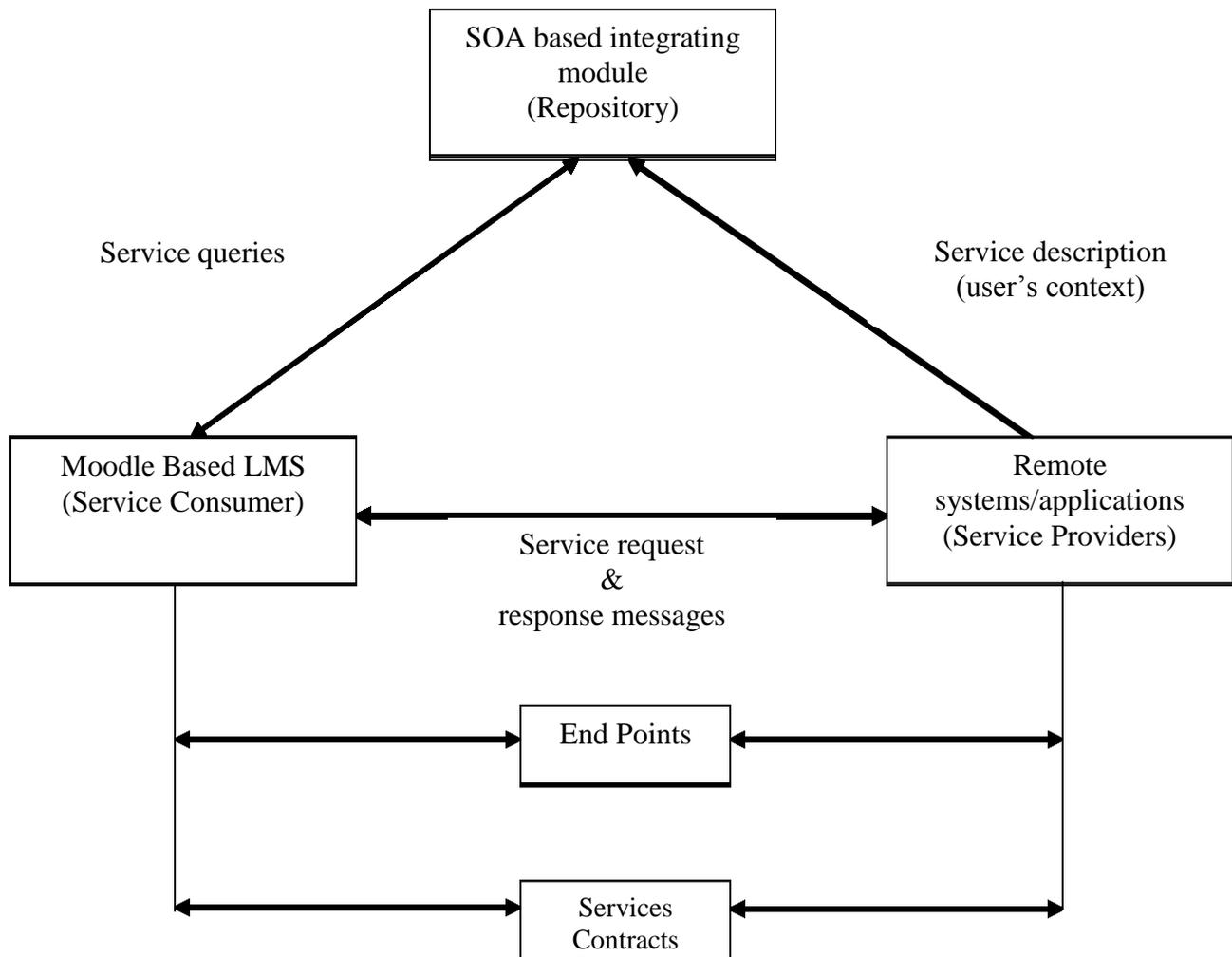
The endpoints provides communication to the service providers and the context for the connection, that is, what service has been requested, where to locate it and its final presentation on the service consumers browser. This is achieved through a graphical user interface which provides for configuration module where details about point-to-point connection between LMS and remote applications are entered. Here, the service consumer which is the LMS knows the endpoint (as configured) and send request is launched when the user clicks on the link(s) provided within the course.

The service contracts in this framework define the relationship between the provider and the consumer, that is, what the service provider will give to the consumer. The contract actually defines what functionality the provider provides to the LMS, what data it will return and in what form. The agreement between the LMS and service providers are entered into when the

administrator fills out a form that typically provides the details governing the two interacting parties detailing what happens after the connection established after authentication.

Messages and Communication between the SOA components
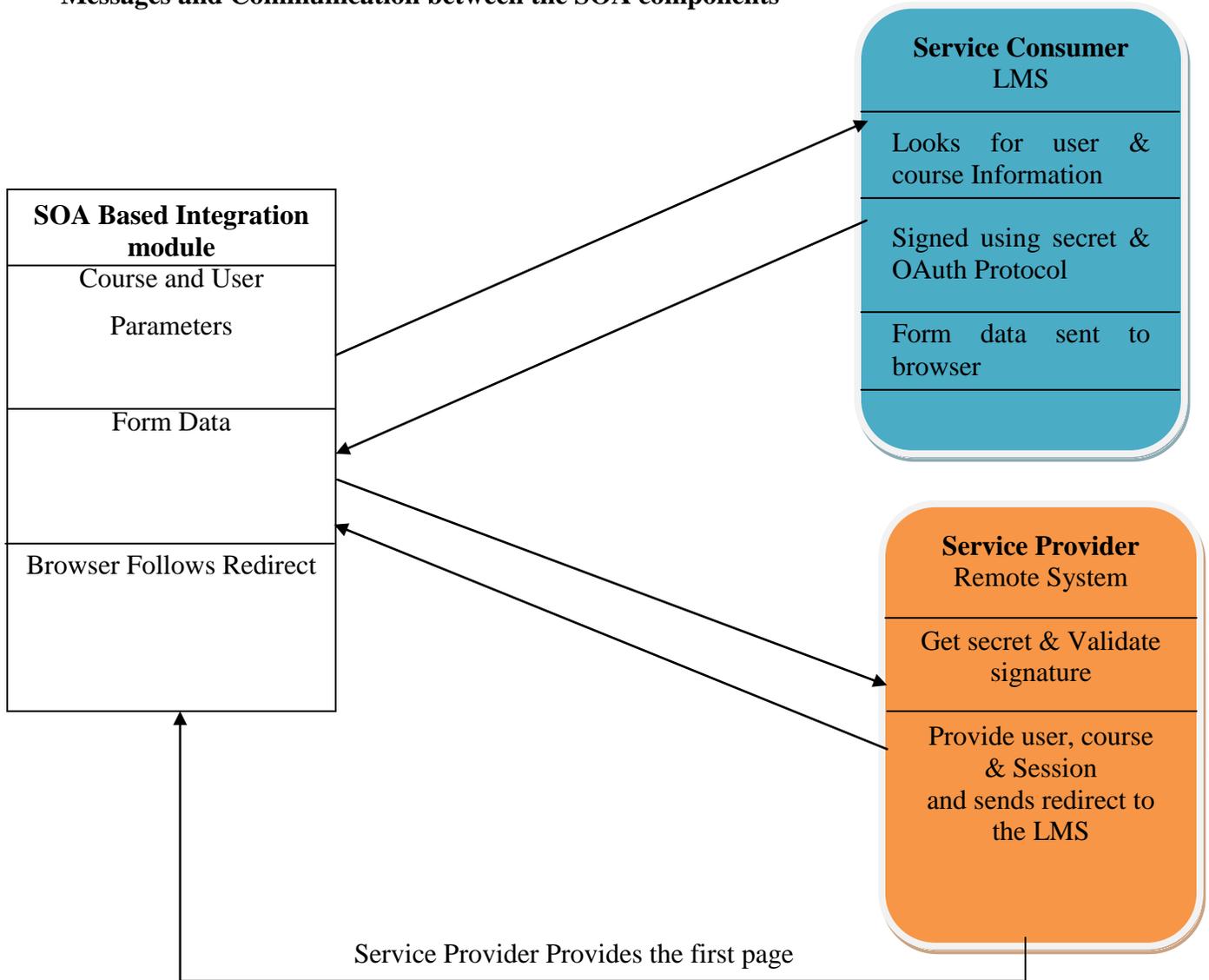
The SOA Framework provides a way for the service consumer (Moodle LMS) to send a user to another system i.e. service provider (this is the service that integrates with the LMS). It allows the user to be authenticated and allow access to a specific course when the service provider renders the content.

The service provider and service consumer communicates through the use of a consumer key and a shared secret which allow any message to be passed between the two systems. The messages are signed using the OAuth (soap uses this protocol over the transport layer) protocol for secure API authorization.

Service Consumer

ua = user context
s = shared key
sig=Oauth_sig (ua, s)

HTTP POST ua, sig

Service Provider

LMS
Moodle

Authentication is a one-way handshake from consumer
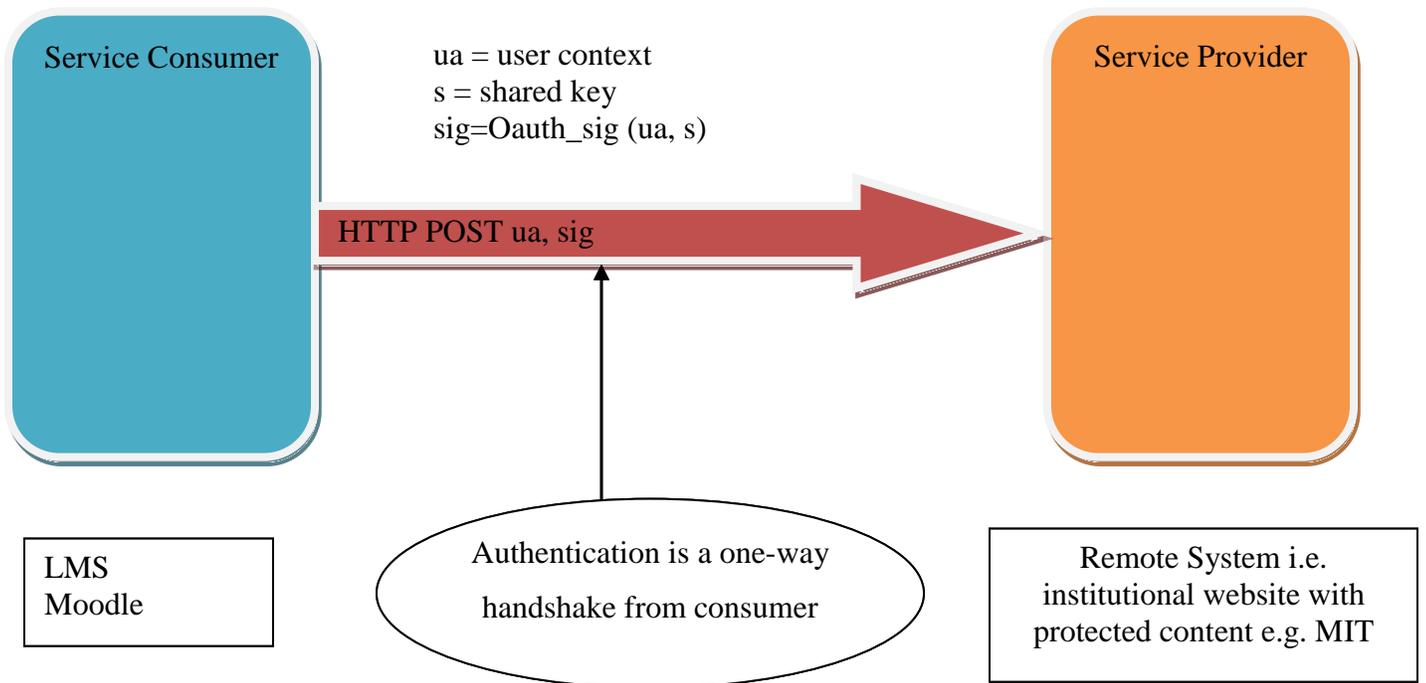
Remote System i.e. institutional website with protected content e.g. MIT

He HTTP POST occurs on the user's browser by submitting a form through JavaScript to an iframe within the LMS hence the student (user) need not to perform other steps in the process of accessing the remote system. The details are entered through the Moodle External Tool configuration form shown below and then submitted to the database.

▼ Tool Settings

Tool Name* ⑦ K-12
Tool Base URL* ⑦ https://lti-examples.heroku.com/tools/ck12/config.xml
Consumer Key ⑦ uon2014
Shared Secret ⑦ ••••••• ☐ Unmask
Custom parameters ⑦

⑦ ☐ Show tool type when creating tool instances
Default Launch Container ⑦ Embed ▼

▶ Privacy
▶ Miscellaneous

Figure 3.2: Moodle External Activity tool configuration window

The following is a list of LTI compatible systems that has employed the use of IMS content and are freely available for implementation in the e-learning systems;

1. **Khan Academy:** Allows searching and embedding lessons and exercise into course material. Khan Academy focuses on short lessons on math, science, etc. Uses the embedded player so students earn points for watching videos.

2. **Public Collections:** Run by Instructure, it allows one to browse or search through multiple content repositories including MIT OCW, Khan Academy, USA Today, etc.

3. **WordPress**: WordPress is a blogging and publishing platform. It can be used to host student or class blogs. A WordPress site allows for auto-login to the WordPress platform. Links can be added to course content, or optionally as course navigation.

4. **CK-12**: CK-12 provides openly licensed and freely available textbooks and multimedia learning materials aimed primarily at grades K-12.

The last two, CK-12 and WordPress, have been employed in the SOA framework discussed in this study. These websites can be accessed by students registered in Moodle LMS, and automatically be authenticated on the remote systems hence allowing accessing to the content packaged in the systems.

3. SOA Based Integrating Module

The integrator provides a single sign on so that Moodle users do not have to re-register on the service Provider platform so as to access content or engage in any activity stored in the remote system. The whole of this process happens automatically. The remote system is accessed within the service consumer which is convenient for learners who might be having useful information on the remote site.

The IMS content packaging specification makes it possible to store chunks of material in a standard format which can be re-used in different systems, without having to convert the material into new formats (Dougiamas 2004). The presence of large amounts of resources available outside the learning management system can now be utilized by the LMS through the use of the SOA integrators. This application allows access of remotely stored content to be viewed within e-learning management systems.

3.7.3 Principles of Adult Learners implemented by the SOA framework

This framework addresses the principles of adult learners as cited in Figure 3.1 as follows:

1) **Experience**

a) **Resource in the learning process & Creation of self-motivated learning material**

The experience that adult learners possess is a great resource in the learning process. The design model, based on SOA, is intended to make eLearning process collaborative while allowing the learners to use their experiences in publishing articles within an e-learning system and to allow them share what they learn. The published articles are subjected to thoughtful contributions from other faculty groups; informal-competency groups i.e. those who possess similar levels of knowledge and experience. As identified by Rodrigues [19] blogging, the method adopted by this research, leads to transformative learning which is based on learners' experiences and encourages reflection and free thinking leading improvement of knowledge. The combination of the contributions from the learners leads to material that one can use to refer to a specific topic of learning as contributed by different adult learners in their professional fields.

2) Self-Directedness

b) Control the learning process

The SOA framework when implemented on eLearning systems for adult learners, enables learners go through instructional materials delivered via the Web at their own pace with no or minimal interaction with an instructor.

c) Access and find the content they need

This is reflected in the SOA framework by providing to learners an e-learning environment that gives the adult learners intellectual freedom, experimentation and creativity. The different sources of learning materials exposed to the learners through the design model enables them access and find the content they need. This is in contrary to what the current pedagogical models provide.

3.8 Implementation

The implementation of the SOA Framework is achieved through the integration of the Moodle LMS and the IMS LTI standard specifications. This is done through the use of tools provided by Moodle appropriately. These included Moodle's resources and activity modules as well as some of its database tables, making the integration easier for the developer and transparent to the learner.

To implement the proposed design model using Moodle LMS, it was necessary to install the WAMP local server that met the basic Moodle systems requirements in its installation including the Apache Web server, MYSQL and PHP. The configurations and setup requires also the IMS LTI (Leal & Queirós 2011) consumer specifications. The researcher implemented the IMS LTI standard because it describes how web services calls are made so as to provide communication between service provider and service consumer (LMS) (Guerrero et al. 2009). Tools provided by Moodle were also used appropriately. This specifically included Resources and Activity modules.

3.8.1 Developing the SOA Framework

The application framework, functioning as a web service, is embedded in the Moodle LMS as an external tool and will provide a remote access to other systems. The application in its entirety is based on the Learning Tool Interoperability specifications. It is responsible in importing and management of the content from the remote systems. The framework employs the IMS Learning Tools Interoperability standard specification that extends the function of the LMS to integrate remote systems and content in such systems in the Moodle LMS.

The LMS through the SOA will be able to:

i. Allow users to configure connections to an external service provider (typically by providing a URL to the service provider's launch page, a key, and a password.

ii. Enable users (teachers or students) to create and display links to the external application from within the LMS for others to access.

iii. Provide a runtime environment to create launch requests and send the launch requests to service providers when links are accessed or clicked.

When a user clicks a link, the LMS packages additional information with an OAuth signature and sends it to the service provider.

OAuth is an open protocol allows secure API authorization in a simple and standard method, enabling service providers to trust that the information in a launch request was packaged by the service consumer.

When the service provider gets the request, it uses the shared secret (password) to decrypt the information and ensure that the request is from the LMS (service consumer).

The SOA launch request is presented from the LMS as an HTTP Post to the service provider with an array of hidden form elements. Launch requests from the LMS to external learning tools are straightforward HTML forms. The data typically identifies the system, the course, the user, and any custom information that the tool requires. It also contains a signature created using a secret known only by the tool provider and the user who configured the link in the LMS.

The service provider receives the request, validates the information, creates user accounts and courses as required, and ultimately creates a session and redirects the user's browser to the appropriate page of the service consumer. With the information provided in the launch request, the tool provider can verify the request, create any users or courses it needs, initiate a session, and redirect the user's browser to the appropriate page, providing a seamless experience for the user.

The SOA integrating module plays a central role in making the Moodle LMS to be service oriented and specifically a service consumer in this study. The service provider and consumer are authenticated to one another through the use of key, secret and a launch URL as explained below.

a. **Key**: represents shared key between the service consumer and provider. It is common and known to both provider and consumer. The key allows secure communications between the two systems.

b. The **Secret**: set up at the service provider system (remote system) is like a secret password that will allow consumer to access a service from the remote system.

c. The **Launch URL**: this is the browsers address of the site to be accessed for the content. When launched it will open the website which is accessed to provide content within the Moodle course.

Once the configuration is done, the remote system is added to the users' (students and/or course instructors) learning material/course as a link inside the LMS, service consumer. These details are stored the tables created together with other Moodle database tables.

The users are directed to the remote system through the signed HTTP post request and then the remote system confirms the signature.

The screenshots below shows the same student authenticated within Moodle LMS accessing content from a CK-12 website in this study regarded as Content provider.

Figure 3.3: A student in the within the Moodle Course

Figure 3.4: The SOA Framework, student accessing CK-12 content within the Moodle Course

CHAPTER 4 : VALIDATION OF THE SOA FRAMEWORK

The validation process was carried out on the prototype that was developed and simulated on the Moodle-based LMS. The purpose of the validation was used to establish whether the adult learners' characteristics identified in this study were incorporated in SOA framework. These included;

1. Use of adult learners experience in the enhancement of learning process and creation of self-motivated learning materials.

2. Self-directedness of adult learners so that;

        a. They can control the learning process.

        b. They can access and find the content they need.

The above two factors were isolated by the researcher as they also satisfy the characteristics for adult learners that separates the adult learners from the pedagogical class and were the basis for evaluation process in this study.

4.1 Procedure used for validation

The validation process involved the following procedure. First, the prototype was made available to the learners for inspection using Abstract Tasks (AT) approach. Abstract Tasks (AT) inspection method describes activities to be performed during the inspection and captures usability experience while identifying the application features on which it is important to focus inspection and describes the actions the inspector should perform during the evaluation [2]. AT inspection aims at allowing inspectors who may not have a wide experience in evaluating e-learning systems to perform accurate evaluations by performing specific tasks. A survey (on a sample size of 58) to establish increment on the motivational level compared to the initial survey (carried on the pedagogical based e-learning system) was then carried out. Secondly, system logs/views were collected from the prototype to measure;

    i. The extent which learners employed the use of their experiences in the creation of self-motivated learning materials through collaboration amongst learners. The self-motivated learning materials were created through the archived ideas exchanged by the learners and;

    ii. Whether the students were able to access the sources of learning materials on their own while within the Moodle-based LMS. This was done by analyzing the number of objects

(external learning sources or documents) accessed by the learners in the simulated e-learning system.

A. **Validation Survey**

A survey using the tools that were used to collect data and information that informed the researcher the need for an SOA framework was designed. To ensure that the participants really interacted with the framework before responding to the questionnaire, they had to carry out an Abstract Tasks (AT) inspection on the system. Abstract Task (AT) inspection method describes activities to be performed during the inspection and captures usability experience while identifying the application features on which it is important to focus inspection and describes the actions the inspector should perform during the evaluation (Ardito et al. 2006).

Ardito et al. (2006) argues that AT inspection aims at allowing inspectors who may not have a wide experience in evaluating e-learning systems to perform accurate evaluations. The method also allowed inspectors to perform the specific tasks that were important as far as the SOA framework in this research study is concerned in carrying out a systematic evaluation of basic constituents or features of the framework by suggesting the activities to be conducted over such features. The AT and survey instrument were chosen for the evaluation process due to limited time. Before carrying out the evaluation survey, all the participants were provided with the 2 ATs that enabled them to carry out the activities which gave them an adequate interaction so as to be able to respond to the questions in the evaluation survey.

The Abstract Tasks performed were first formulated using the following template which provided a consistent format and included five items (Ardito et al. 2006):

- − AT Classification Code and Title univocally identify the AT and its purpose
- − **Focus of Action** lists the applications objects to be evaluated
- − **Intent** clarifies the specific goal of the AT
- − **Activity Description** describes in detail the activities to be performed during the AT application
- − **Output** describes the output of the fragment of the inspection the AT refers to.

For the participants to evaluate the SOA framework for its functionality in regard to the satisfaction and motivation of the adult learners, the following were the activities that were performed using the AT method before responding to the questions in the questionnaires distributed online to each inspector.

AT-01: Availability of Collaboration & Interaction Tools

Focus of action: Collaboration and interaction tools

Intent: Evaluate the functionality of collaboration tools

Activity description:
- Identify the tools provided for students to share and collaborate together within the course that they have been pre-registered
- Try to access the content created by other students and interact/collaborate with them
- Create your own content in the collaborative environment accessed
- Access the shared resources by accessing other links provided in the course for institutional level collaboration

Output: a description of reporting if;
- The collaboration tool offered by the SOA framework allows for the incorporation of adult learners' experience in the social construction of knowledge and sharing amongst the leaners.
- The SOA framework allows the learners to see the reality of context and if they can relate to one another in order to achieve self-directed in the process

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AT-02: Provision of tool by the SOA Framework to allow for self-directed learning

Focus of action: Access of interactive content or learning resources located outside the LMS

Intent: Evaluate for the provision of self-directed learning

Activity description:
- Try and access content provided from external source within the Moodle LMS.

Output: a description of reporting if;
- The institutional-level collaboration will allow for access of more learning resources for adult learners to choose from

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The participants were required to carry out the above abstract tasks so as to interact with SOA framework embedded within the Moodle LMS and help the learners go through the aspects of adult learners that were incorporated in the e-learning environment.

B. System views/logs

As identified in this study the adult learners' experiences and self-directedness were the two characteristics that were identified and incorporated in the design and implemented in the SOA

framework. The learners' experiences were manifested through the provision of collaboration between learners through the exchange of comments/ideas between students.

To allow for self-directedness to the learners, the framework allows the adult learners to be able to access many sources of learning materials for student exploration. The content accessed remotely from and within the LMS gives learners the freedom to choose the content they would like to learn on their own unlike when they only rely on only one source of content from the instructor(s). To measure for the self-directedness, the researcher sought to analyse the number of objects/documents accessed by the learners in the e-learning system.

4.2 Validation results

a) Results from the survey

After the carrying out the activities described by the abstract tasks, the assumption was that the learners were now on the position to respond to the questionnaire posted to the learners to assist in the evaluation of the SOA framework. The survey analysis that was carried out in comparison with the initial survey which informed the researcher the need for an SOA framework is shown in the table 5 below. The participants who were involved in the evaluation of the design model were 58.

Table 4.1: The evaluation results from the SOA framework

Statement (N=58)	SCALE	Initial Survey		Use of the SOA framework within LMS	
		Freq	**%**	**Freq**	**%**
The e-learning system provides many sources of learning materials for student exploration	Strongly Agree/ Agree	5	2	**44**	**76**
	Strongly Disagree/ Disagree	221	98	**14**	**24**
	Undecided	0	0	**0**	**0**
	Total	**226**	**100**	**58**	**100**
I believe that my abilities and previous experiences/ achievements have been acknowledged and respected in this e-learning course	Strongly Agree/ Agree	72	32	34	58
	Strongly Disagree/ Disagree	144	64	17	29
	Undecided	10	4	7	12
	Total	**226**	**100**	**58**	**100**

In this e-learning course I have been treated as an experienced adult where my opinions/contributions are listened to, honored and appreciated/respected	Strongly Agree/ Agree	76	34	32	55
	Strongly Disagree/ Disagree	129	57	22	38
	Undecided	21	9	4	7
	Total	**226**	**100**	**58**	**100**
This e-learning environment has promoted interaction with the instructor and between students	Strongly Agree/Agree	108	48	32	55
	Strongly Disagree/ Disagree	97	43	19	33
	Undecided	21	9	7	12
	Total	**226**	**100**	**58**	**100**
Self-directed e-learning has been encouraged in this e-learning environment	Strongly Agree/ Agree	195	86	52	90
	Strongly Disagree/ Disagree	26	16	6	10
	Undecided	5	2	0	0
	Total	**226**	**100**	**58**	**100**
The e-learning system allows for collaboration among students & instructors	Strongly Agree/ Agree	75	33	43	74
	Strongly Disagree/ Disagree	136	60	13	22
	Undecided	15	7	2	4
	Total	**226**	**100**	**58**	**100**
I would prefer to interact and share information with peers rather than to learn on my own in an e-learning course(s)	Strongly Agree/ Agree	184	81	48	83
	Strongly Disagree/ Disagree	15	7	6	10
	Undecided	27	12	4	7
	Total	**226**	**100**	**58**	**100**

The evaluation involved 58 postgraduate students from one of the leading Universities in Kenya. These students were part of those who were involved in the survey that informed the researcher on the need for the SOA framework. The small number of the participants involved in the evaluation was due to the fact that the evaluation was carried out during examination period when most of the learners were busy preparing for their examination. The other reason that must

have contributed to the low number was probably because the evaluation process was time consuming. The inspectors were first required to carry out the AT activities before responding to the questions raised in the evaluation. Since there was no external motivation or incentives to the learners most of them could not respond as expected. However, the analysis from those who were involved was adequate enough to give a clear effect of using the SOA framework when compared to the initial survey carried out on the current e-learning systems which the learners used in their learning.

Participants in the evaluation process could access a pre-set course in the Moodle course module. From the course the learners could then access the Wordpress Site within the course. The wordpress site provided a platform through which learners could collaborate and interact. There were other links that were provided within the course module which when clicked led to access of interactive course content/resources from remote websites. These sites exposed their content as web services which were then fetched while within the pre-set course in Moodle LMS.

After carrying out the AT inspection, the inspectors, who were the study participants involved in the survey advanced to respond to the questions identified from the early survey. From the analysis of the evaluation results as shown in table 5, it is evident that in all the survey items, there was increase in the percentage when compared to the same results from the initial survey carried out on the current system that were being used by adult learners. This indicates that the used of the SOA framework increased the motivation hence the satisfaction of the learners. Since the SOA framework delivered a design model that incorporated the adult learners' characteristics, it allowed the adult learners to feel that the experience and intellectual ability were respected and appreciated. From the survey it can be concluded that the SOA framework delivers an adult learning environment that utilizes the learner's capabilities, experiences and adult learning characteristics.

It was observed that 76% of learners were in agreement that the SOA-based eLearning system provides more sources of learning materials while58% indicated that they felt their experiences and previous achievements were acknowledged and respected. This is in concord with other previous studies (Ismail et al. 2010; Kim 2009) which established that when left to explore on their own, they feel respected, more satisfied and motivated to engage in e-learning and that adult learners like taking their own responsibility in their learning as they are independent and autonomous in their thinking. From the survey it can be concluded that the SOA framework

delivers an adult learning environment that utilizes the learner's capabilities, experiences and adult learning characteristics.

b) System views/logs

There were two types of system logs/views that were collected to establish the manifestation of adult learners' experiences and self-directedness in the SOA framework respectively. To measure for self-directedness which it the context of the SOA framework analysed the number of objects/documents accessed by learners were analysed. The table below shows the

1. Evaluation for collaboration and students' interaction

The system logs collected from the system were used by the researcher to establish whether the students exchanges and access of remote objects/content increased positively to a point of demonstrating whether the students were able to collaborate and interact with one another within the wordpress blogging platform. The logs captured by the system indicated the number of participants who accessed the platform and either viewed other students' posts or created their own posts. There were a total of 22 students whose logs were recorded into the system and analysed as follows showing the students who accessed and viewed other students' posts.

Table 4.2: Students' access to other students' posts

Student Number	Number of posts viewed
1	1
2	1
3	3
4	3
5	3
6	5
7	1
8	2
9	2
12	1
11	1
12	1
13	4
14	3

15	3
16	1
17	7
18	4
19	3
20	1
21	1
22	8
Totals	**59**
Average	**2.6**

There was an average of 2.6 views for each student which indicated that approximately each student was able to view or interact with others at least 3 times. The total number of posts created was 3 and the exchanges between the students through the posts are summarized below:

Table 4.3: Summary showing the posts created exchanges on them

Post Number	Number of exchanges/comments from other students
1	7
2	3
3	0
Average number of exchanges	**3.3**

The average number of exchanges shows that for each post created, there were 3 other posts/comments on the original posts created. The number of posts created was lower than expected. This could be attributed to the limited time and the fact that the deployment was not on the actual learning scenario.

However, as far as this study is concerned, the exchanges among students who were involved in the study indicate an improvement in collaboration between students when contrasted to the analysis carried out by the researcher before the survey which indicated that the course module in the LMS was being used to deliver content in HTML format to the learners. From this analysis it was also found out the instructors sent the learners learning materials through their email addresses.

The researcher in study therefore was able to observe that through the SOA framework, collaboration among instructor and learners was achieved as compared to the current e-learning systems where there is no collaboration at all.

2. **Evaluation for provision of student-centered learning (self-directedness)**

The course that was created on the SOA framework for evaluation purpose provided access to 3 external education applications that delivered remote content in the Moodle based LMS as services. The views which indicates the number of times the sites were accessed for content is summarized below:

Table 4.4: Evaluation results for self-directedness in the SOA framework

Remote Application	Number of Views
K-12 Learning Resources	24
Public Collections	24
Interactive Programming Tutorials	25
Average number of views	**24.33**

Since the total number of students who accessed the remote systems was 22, the average number of access for each student to the external systems is 3 indicating that for each of the 3 educational applications each student had an access.

The system logs/views analysis shows that the collaborative and interactive learning environment which was made available for students allows the students to make use of their experiences to collaborate and interact among themselves. Self-directed learning incorporated in the SOA framework was able to allow students to be in charge of their learning by accessing learning resources within the LMS hence providing the freedom for students to choose from where they learn and in so doing learners are able to maintain their independence in the learning process.

CHAPTER 5 : DISCUSSION AND CONCLUSION

5.1 Discussions

From the conceptual framework it was established that maturity affects how adults learn and take in information (Knowles 1996). Adults are independent, experienced and self-directed when it comes to learning. If they are treated the same way as children, they feel that their independence and experience in the knowledge gained is never appreciated or acknowledged. The survey carried out also demonstrated that current e-learning systems used to teach adult learners are same ones used to instruct children. This lowers the motivation hence dissatisfaction in adult learners. This was the reason for the need of an SOA framework that incorporates adult learners' principles.

The SOA framework in this study employed the Wordpress blogging tool into the Moodle LMS to facilitate collaboration as an important principle to adult learning process. The framework also allowed access of external content which demonstrated collaboration at the institutional level.

The SOA framework was able to provide an environment for collaboration, content construction and self-directed learning amongst adult learners.

When adult learners, who engage in web-based e-learning, are provided with a learning environment which allows them to collaborate interactively, they feel motivated to learn and this leads to their satisfaction. This way, their experience is exploited and brought to the center of the learning process. The researcher in this study sought to design a model for adult learners that incorporated the adult learners' experiences and self-directedness.

It was also established that outside the Learning Management Systems are applications that stores resources and learning environment/interfaces that exposes their functions as web services and can be utilized within LMSs through the SOA framework proposed in this study. An example of such sites that allow for interaction or collaboration include Code academy website which allows programming exercises and tutorials for students. The site was linked to the Moodle course module through the SOA framework, discussed in this study, and allows students to write and execute programs without installing the programming API interfaces on their Personal Computers.

This study therefore proposes an SOA framework for adoption in the Learning Management Systems used by institutions of higher learning especially those that offer teaching adult learners

so as to provide interactive collaborative. This ensures that the motivation for adult learners is maintained throughout their programs and consequently avoid dropouts and encourage distance and open learning though web-based learning.

5.1.1 Limitations of the Study

It should be acknowledged that there were some limitations to this study. The SOA framework could have been validated through an experimentation process requiring deployment of the design model for adult learners for a longer period. The SOA framework, if time was not a limitation was supposed to be made available for one semester ensuring that all adult learners in the course were involved in the learning process so as to give the actual picture of how the motivation and satisfaction of the adult learners could be affected compared to their use of the current e-learning systems in the learning process.

Since the system was not available to the learners throughout a one semester course, the researcher in this study adopted the AT inspection method before inviting the inspectors (study participants) to carry out the evaluation survey. This led to a reduced number of those who participated in the evaluation process. It is assumed that either the process was time consuming or there was no incentive for the learners to carry out the evaluation process.

However, if the system was made available to the learners in the normal learning time for example one semester, the AT inspection process could not have been adopted. Learners could have only carried out the survey independently without the AT inspection process and hence the evaluation results could give results more close to what was anticipated by the researcher and also from the work done by other researchers as discussed from the literature review of this study.

5.1.2 Recommendations for future study

There exists also a researcher gap in this research project for future study. The Wordpress Content Management System (CMS) which was adopted by the researcher is famously used for blogging. Johnson (2010) argues that blogging leads to transformative learning which is based on learners' experiences and encourages reflection and free thinking that leads to improvement of knowledge and social construction of knowledge within groups where problem solving and collaboration occurs. This was the reason for the choice of using the SOA framework to provide the blogging functionality of Wordpress sites within the Moodle LMS course.

Blogging, even though widely adopted by many, however has never been used in the formal to learning process. Therefore its adoption into the Moodle LMS through the SOA framework will only be able to provide the blogging functionality within the Moodle course informally. As its adoption in to the learning process will take place one thing will therefore be lacking; how do we make blogging within the LMS formal through provision of grading? Blogging, which enables learners to create and publish their articles within the LMS, needs to also provide a way of ensuring that it does not only provide the interaction and collaboration process, but also grading. The questions to this problem may include: if learners create and publish articles within the LMS how will their evaluation be done hence finally provide some grading into the LMS exercises and grading process. Is it possible to make the Wordpress blogging functionality formal within the LMS and hence part of learning? If so, how will this be achieved especially through the use of the Service Oriented framework developed and implemented in this study?

5.2 Conclusion

Adults are independent, experienced and self-directed when it comes to learning. If they are treated the same way as children, they feel that their independence and experience in the knowledge gained is never appreciated or acknowledged (Knowles 1996).

This study established that there is a possibility of using an andragogy based eLearning framework that runs on an SOA platform. The SOA framework employs the Wordpress blogging tool in a Moodle LMS to facilitate collaboration as an important principle to adult learning process. The framework also allows access of external content which demonstrates collaboration at the institutional level and provides an environment for collaboration, creation of self-motivated learning materials amongst adult learners. When adult learners, engaging in web-based e-learning are provided with a learning environment which allows them to collaborate interactively, they feel motivated to learn and this leads to their satisfaction (Kim 2009; Ismail et al. 2010). This way, adult learners' experiences are exploited and brought to the center of the learning process.

The SOA framework integrates the principles of adult learners into the learning process hence maintaining the motivation hence satisfaction for adult learners who carries their studies via e-learning environments. This is true when the adult learners' experiences are exploited and incorporated in the learning process and that provides them with opportunities to interact with themselves and instructors (Holton, 2010).

The SOA framework contributes to the improvement of the motivation of adult learners who sometimes may drop out of their learning because of lack of motivation as majority of the eLearning systems currently in use are more appropriate for younger learners. Knowles (Knowles 1996) also argues that adults should not be treated the same way as children when it comes to learning.

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APPENDICES

Appendix A: Analysis Scheme for the Service Oriented e-learning environment

The questions that guided the evaluation of the e-learning environment that the participants involved in this study were using in their learning are as follows;

1. Tools provided by the system for teachers to present their ideas/information to students

2. Tools provided by the system for students to articulate their opinions and ideas to teachers and other students

3. Learners: Importation of external content in the course to supplement what the instructor provides

4. Interaction of students and teachers inside the course

   a. Through the use of emails
   b. Links to the external communication systems

Appendix B: Research Questionnaire for the Survey Study

Dear Respondent,

I am a student pursuing a Master of Science degree course in Distributed Computing Technology at the University of Nairobi. My research topic is **"An SOA Framework for Web-based E-learning Systems: A case of Adult Learners"**

The purpose of this study is to identify and explore factors that motivate or demotivate adult learners who engage in self-directed e-learning with an aim to develop a design model that will enhance learning for working adults and adult learners.

Kindly fill this questionnaire to the best of your knowledge to help me complete this academic endeavor. The information you will provide will be treated with utmost confidentiality and shall be used for academic purposes only.

A. Background Information

1. Which age group do you belong to?

☐24 or younger   ☐25-34   ☐35-44   ☐45-54   ☐55 or older

2. What is your gender?

☐Female   ☐ Male

3. What is your marital status?

☐Married   ☐ Single

4. **What is your academic status?**

(Please select the one you were when you took the e-learning course.)

☐Student – undergraduate   ☐Student – graduate ☐ Working professional

5. Which one of the following best describes your motivation for taking this course?

☐For personal development

☐To enhance my job skills

☐To receive a certificate

☐To complete mandatory training or class assignment

6. **For what reason(s) did you choose an e-learning option?** (Please select no more than three)

☐ Classroom training did not fit my schedule.

☐ Classroom training was not available.

☐ Convenience of online learning (learning anytime anywhere)

☐ Flexibility of self-paced learning

☐ Cost less than taking classroom instruction

Adult Learning Satisfaction/m Motivational Features

INSTRUCTIONS: The following statements ask your opinions about the motivational aspects of the self-directed e-learning course that you took. Please indicate your response to each of the following statements by checking ONE of the five responses from "**strongly disagree**" to "**strongly agree**" for each statement.

7. **I liked being able to learn at my own pace.**

☐ Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree

8. **How often did you interact with an instructor or technical support staff while you took this course?**

☐ Never ☐ Seldom ☐ Occasionally ☐ Frequently ☐ Very Frequently

9. **Hands-on activities in this course helped me engage in learning.**

☐ Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree

10. **Taking a self-directed e-learning course was worthwhile.**

☐ Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree

☐ Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree

11. **There should be many resources that I can explore in the course**

☐ Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree

Part III: Adult Learning Characteristics

INSTRUCTIONS: This part of the survey asks your opinions about the adult characteristics that impacts adult learning experience through e-learning. Please choose the answer that best describes your situation by checking ONE of the five responses from "**strongly disagree**" to "**strongly agree**" for each statement.

12. The e-learning course was offered on an environment that made me feel my individual needs and uniqueness are respected

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

13. I believe that my abilities and previous experiences/ achievements have been acknowledged and respected in this e-learning course

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

14. The e-learning system/course has encouraged intellectual freedom, experimentation and creativity.

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

15. In this e-learning course I have been treated as an experienced adult where my opinions/contributions are listened to, honored and appreciated/respected

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

16. This e-learning environment has promoted interaction with the instructor and between students

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

17. This e-learning environment allows for academic feedback regularly/timely from the instructor

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

18. **In this e-learning environment I have been treated fairly and the instructor has listened, responded and made adequate changes**

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

19. I would prefer to interact and share information with peers rather than to learn on my own in an e-learning course(s)

☐Strongly Disagree   ☐Disagree   ☐Undecided ☐Agree   ☐Strongly Agree

20. What would make self-directed e-learning courses more interesting and engaging for you?

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Thank you for taking time to fill this questionnaire

Appendix C: Procedure for application of the SOA Framework

The application of the SOA framework described this study allows for inclusion of external tools into web-based e-learning systems and for this study Moodle LMS was used. The framework allows course instructors to include into the Moodle course content activities and tools that allows for interactive learning environment through Wordpress Content Management System – the users inside Moodle can now interact with one another using an external platform i.e. Wordpress.

The procedure for integrating the Wordpress CMS into Moodle LMS is described below;

1) Setup Wordpress Multisite on a webserver

2) Upload the SOA Framework LTI files and folders inside wp-content of the Wordpress Site

3) Setup the Wordpress Learning Tool Interoperability Consumer and Secret Keys on the Wordpress Multisite
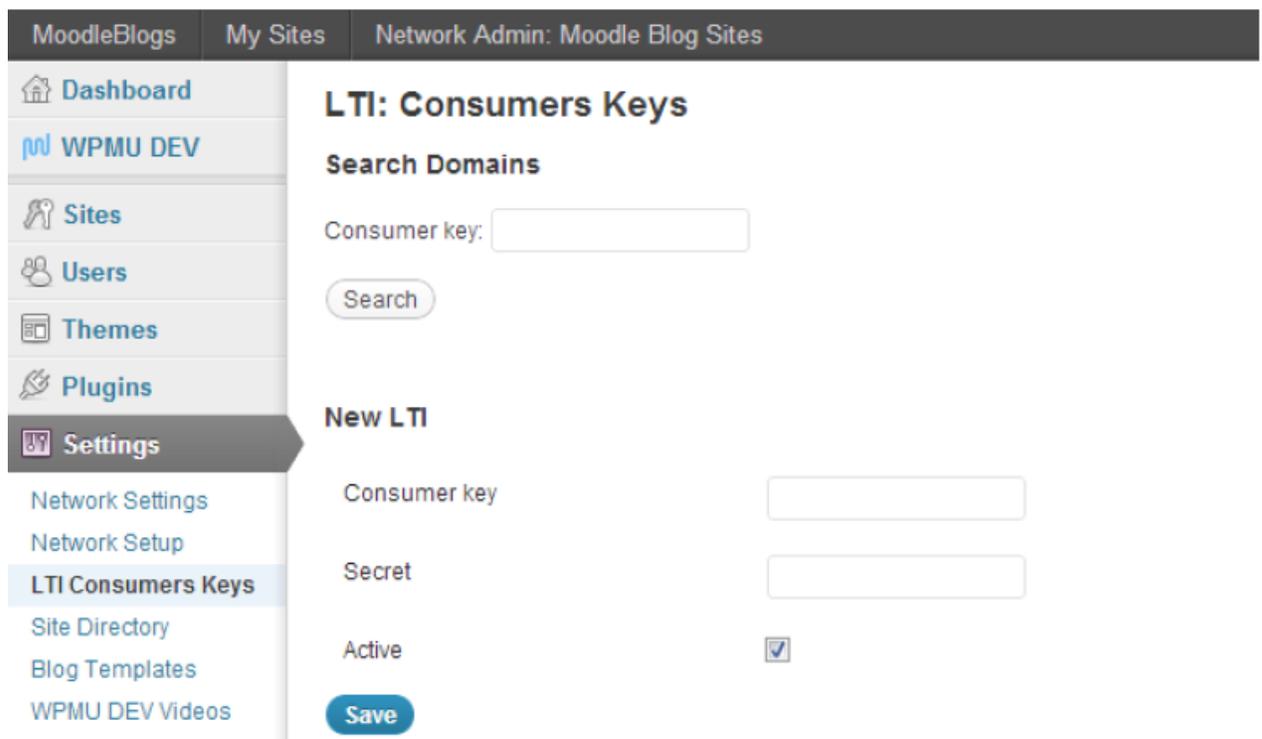
4) Setup the Moodle LMS external tool configuration settings to march match (4) above. The Moodle Version should be 1.9 or later version as these versions allows plugins compatible with the LTI to be integrated into Moodle LMS.

Moodle external tool configuration settings

      i.   The Tool Base URL is the address to your wordpress site.

      ii.   The Consumer Key and Secret are the ones added on the Wordpress.

      iii.   Default Launcher is set embed.

5) Login as Admin Moodle user and add to course(s) external activity and select the SOA plugin.

6) Login as a student Moodle user. Access the course(s) containing the plugin as an external tool.

7) Click on the external tool link. Notice that you will be redirected to the external Wordpress Site which will allow for interaction to all students enrolled in that particular course.

The above procedure makes it possible for the SOA framework to be integrated into the Moodle learning system.