EMPLOYING ACTION DESIGN RESEARCH FOR DESIGNING COURSE AND LABORATORY TO TEACH WEB MANAGEMENT IN A MIXED CLASSROOM

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Abstract

Due to the boom in the web industry and growing trends in online shopping, there is an increase in the demand for skilled work force to develop and manage the usable interactive web sites and web content for several companies across the world. Many students want to equip themselves with required web development knowledge by participating in courses from distance. Information and communication technologies (ICT) based on internet have opened up new potentials in higher education. To keep up with the influx of students several universities offer some coursework online and some have converted complete programs of study in order to make them entirely available online to campus as well as distance students (including professionals) at the same time. Distance education always have unique requirements. In this article, I reported the design of a course and an online lab for web development and management based on initial design principles derived from kernel theories such as Conversational Framework, Constructive Alignment and Personalized System of Instruction. The overall research was conducted using the action design research approach. The iterative cycles and critical reflections during the building, intervention and evaluation process helped to refine the initial design principles. The study contributes to the researchers and practitioner's community by providing design principles and an online Lab model that utilizes state-of-the art technology for mixed classrooms.

Keywords: *Web management, Action design research, Online Lab.*

1 INTRODUCTION

The abundance of information in our daily lives is visible with the presence of smart phones, activity monitors, smart watches, tablets and new Internet enabled appliances of every kind (Rosenfeld, Morville, & Arango, 2015). Although, our life has improved a lot due to advancement in Information Technology (IT), but at the same time it also introduces new challenges. The biggest challenge is to find the correct information scattered in so many places and to understand it correctly (Rosenfeld et al., 2015). Information architecture is considered a design discipline that is focused on making information findable and understandable. On the web, people want to find information about the products and services marketed by different companies. Yet, companies are struggling in this digital information age with an immense overload of mainly unstructured data on their websites. However, due to shortage of technically skilled workforce to maintain and develop web solutions reducing search times, fulfilling compliance requirements and maintaining information quality are challenges that all the organizations need to tackle for their smooth operations (Ravi, Yu, & Shi, 2009). The boom in the web industry and growing trends in online shopping has increased the demand for skilled work force to develop and manage the usable interactive web sites and web content for several companies across the world. This situation places the responsibility on higher education institutions to adopt and develop techniques that can be utilized simultaneously to educate and prepare both campus and distance students including professionals (those individuals who have full time jobs and mostly want to study from distance to enhance their web development skills).

Information and communication technologies (ICT) based on internet have opened up new potentials in higher education. Many universities offer some coursework online and some have converted complete programs of study in order to make them entirely available online to campus as well as distance students

(including professionals) at the same time (Zacharis, 2015) . Teaching in an educational institute has been described as a complex system where different components of this system including teachers, students, the teaching context, student learning activities and the outcome interact with each other at the classroom level (Biggs, 1996; Von Bertalanffy, 1968). With the prevalence of web applications, online learning is definitely gaining popularity over the years and has evolved as a viable and flexible alternative to traditional brick-and-mortar academic approaches (Zacharis, 2015). Even recently, online learning options, including massive open online courses (MOOCs), have become increasingly available as a means to produce learning in students who cannot attend classes in person and have been proposed as alternative learning paradigms (Stockwell, Stockwell, Cennamo, & Jiang, 2015).

However, online education brings certain challenges for the educators and institutions (Iqbal & Thapa, 2013). For instance, how to provide equal opportunities of hands-on exercises for the campus and distance students at the same time. Linnaeus university located in Sweden, offers the web management course as part of the two undergraduate degree programs (System science program and Interaction design program). Half of the students join this course on campus and half are distance students. University could not adopt a ready-made model of such a course design where practical work related to Lab exercises is based on pedagogical design principles for teaching web development course. This situation fosters the question that "how can we develop and use a Lab based on pedagogical principles to teach web management for mixed classrooms?". The lack of design principles and pedagogical approaches to develop such a Lab and exercises was visible in the existing literature and it could hinder the accumulation of pedagogical knowledge essential for the growth of a common body of knowledge in this field. Hence, this study focused on the issue of designing the web management course and Lab for hands-on education of undergraduate students. Interventions that encourage institutions offering distance education to adopt and use e-learning platforms for hands-on education are of extreme importance for many reasons. For instance, using the e-learning platform appropriately based on specific pedagogical principles might help to develop design exemplars for practitioners to understand when and how to manage and use a specific design to improve hands-on education (Iqbal & Päivärinta, 2012).

The remainder of the article is arranged as follows: Section 2, provides an overview of the theoretical framework comprising pedagogical theories. Section 3 discusses the method for data collection briefly. In section 4 course design description and the pedagogical approach is discussed. Section 5 describes the building, intervention and evaluation of the online Lab to support practical work. Results are presented in section 6. Section 7 discusses formalization of learning. Section 8 concludes the article with discussion of results and further suggestions.

2 THEORETICAL FRAMEWORK

Categorically, both instructional design literature and constructivist learning theory are considered as popular source of stimulus in higher educational practice (Biggs, 1996). Objectivist and Constructivism and phenomenography are considered as two major theoretical traditions in higher education (Iqbal, 2013; Jonassen & Duffy, 1992; Marton, 1981; Steffe & Gale, 1995). Constructivism view the learner's activities as the central aspect of the Constructivism related theories when it comes to the implications for teaching and assessment (Biggs, 1996; Iqbal, 2013; Steffe & Gale, 1995). Constructivism promotes a classroom culture where the teacher acts as a facilitator for the development of individual and group meaning instead of being only a traditional lecturer (Biggs, 1996; Richardson, 2003). Biggs (1996) states that the Constructive alignment theory (Biggs, 1996) pushes the teachers to design teaching / learning activities according to the course goals prior to the start of study in order to engage the students in interesting activities actively both individually and collaboratively. Laurillard (2002) endorses that knowledge industries create the means by which individuals can acquire the immediate skills and knowledge those industries demand. Moreover, the fundamental design formats for learning technologies (Laurillard, 2002) can support the practice of elevated cognitive skills and to help ease the complex learning experience. Constructive alignment theory and conversational framework (Biggs, 1996; Laurillard, 2002) together puts forward following important implications:

- Universities will maintain their competitive edge against the knowledge industries through the maintenance of their core values-including research-based teaching and a curriculum that provides for long-term cognitive needs of individuals.
- Attempts to enhance teaching need to address the system as a whole, not simply add "good components, such as a new curriculum or methods".
- When curriculum and assessment methods are aligned, the results of instruction are massively improved.

The theoretical framework based on constructive alignment theory and conversational framework (Biggs, 1996; Laurillard, 2002) not only helps to specify what digital technologies should be doing but it also captures the essence of university teaching as an iterative dialogue between teacher and students operating on two levels: The two levels bridged by each participant engaging in the processes of adaptation (practice in relation to theory) and reflection (theory in the light of practice). These ideas are in-line with my views of promoting ties between theory and practice in the department of informatics at Linnaeus University for enhancing quality of teaching and learning. The theoretical framework has been used to guide the ongoing research process for improvement in the web management course as well as for the development and use of e-learning platform. The theoretical framework comprising pedagogical theories presents a holistic view of course development which guides the Instructional designer from stating the course objectives to properly align the course objectives with intended teaching / learning activities and suitable assessment methods. Additionally, the theoretical framework discusses in detail about the media types to be used during teaching. The theoretical framework helped to categorize the e-learning platform at Linnaeus University for instruction in the following manner in table 1:

Media	**Purpose**
Learning management system (Moodle)	Interactive
Virtual classroom (Zoom)	Communicative
Online Lab	Productive

Table 1. E-Learning Platform at Linnaeus University adapted from (Iqbal, 2013)

The existing e-learning resources such as learning management system (LMS) Moodle and virtual classroom Zoom were categorized as interactive and communicative media whereas the online Lab which was missing and needed to be developed was categorized as productive media. The online Lab will provide both campus and distance students equal opportunities to practice their skills.

3 METHOD

The Action Design Research (ADR) (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011) method was selected for this research project. ADR promotes continuous stakeholder participation in the project, which was an important factor in bringing the necessary pedagogical improvements. It was important to incorporate the design science research elements in this project in order to contribute to design theory in the longer run based on continuous reflections during and following the work, and by elucidating some general design principles (Gregor, Imran, & Turner, 2014; Sein et al., 2011). ADR (Sein et al., 2011) embodies four stages:

- Problem Formulation
- Building, Intervention and Evaluation,
- Reflection and Learning
- Formalization of Learning.

Contrary to the stage-gate models one of the key characteristics of ADR method is the concurrent evaluation. It means that the decisions about designing, shaping, and reshaping the artifact (online Lab) and intervening in organizational work practices such as lab-based exercises should be interwoven with ongoing evaluation. Formative assessment was conducted during the testing of Alpha version of online Lab together with volunteer students and assistant teacher. The initial Alpha version of the Lab was tested within the ADR team together with three volunteer students. These students gave their input via face-to-face discussions to improve the Alpha version. This input via discussions between the ADR team and volunteers

lead towards development of stable Beta version that was launched in the class exercises. Summative assessment was conducted with students through a survey questionnaire and the reflection from their written reports about their exercise task. ADR promotes generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting (Sein et al., 2011). ADR addresses a problem situation encountered in a specific organizational setting by constructing, intervening and evaluating an IT artifact that addresses the class of problems characterized by the encountered situation. ADR not only focuses on the intent of the researchers but also the influence of users and ongoing use in context (Sein et al., 2011). Subsequently, we will go through all the four stages of ADR method.

Problem Formulation: The problem formulation stage comprises of two principles: Practice inspired research and Theory ingrained artifact. This research is motivated by the need to provide hands-on exercises both to campus and distance students at the same time, lack of pedagogical approaches to teach web management course and to promote practical Lab work based on pedagogical principles. The on-going research process was guided by the theoretical framework comprising pedagogical theories: constructive alignment and conversational framework (cf. secion2). The course design description and pedagogical approach selected for the course are described in the next section before explaining the building, implementation and evaluation phase of Lab.

4 COURSE DESIGN DESCRIPTION AND PEDAGOGICAL APPROACH

4.1 Objectives and Course Plan

The course is a basic 7.5 ECTS course in web management. It aims to provide basic knowledge about web management. Extra focus in the course is on developing websites. After completing the course, the student should be able to:

- Have good knowledge of theoretical and practical uses for web management
- Have basic skills in content management and developing dynamic websites using Content Management System (CMS)
- Be able to manage and modify existing templates in CMS based on specific requirements

The Personalized System of Instruction (PSI) approach was selected based on the pedagogical requirements of the course. The PSI approach suits well with the course objective to enhance the mastery of course topics. Most of the students want to relish individualized and flexible learning which are important factors in general and for distance students in particular. Some of the distance students are professionals who wish to study and work at the same time and cannot follow a harsh schedule.

4.2 Literature

Course literature:

- Rosenfeld, L., Morville, P & Arango, J : Information Architecture for the Web and Beyond, 4th Edition 2015. ISBN : 978-1-491-91168-6.

Reference literature:

- Vanessa Donnelly ”Designing Easy to Use Websites”, Addison Wesley, ISBN: 0201674688 or ISBN 9780201674682
- MacCracken & Wolfe, (2004) User-Centered Website Development – A Human-Computer Interaction Approach, Pearson Education, Inc., ISBN 0-13-041161-2
- Published articles related to subject suggested by the teacher.

4.3 Content Management System

Traditionally, a couple of decades ago, the web sites were developed to publish only static information, however, this trend has evolved steadily and ubiquitously to serve dynamic and complex web content and business functions. Two developments were notified by Souer et al, (Souer, Van De Weerd, Versendaal, & Brinkkemper, 2005) which gradually lead towards content management system (CMS) based Web-applications. The first development was the growing use and utilization of the World Wide Web and the other development was the unrestricted growth of digital content, which resulted in lack of information control and loss of data due to the large amount of digital content. New information systems were built to cope with the digital content. Today, majority of web applications employ a CMS to allow organizations to manage the content of the application with a software system. Any content-intensive site that requires regular maintenance, for example to update the website with news or updating product information benefits from a CMS because it allows the non-technical users that are responsible for the content to do so themselves without the help of a development team or webmaster. CMS-based web applications are found everywhere, in all sorts of applications and in every industry: e-commerce sites, bank and insurance sites, corporate portals, intranets, extranets, communities, news portals, to name just a few (Souer, 2012).

Web applications are evolving towards strong content-centered Web applications Yet, with the growing popularity of web sites and web applications, the web aligned with e-business models started to emerge (Ravi et al., 2009). Moreover, in response to the increasing amount of content to be managed and its scatteredness throughout organizations have resulted in the growing popularity of content management products (Hilhorst, Grahlmann, Helms, & Brinkkemper, 2010; Ravi et al., 2009) . To provide organizations with and their marketing communications department in particular the flexibility to publish dynamic and personalized content on the web, a specific type of content management product software evolved called web content management system (WCMS). A WCMS is product software which can be tailored and customized by means of configuration and will lead to a CMS-based web application (Souer, Van De Weerd, Versendaal, & Brinkkemper, 2007). Most dynamic web sites utilize some sort of WCMS to support the organization with their online business because it allows them to create web initiatives in a time- and resource-efficient way based on standardized components (Souer, 2012). Table 2 presents properties of popular open source content management system.

Content Management Systems	Properties
Drupal	Flexible layout, compact, support multi-domain management
WordPress	Large community, intuitive user interface, plugins
Joomla	More than 7000 extensions, vast community forum support, user friendly templates
Contao	User friendly, multi-lingual backend, good security
Magento	Marketing and customer service, search engine optimization,
TYPO3	Variety of functions and extensibility, rights management,

Table 2. Popular open source content management systems

Joomla is considered one of the most powerful Open Source CMS. Joomla can help in creating interactive multi-language Web sites, online communities, media, portals, blogs and E-commerce applications. Keeping in view the pedagogical requirements, Joomla was chosen as the CMS to conduct project work in this course.

4.4 Pedagogical approach

PSI approach (Keller, 1968) initially appeared in the form of programmed instructions in the field of psychology, however it has also been applied in various other educational fields such as applied behaviour analysis, engineering and programming courses (Cumming & McIntosh, 1982; Emurian, Hu, Wang, & Durham, 2000; Koen, 1971; Nilsen & Larsen, 2011). Nilsen and Larsen (Nilsen & Larsen, 2011) noted that in some cases procrastination was identified as a problem for weaker students although, some other scholars (Crosbie & Kelly, 1993) noted positive student feedback by applying the PSI approach. Overall, PSI approach is considered favorable (Pear & Novak, 1996) for distance students. Hence, PSI approach was applied in this course. The distinctive features of the PSI are as follows: -

- To Provide clear study objectives

- Division of course content into smaller modules/units
- Flexibility (study at your own pace)
- Mastery of the course unit/module
- To Provide immediate feedback on each course unit/module
- Use of Teacher, Assistant/Proctor

4.5 Assignments

There are three compulsory assignments in this course. The compulsory assignments are carried out individually and, in a group, comprising of maximum two students. It is preferable that students shall work in groups for final project assignment, however they can also choose to work individually. Assignments comprises both theoretical and practical parts in the way that students should analyse and reflect over a website considering some methods for analysing and designing a website. The methods and techniques used in the two first assignments should then be used in the third assignment when redesigning and developing a prototype for an existing website using a Content Management System (CMS).

Assignment 1 – Analysis (Individual)

Need analysis, User analysis, Task analysis, and Functionality analysis

Assignment 2 – Design (Individual)

Organisational schemas, Organizational structure, Search and Navigational schemas

Assignment 3 – Project (individual / group)

Choose a "bad" website and redesign it. Make a prototype in a CMS (Joomla) showing improvements in the website. The word "bad" refers to poor information architecture in a website. Table 3 shows the grading criteria.

1301	Analysis	3 ECTS	U eller G *
1302	Design	2 ECTS	U eller G
1303	Project work	2.5 ECTS	U,3,4 eller 5

Table 3. Grading and Evaluation Criteria

*U= fail, G= pass, 5 is the highest mark (A) whereas 3 is lowest (C).

5 BUILDING, INTERVENTION AND EVALUATION OF THE ONLINE LAB

5.1 Online Lab Architecture

Web management course was used as a case study to carry out the first iteration of the building, intervention and evaluation (BIE) of the Online Lab. A set of five initial design principles comprising: Contextualization, Collaboration, Flexibility, Cost-effectiveness and Scalability were followed in the process (Iqbal & Thapa, 2013). The contextualization principle was used to gather the contextual requirements from different sources such as organizational goals, course goals, and pedagogical requirements. Likewise, the collaboration principle was utilized as a means to motivate all the stakeholders (including teacher, developer and IT staff). The stakeholders were motivated to hold meetings to achieve a purposeful design for the online Lab and related practical work. Overall, the course design was guided by the assumptions to provide students with a flexible online educational Lab that could support their practical work of developing a design prototype for a website from distance, freely without time or location constraints.

Primarily, an ADR team was created which included, a teacher, a developer from IT Staff at the University's IT department and a teaching assistant. The course goals which were in line with the organizational goals for distance education required that we should develop an online Lab to provide remote access to our

distance students from anywhere in the world. Given the fact that we were going to make use of an open source software such as Joomla to be installed properly within our Lab, we could proceed with limited funding available to develop the Lab at this stage. The ADR team discussed and decided to make use of virtualization techniques that supports both making the Lab cost-effective and at the same time assisting in preparation of an infrastructure, which is easily upgradable based on the requirements of the course.

Consequently, the online Lab was deployed in the private network of the University. The design of the online Lab following the initial design principles dealt with different issues such as flexibility, stability and scalability. The online Lab was made available for the students in terms of 24 hours availability and accessibility. The design layout of the Lab is shown in figure1.

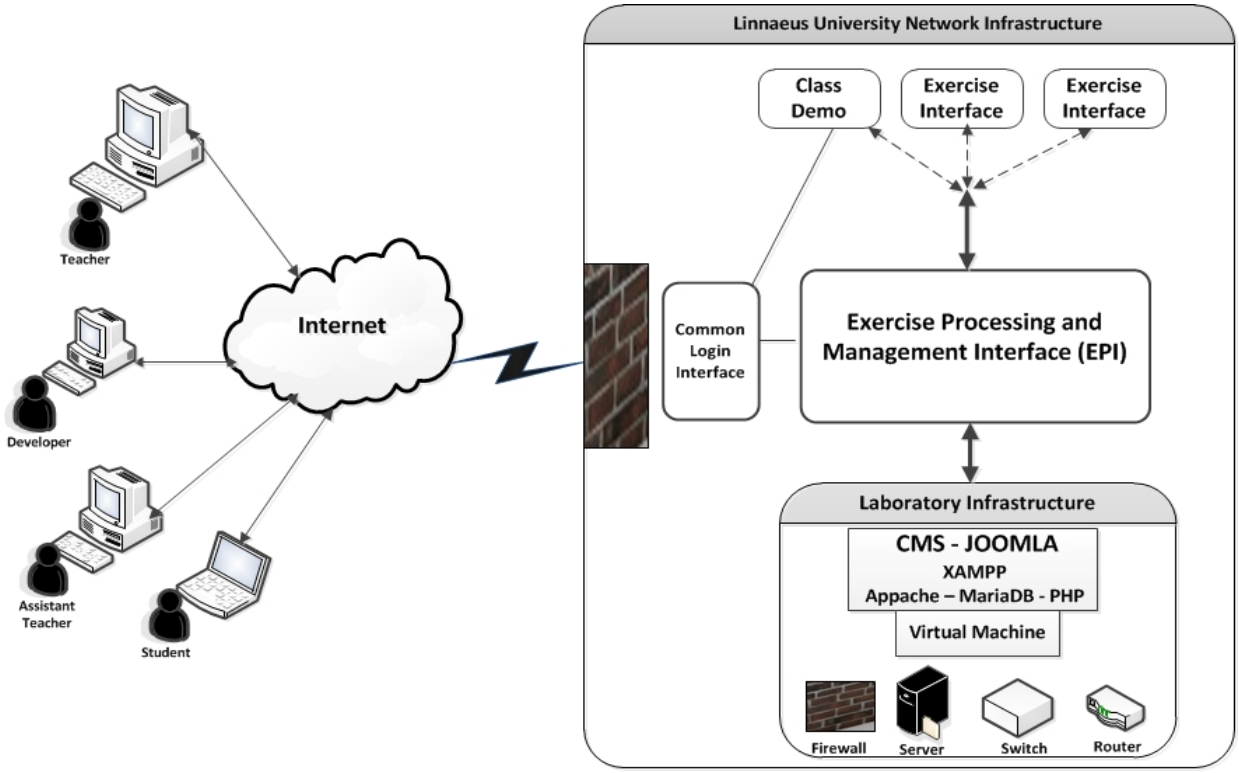

Figure-1. Online Lab for web development

Figure 1 explains the Lab set up for creating exercise instances for the students to practice their web management and development skills using the CMS Joomla. As a teacher, the developer grants you all the rights so that you can easily access the Lab resources remotely via back-end Lab infrastructure and create exercise instances for the students. The Lab infrastructure has been created in such a way that the developer has to first install a suitable software package such as WAMP, MAMP OR XAMPP etc. based on the server requirements. In this case the developer from IT staff at the university as part of the ADR team installed the XAMPP package together with Apache (web server software, apache.org) and MariaDB (database server, mariadb.org). A database was created by accessing phpMyAdmin via localhost (localhost/phpMyAdmin) to be used during installation of Joomla account. The password for database is created as a means of security so that only authorized people can make changes to the database. The CMS Joomla is downloaded from joomla.org which is an open source free software. The developer also installed a super user administrator account for the teacher to be used as a demo account during supervision sessions held in the virtual classroom on Zoom.

Subsequently, in this scenario as depicted in the figure1 the teacher and assistant teacher has been given full rights to access the actual Lab infrastructure via remote access. Accordingly, teacher used the Microsoft Remote Desktop application to access the main Server. Once in the server, the teacher can create individual exercise instances for the students following the pedagogical principles of PSI approach. Teacher will use the resources available in directory c: \ xampp\apps\joomla\ to install several exercise instances for

individual students. It requires the installation of joomla instances appropriately within the same Server environment.

Figure 1 also denotes that for security reasons the students are not provided access to the Lab infrastructure back-end comprising server which is hosting all the student Joomla accounts and subsequent database. However, the teacher provided individual students with direct links to their respective exercise interface instance. For instance, each student is provided with following information:

"Hi,

I am sending you the log in details for your joomla site on our webserver at xyz.

You are a super administrator. Your log in details are following:

Web url : http://xyz424.abc.se/joomlastgroup1/administrator/index.php

User name: admin

Password: 12V4U6789J"

In cases where the students are supposed to work in teams they are also advised to create a new super user for their group mate and provide him/her the log in information quickly. While, Joomla provides this feature that multiple users with similar rights can work on both front-end and back-end after they have made a good plan on designing their project prototype and divided their roles. It was made sure that the Lab is 24 hours operable by the students during the course. Flexibility of handling the Lab resources remotely made it possible to provide immediate support to the students in case they made a catastrophic mistake and they needed to be provided with new instance or some back up from existing material. The design principle of scalability was applied in Lab in order to support every student in the class within the available limited budget and resources. With the equipment we had, we created 70 exercise instances for individual students. From a technical perspective, the Lab has been built using a virtual machine inside the University's infrastructure behind the University's firewall in order to avoid security attacks from the outside world. The online Lab infrastructure solves the issue of keeping track of students work. The online Lab environment also enhances the motivation of the students to spend more time on polishing their web development skills. One important design principle that emerged during the BIE process was "Robustness and Transparency". In case, two students as a team have been assigned the work task to develop a website prototype in CMS, it becomes easy for the examiner or teacher to see if they attempted to block each other using the back-end administration panel of CMS.

6 REFLECTION AND LEARNING

6.1 Course results and Dropout rates

The lab functionality was examined continuously and no major issues were noticed. The first iteration of Alpha version of lab was within the ADR team including volunteer students and only the stable Beta version was implemented in class. Overall, the students felt quite comfortable while studying this course and working with lab from distance. Hence, the dropout rate was almost non-existent. However, procrastination became a problem for two students. One of the students had a special health related issue which lead towards the condition that he requested to complete the final assignment individually and on a longer period stretched over two months.

6.2 Feedback and Evaluation

The students were sent out an evaluation survey at the end of the course for summative assessment purposes. The response rate based on a Likert scale for evaluation purposes was quite satisfactory as 41out of 70 students responded the survey. Feedback showed that 45% students agreed that the course stimulated the creative and critical thinking. One of the student's mentioned in the feedback that "the course helped me to improve critical and creative thinking for design considerations regarding information architecture". 70% students agreed that the pace of the course was 26-50% which is required for a course which runs for one LP under 10 weeks. 51% students agreed that the course quality was very good while 45% students

mentioned it was satisfactory. 60% students mentioned that the pedagogical quality of the course was very good.

In the comments and reflection one student mentioned that "I felt there must be more training lessons with joomla before I am asked to prepare an assignment. One student mentioned that "I would prefer to work with CSS and HTML instead of Joomla". Many students mentioned that they liked using Joomla as a CMS. Majority of the students mentioned that they were happy with the laboratory functionality and experienced no problem. A couple of students mentioned about the difficulty they faced in the beginning of the project regarding uploading their desired material. However, upon notification from students the issue was solved by the lab administrator immediately by increasing the required space to upload material. Some of the students praised the theoretical assignments and practical project work connection with such comments such as "I like the theoretical exercises which gave me good knowledge before I can start practical project work but I think some more practical lessons would be good for joomla training". However, in addition to the prototype development, the students wrote 2000 words written report in which the last section was reflection to allow them to reflect on the assignment and overall practical work. The reflection suggested that the students were satisfied with Lab environment however, some of them complained about availability of suitable Joomla templates for their customized needs.

7 FORMALIZATION OF LEARNING

The online Lab was built and implemented in the web management course. The intervention of the online Lab in Web Management course and the evaluation of its effect generated six design principles (see Table 4). Right hand column of Table 4 also shows the implications for Lab development. The ADR team developed and participated in this research work was composed of stakeholders such as teacher, developer and teacher assistant. Three student volunteers participated as part of ADR team only during preparation of the alpha version as suggested by ADR. This lead to a formative assessment of initial alpha version of the online Lab which helped the development team to unveil the weaknesses at an early stage and correct them before launching the Lab for actual practical work by the students. The development team was generally satisfied with several aspects of the Lab. During Building, Implementation and Evaluation process, the principle of "Robustness and Transparency" emerged and was applied. The Robustness and Transparency principle ensures that the Lab administrator including teacher should be able to handle any student mistakes that may damage Lab software or hardware facilities. Furthermore, this principle is important to promote transparent practical exam work from distance. The end users including teacher, assistant teacher and students participated in the implementation phase of the ADR process and used more stable Beta version of the online Lab for actual practical assignments successfully. A survey questionnaire was sent to the students to inquire about their experience of using the online Lab. The results revealed that almost all the students admired the online Lab and the personalized instructions provided for them regarding assignment tasks. The online Lab performance was rated acceptable and satisfactory. The students did not encounter any problems while accessing Lab remotely. Students also appreciated Lab tutorial. However, some students mentioned minor issues concerning Lab work which included adjustment of space needed to upload material and lack of suitable templates. Table 4 shows design principles:

Design Principles	**Implication**
Contextualization	- Contextualization requires streamlining organizational goals, course goals, teacher goals, constraints, and requirements. - Course activities including assignments shall be based on a specific pedagogical approach.
Collaboration	- Collaboration requires stakeholders mutual understanding that can be enhanced via regular meetings between stakeholders of Lab for design, development and implementation purposes including teacher (instructional designer), practitioners (developer, IT staff) end users (teacher, assistant teacher, students)
Flexibility	- 24/7 uninterrupted remote access to Lab resources. - Streamlined Lab activities based on modules.
Cost-effectiveness	- Utilizing Virtual technologies and open source software for best resource allocation to develop the Lab.

Scalability	- Availability of open source software upgrades via community support and utilizing virtual technology ensures Lab resources can be easily upgraded and expanded as desired based on the practical requirements.
Robustness and Transparency (emerged principle)	- Support end users including students mistakes and damage - Transparency control for group work during exam - Instant support to install new exercise instance in case of total recovery failure including the support for back-ups.

Table 4. Design principles for Online Lab for Web development adapted from (Iqbal & Thapa, 2013)

8 DISCUSSION AND FURTHER RESEARCH

The primary focus in this research has been on the process of conceptualizing, designing and developing an online Lab to teach web development and management in a mixed classroom environment both to on-campus and distance students simultaneously. Hence, the researcher focused not only on the ways in which Lab is developed but also how students and teachers can make use of the Lab to enhance hands-on education for web development using a free open source software. This research work investigated the conceptual foundations of an online Lab in terms of a generalized model (see fig 1). The proposed online Lab model based on ADR method helps in describing its building blocks, identifies the roles of important stakeholders in the development process and the influence of methodology on the development process.

This research contributes by exhibiting the design, development and implementation of an online Lab for web management course. The Lab aimed at the improvement of hands-on education for both on-campus and distance students and the evaluation of its use in context. The study also described the ADR process through Online Lab intervention in the web management course. The positive feedback from stakeholders and results show that project was implemented successfully. Furthermore, the student feedback demonstrated that the proposed online Lab environment is practically useful both as a teaching and learning tool.

In this research, during the BIE process the researcher implemented a set of initial design principles (Iqbal & Thapa 2013). The design principles: contextualization, collaboration, flexibility, cost-effectiveness, scalability and robustness and transparency (emerged during BIE) were mutually shaped together with other stakeholders. A theoretical framework based on Constructive Alignment Theory (Biggs, 1996) and Conversational Framework (Laurillard, 2002) was prepared in the initial stage of ADR process. Theoretical framework was used to guide the research process by analysing existing e-learning resources available to teach web management course. Moreover, the PSI approach (Keller, 1968) has been used as a kernel theory keeping in view the contextual and pedagogical requirements of the course and Lab exercises. In most cases, existing research lacks pedagogical design principles for the design, development and use of online Labs in web management courses.

The design principles presented in this research suggest practical contributions for all stakeholders including teacher and students respectively. Design principles: contextualization, collaboration, flexibility, cost-effectiveness, scalability and robustness and transparency provide necessary support to endorse individualized learning by following flexible pedagogical approaches such as PSI to design Lab exercises. Pedagogical underpinnings help to enhance and encourage collaboration among different stakeholders of the Lab and provide transparency and control to the teacher which is necessary to maintain effective learning in mixed classroom environment as well as for online examination. The design principle of contextualization is also important since it provides necessary help to gather contextual requirements from course and program objectives and at the same time elucidate the scope of the Lab work by considering relevant contextual factors. The utilization of open source software and virtual technologies make the online Lab infrastructure scalable and cost-effective. The design principle of robustness and transparency invokes the Lab administrator and teacher to make sure that the students get the essential instant support to complete their practical Lab work even when they make a serious mistake. Robustness and transparency principle also ensure that a control structure needs to be established by the teacher for transparent practical work for distance students. Overall, together the design principles and the online Lab model proposed in this study provide important guidelines for Lab developers and teaching staff members to align their teaching/learning activities and consequently enhance the quality of online hands-on teaching in mixed classrooms.

Considering the future work, the stakeholders showed positive attitude for further instantiations of the online Lab in other similar courses for the next phase of the project. Through engagement of more teachers in this project the Lab model can be implemented in other similar courses which can help us to move towards developing an ensemble artefact via the iterative process based on ADR method. Furthermore, researchers and teachers involved in practical courses for both on-campus and distance students will be able to develop specific design exemplars based on various Lab experiments in different courses. Moreover, the introspective knowledge produced by collaboration and reflection of the researchers, developers and end users will help to refine the artefact and emergent design principles.

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