Regular Paper

Lecturer Based Supportive Tool Development and Approaches for Learning Material Sharing under Bandwidth Limitation

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Received: June 30, 2015, Accepted: December 7, 2015

Abstract: Currently, lecturers have been offered various LMS's. The Learning Management System (LMS) could provide high quality, rich and complete materials in Higher Education Institution (HEI) that use LMS as part of academic activities. In those activities, lecturers are the key persons responsible for enriching learning materials. Therefore, it was a common sense if lecturers need to be supported for enriching learning materials in any condition, whether it is online or offline. There are several options for a lecturer when he needs to use a LMS: use the LMS directly (access to the LMS server) or by implemented on a local machine as a local server. The use of LMS as a server application to give services for a virtual classroom brings many issues like installation, configuration, learning materials authoring, LMS operation, etc. In this particular case, we focus on the Indonesian educational environment, where a highly motivated lecturer is eager to use LMS to deliver lectures but restricted to use a limited bandwidth. Therefore, tools that can be used online as well as offline and are able to share the contents over diverse LMS are needed. The present paper discusses a supportive tool to support offline authoring, and delivery methodology development in existing LMS or even HEI with no LMS installed, considering all the issues related to LMS and the limited bandwidth environment where it will be used. As a result, we developed a Lecture Based Supportive Tool (LBST) as an approach to enable a lecturer to create learning materials in offline conditions and/or limited bandwidth, and then upload it on a remote LMS as an activity to share and enrich learning materials.

Keywords: LMS, lecturer based supportive tool, offline authoring, bandwidth limitations

1. Introduction

Lecturers are the key persons to ensure that there is a knowledge transfer from the literature to the student. For this situation, lecturers need a learning environment. Using a virtual learning environment so called Learning Management System (LMS), a lecturer could provide a learning material that can be accessed anytime and anywhere by a student using internet connections [1], [2]. Therefore, there is an extensive technique when using LMS in order to enrich the learning material and make it available to students [3], [4].

Without a reliable internet connection in developing countries like Indonesia, the use of LMS to enrich learning materials will remain ineffective [5]. The download index from Netindex.com locates Indonesia in the 142th position worldwide and according to Akamai, the average Internet connection speed in Indonesia is 2.4 Mbps, which is located in the 93rd position in the worldwide rank [6], [7]. **Table 1** shows a simple comparison between the internet access speed in Indonesia: residence, 1st author's home university (Universitas Muhammadiyah Sidoarjo-UMSIDA) and Japan: Kumamoto University (KU) and 1st author's residence in Japan.

Table 1 Bandwidth evaluation between Indonesia Japan. Experiment conducted on September 2013.

Place	Download(Mbps)	Upload(Mbps)
KU	14.38	28.56
UMSIDA	0.71	0.83
Home, Japan	5.20	3.02
Home, Indonesia	0.218	0.52

Bandwidth limitations problems are well known in the Bandwidth Gap, which has brought difficulties to the use of LMS to support academic activities since lecturers required an Internet connection to create a learning material [5], [8], [9].

A common solution to solve some of the previously mentioned problems is the installation of a desired LMS in a local machine. Since there is a need to use it in offline situations, lecturers need to learn how to install and configure the chosen LMS. This prerequisite made the lecturer to leave the LMS behind for use as part of academic activity.

On the other hand, a lecturer possibly teaches in more than one university. This condition, implied from the regulation by the Indonesian Government, as is written in: The Master Plan for Acceleration and Expansion of Indonesian Economic Development (MP3EI), demand the Higher Education Institution (HEI) to have collaboration, among others [10], [11]. This collaboration could be as sharing resources among HEI and/or pursue lecturers to teach on different HEI in Indonesia [10], [11], [12]. Because there

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is no regulation yet of what LMS should be implemented, one HEI between others could have implemented different LMS's. As an effect of this characteristic, lecturers are obliged to adapt their contents and skills to different LMSs, the later could generate a non-academic overwork to the lecturer having effects on their performance [12]. The main role of the use of a LMS is its role as a supportive tool, not to become an obligation to the lecturer to learn it.

This paper presents the development of a supportive tool designed based on the lecturer needs and discusses the portability approach that is suitable with the Indonesian education environment (which includes the bandwidth limitation and governmental regulation issues), in order to deliver learning materials to an existing LMS. The organization of this paper is: Section 2, discusses the work related to learning materials and content sharing under limited bandwidth conditions; Section 3, explains our proposed approach; Section 4, shows the development and implementation process of the proposed approach; and Section 5 explains our experiments and evaluation of the proposed method. Section 6, conclusions and future work.

2. Related Work for Learning Material Sharing under Bandwidth Limitation

2.1 Offline Method for Distance Learning

Johnson et al., proposed the use of the File Transfer Protocol (FTP) in combination with the use of information stored in a Compact Disk (CD) as a part of the distance learning process to be used in online as well as offline environments [13]. The mentioned approach is suitable to be used in limited bandwidth environments, but the further use of this approach requires complex FTP server configurations, as well as translation from raw resources to end user pages and resources needed to the creation of the CD contents. When using the proposed Johnson et al. method, lecturers will need to master the use of how initiate and adapt both media.

2.2 Learning Object Sharing Peer to Peer – LOP2P

Rafael & Andre, 2010 approach to enrich learning materials are to distribute free learning material based on the Peer to Peer (P2P) mechanism [14]. This mechanism, is powered by developing a plugin installed on a university LMS. The role of this plugin is to communicate with a system called "Mediation Layer" [13]. With the information contained in the "Mediation Layer" other universities LMS can start to share the learning material. The main objective of this approach is not to solve or to be used under limited bandwidth environments but its use of http proxy could represent a solution for that purpose. The main output of this approach is to share content between similar LMS environments installed in different Academic institutions. However, the plugin developed by Rafael et al., is limited to a specific LMS version. The LMS called Moodle LMS [29].

2.3 Unidirectional Synchronizations

Unidirectional Synchronizations is the novel method proposed by Roy et al. [5]. The aim of the proposed method is to solve the lack of learning materials shared from an experienced HEI which already have a Moodle system implemented and a new HEI that have recent Moodle implementations by making the mature Moodle LMS as Master LMS and the young LMS as Slave LMS. The synchronization is done completely by comparing the change set of both databases from the master and the slave LMS. This proposed method is quite similar as the one proposed by Rafael et al., where it tackles the reusable content that could be shared between institutions. Even though Roy et al. proposed a method that was developed to be used under limited bandwidth conditions, still, what Roy et al. proposed, requires a mandatory internet access to retrieve a master and a slave LMS, also limited by a specific Moodle version (Moodle 1.9).

The similarity of the mentioned three related works, resides in their lack of solution to the pre-existing conditions like: lecturers have different assigned courses in several HEIs where there is a variety of installed and used LMSs [5], [13], [14]. Also, ease of use when lecturers intend to use: Johnson et al. requires specific configurations to be used. Meanwhile, Rafael et al., and Roy et al. have an assumption that the lecturer will use the same implemented LMS, in this case is Moodle LMS.

3. Problem Analysis and Proposed Method: Lecturer based Supportive Tool for Learning Materials Sharing under Limited Bandwidth Conditions

3.1 Offline Authoring and Its Problem

Enriching learning materials under the limited bandwidth condition, must take into consideration to the following research question: "*How the authoring process could be and the need to store those enriched materials in an offline environment or where there is no available internet connection?*." The solution proposed by Johnson et al., using multimedia material stored in a CD to be distributed alongside the learning materials could solve part of the problem meanwhile the other two close references (2.2, 2.3) do not present any solution to the particular. The other related work (2.2, 2.3) could not work under offline or unavailable internet connections. At the same time those two references have a fair approach when it comes to share the learning materials under standard environments and HEI's using the same implemented LMS.

On the other hand, web-based applications offer numerous advantages, such as instant access, automatic updates, multiplatform and device, and opportunities for collaboration on a massive scale. However, developing web applications requires different approaches than desktop applications and involves the integration of numerous technologies [15], [16].

Under normal conditions, web-based applications such as LMS are deployed in a server machine. Moodle for example, in order to create learning materials, lecturers need to access Moodle through an Internet connection, no installation required in the client side terminal. In the case Lecturers need to use Moodle in an offline environment, a local installation is required. The local machine could be a Desktop or Laptop PC with LAN access. **Figure 1** illustrates lecturer activities before they post the learning materials. After authoring, lecturers need to save them

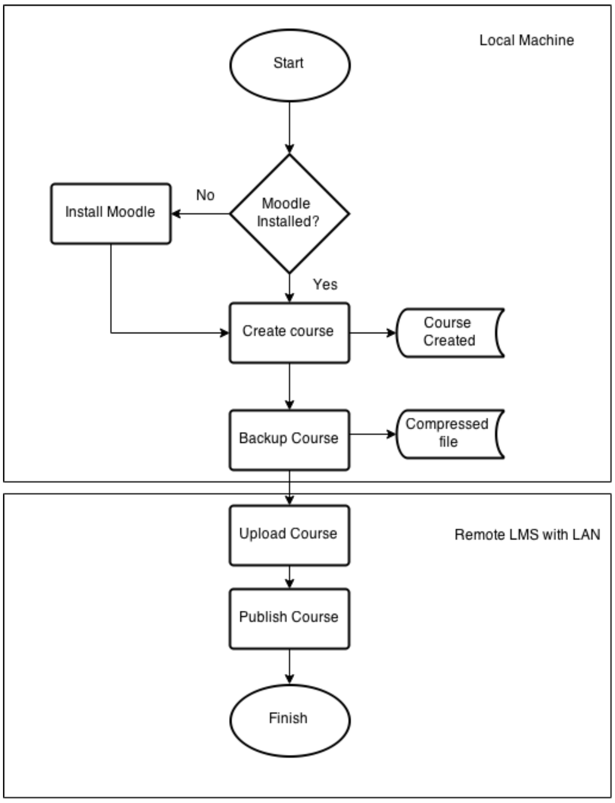


Fig. 1 Lecturer's basic activities while using Moodle.

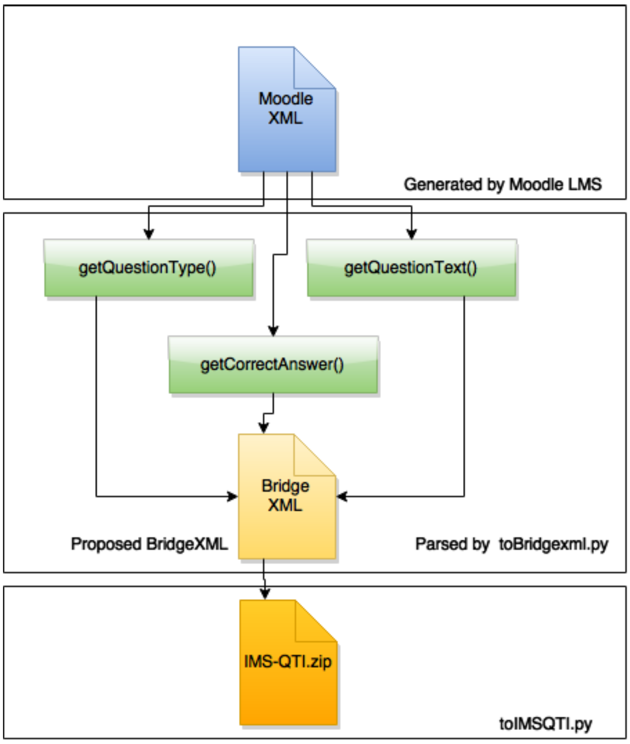


Fig. 2 BridgeXML as an approach for portability assessment between MoodleXML and IMSQTI.

in a format defined by Moodle. The next step is to upload it to the University LMS Server using the University LAN. The activity could be shorter if the lecturer has already installed Moodle. However, the installation process is not an easy task for lecturers that have never experienced that process or received any Moodle related training. Because Moodle is a web application, if lecturers require to use it on their local machine, they need to install a Webserver like Apache or Nginx [31], [32]. Also a database engine such as MySQL or PostgreSQL [33], [34]. Additional to this required knowledge, lecturers need to know how to configure files like: php.ini and Moodle config.php. More issues if lecturer teaches in different universities and found they implemented different LMS other than Moodle LMS.

From this point of view we draw lecturer's needs which are an application that includes all the same features of a LMS regarding the learning material authoring, and addressing the following issues:

1. Enable offline authoring capabilities.
2. Easy to use, install and initiate. No complex configurations.
3. Being able to interoperate with existing LMS to share learning materials.

3.2 Existing Approaches to Enrich and Share Learning Material

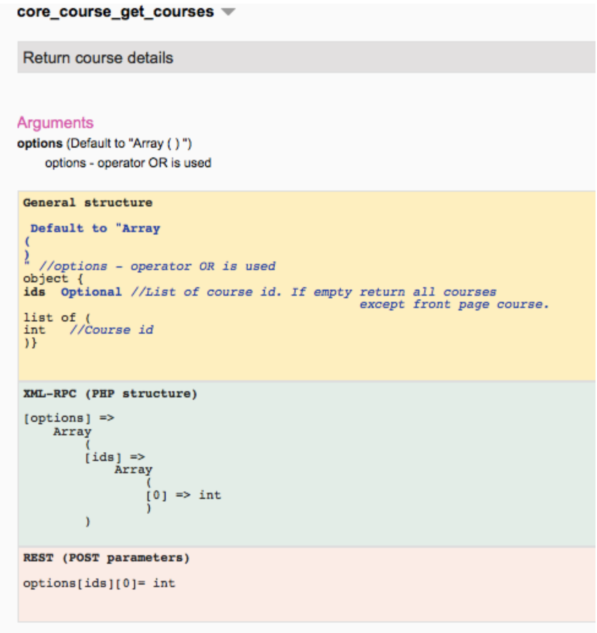
3.2.1 Using Standardizations

The definition of a learning material is a material that is authored by a Lecturer and updated to the LMS. Articles, multimedia (video and presentation files) and lecturer notes could be considered examples of materials. Discussions related to enrich materials usually involve topics such as standardization and interoperability [17], [18]. Many LMS platforms that have basic standardization characteristics have a function to make sure learning materials can be reused in different platforms. This standardization effort is useful to support learning material sharing among HEI that have implemented different LMS.

As a first step in our research we would like to address our first question: "How UMSIDA (first author's home university) that already implemented Chamilo LMS [19], can enrich their learning material from Kumamoto University (KU), which is a mature university that already had implemented Moodle LMS?"

We examined how a well-known LMS like Moodle could share learning content with a younger LMS [20]. Some of the Moodle's advantages are their wide community and large user number, its major disadvantage is its complex configurations. Chamilo's advantage, the younger LMS, is its standardization support like IMS, the major disadvantage is the lack of created learning material [21]. Learning materials in Moodle have many activities, such as Chat, Forum, Wiki, Quiz/Assessment and SCORM (Sharable Content Object Reference Model) package. Some activities use the same standard, for example the SCORM package. Even Though Moodle and Chamilo support SCORM to create a learning material, but not Quiz/Assessment. This means, Moodle learning content in a SCORM format could be exported to Chamilo and vice versa, but not the Quiz/Assessment. Moodle has its own assessment tool called Moodle XML, and Chamilo uses already a IMS standard tool called IMS QTI. In order to enable content sharing for an assessment purpose we proposed Bridge.xml, this tool will enable assessment sharing on both LMS. **Figure 2** shows how Bridge.xml will work.

From a series of experiments using the developed conversion tool, bridge.xml, we could support the idea that interoperabil-



core_course_get_courses

Return course details

Arguments

options (Default to "Array ( ) ")

options - operator OR is used

```
General structure

 Default to "Array
(
)
" //options - operator OR is used
object {
ids  Optional //List of course id. If empty return all courses
                                         except front page course.
list of (
int   //Course id
)}
```

```
XML-RPC (PHP structure)

[options] =>
    Array
        (
        [ids] =>
            Array
                (
                [0] => int
                )
        )
```

```
REST (POST parameters)

options[ids][0]= int
```

Fig. 3 Moodle API documentation for "*core_course_get_course*" function call.

http://203.xxx.xx.xx/moodle/webservice/rest/server.php?
wstoken=**4efae5020a47a502749a9e48fc255054**
&wsfunction=core_course_get_courses
&options[ids][0]=10

Fig. 4 Example URL for get course information from Moodle web services.

ity/portability is an alternative way to enrich shared learning materials among different LMSs. With or without an internet connection.

3.2.2 Using Web Services

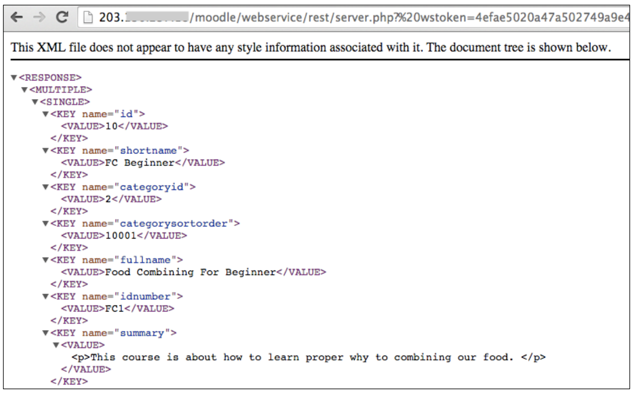
Beside standardization, other approaches to share learning material are using web services [22]. For this specific research purposes we were targeting Moodle Web Services as sample LMS because Moodle LMS's are widely used among HEIs in Indonesia and Japan [5].

Moodle offers several web service protocols including REST [30]. With REST protocol, it is possible to use a request as similar as CRUD (Create, Read/Retrieve, Update and Delete) operation.

To use Moodle web services, a web service consumer needs an URL that is a combination of:

1. Server address: IP Address or domain name.
2. Token. It was generated by Moodle Administrator.
3. Moodle Function Call and its parameter that are shown on the Moodle API documentation [30]. For an example, if a web services consumer needs to get information about some course that is available on Moodle LMS server, he needs to use "*core_course_get_course*" function call. In order to use those REST function call, based on the Moodle API documentation, he needs "option[ids][0] = int" as the REST parameters, shown on **Fig. 3**.

Next, web service consumers use those URL combinations to make a request to Moodle web services. **Figure 4** shows the example of a correct URL to get the detailed information of some course on a remote Moodle LMS with id = 10.



203.[redacted]/moodle/webservice/rest/server.php?%20wstoken=4efae5020a47a502749a9e4

This XML file does not appear to have any style information associated with it. The document tree is shown below.

```
▼<RESPONSE>
  ▼<MULTIPLE>
    ▼<SINGLE>
      ▼<KEY name="id">
         <VALUE>10</VALUE>
       </KEY>
      ▼<KEY name="shortname">
         <VALUE>FC Beginner</VALUE>
       </KEY>
      ▼<KEY name="categoryid">
         <VALUE>2</VALUE>
       </KEY>
      ▼<KEY name="categorysortorder">
         <VALUE>10001</VALUE>
       </KEY>
      ▼<KEY name="fullname">
         <VALUE>Food Combining For Beginner</VALUE>
       </KEY>
      ▼<KEY name="idnumber">
         <VALUE>FC1</VALUE>
       </KEY>
      ▼<KEY name="summary">
        ▼<VALUE>
           <p>This course is about how to learn proper why to combining our food. </p>
         </VALUE>
       </KEY>
```

Fig. 5 Response from Moodle Web Service.

Table 2 REST Function provided by Moodle.

Course	REST Function	Moodle Responses
Create	core_course_create_courses	Created courseID
Read	core_course_get_courses	Course Info
Update	core_course_update_courses	Course Info
Deleted	core_course_delete_courses	Deleted courseID

Using the above URL, Moodle server will give the response that is shown in **Fig. 5**.

By taking advantage of Moodle Web Service responses it is possible to do CRUD activity on a remote LMS, such as upload, change and delete created materials. Other advantages using web services are:

1. Support various versions on Moodle LMS's. This means, various versions of implemented Moodle among HEI will not become a problem.
2. By specifically selecting the REST protocol, Moodle LMS becomes a resource, not only as an LMS (a system that manages a course). Also, it's made possible accessing Moodle LMS from third party applications.

Other REST Function that could be used as CRUD operation, shown on **Table 2**.

3.3 Proposed Method: Lecturer Based Supportive Tools (LBST)

Both approaches (3.1, 3.2.1), could support sharing material in an offline condition with the assumption the lecturer already installed the LMS's. In addition to their own advantages and disadvantages of Chamilo and Moodle, lecturers have to access any of them in the case of authoring or sharing the learning materials. This condition requires an internet connection, which will be a burden for lecturers who live in Developing countries such as Indonesia where the bandwidth condition is limited. Based on this point, before a lecturer could share the learning materials with involving the above standardization, it is necessary to a supportive tool that a lecturer authors learning materials in any condition (offline and online).

LBST was proposed to support the lecturer regarding the authoring of learning materials in an offline environment (no internet connection required), and to share the authored learning material to the remote LMS using the existing Campus Wi-Fi or

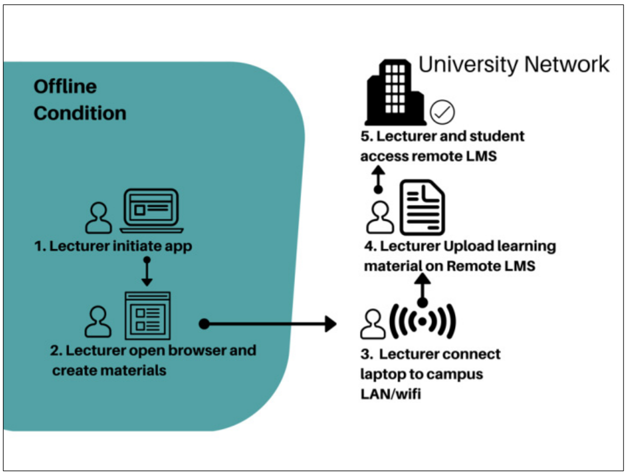

Offline Condition
1. Lecturer initiate app
2. Lecturer open browser and create materials
University Network
5. Lecturer and student access remote LMS
4. Lecturer Upload learning material on Remote LMS
3. Lecturer connect laptop to campus LAN/wifi

Fig. 6 Lecturer activity from creating the learning material until uploading learning materials using the proposed supportive tool.

another LAN infrastructure [23]. The lecturer's activities from the application initiation until the material uploading are shown in **Fig. 6**.

Since LBST has been proposed to be developed with a python script based framework, it can be implemented on a minicomputer that is powered with an ARM processor and lightweight Linux Operating Systems. With this implementation LBST could be as a portable LMS server when teaching in a HEI that has not implemented LMS yet.

The presented method brings other considerations such as: Lecturers Laptop becomes the master file of learning materials. Meaning that the copyright ownership lies on the Lecturer and not in the institutions. This represents an advantage for the lecturer since they can keep their materials. Furthermore, according to Indonesian government regulations, lecturers are obliged to submit their portfolios, so LSBT could be used as a tool to support the Lecturer to collect all their original learning materials.

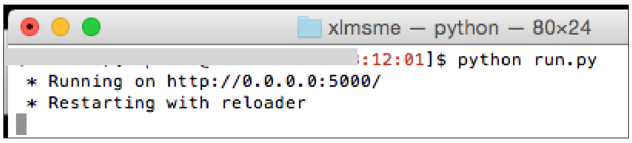
4. Implementation

This section discusses the proposed method implementation addressing the mentioned issues in Section 3.

4.1 Addressing Offline Authoring and Ease of Use of the Lecturer Based Supportive Tools

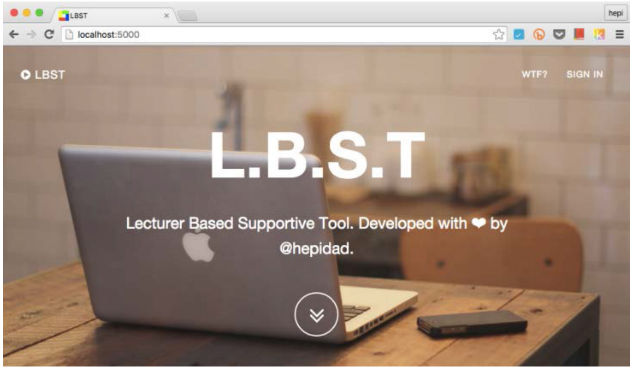
Most of the problems found while installing a web application such as Moodle and Chamilo LMS are related to its web server nature. In order to use any web application, it is required to be placed in a web server. In this case, the user needs to configure the web server and configure the interaction of those web servers and the LMS's itself. Also, interactions of what will the web server do when there is a user request. This interaction is mainly handled by the CGI module [24].

To preserve the concept of easy utilization of the application, Flask web framework being is chosen for LBST development [25]. The reason behind this decision is that Flask has already built in the Web Server Gateway Interfaces (WSGI) module. With the WSGI module, the Lecturer's computer will become a Web Server with no need to configure the CGI module again. By using Flask, lecturers only need to run a single python script to activate the Web Server (**Fig. 7**).



```
[redacted]:12:01]$ python run.py
 * Running on http://0.0.0.0:5000/
 * Restarting with reloader
```

Fig. 7 The lecturer executes run.py to activate the Web Server.



Lecturer Based Supportive Tool. Developed with ❤ by @hepidad.

Fig. 8 Welcome page of LBST.

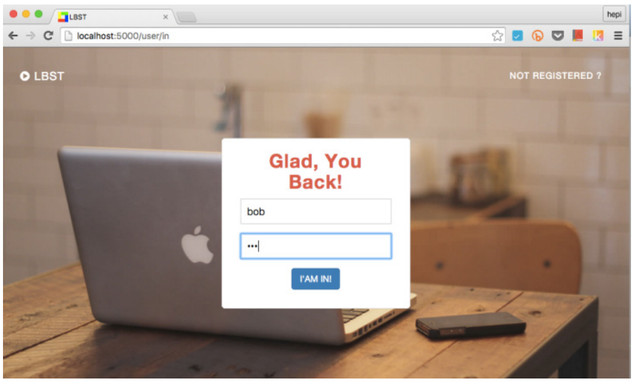
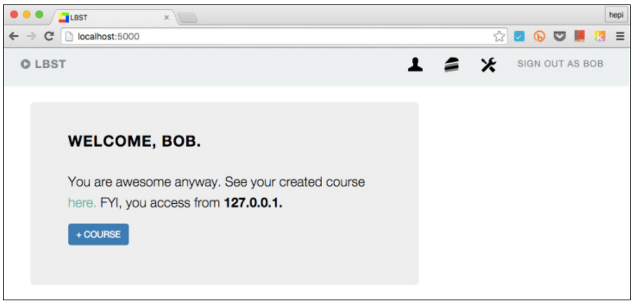


Fig. 9 Login form of LBST.



WELCOME, BOB.

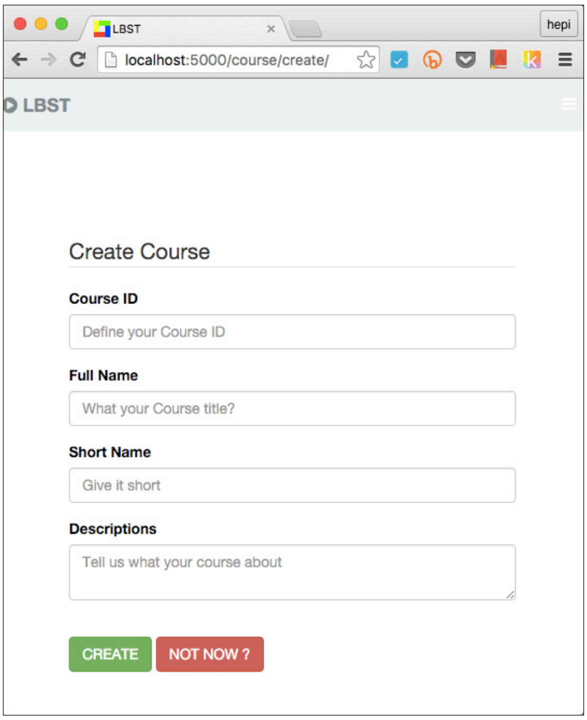
You are awesome anyway. See your created course here. FYI, you access from 127.0.0.1.

Fig. 10 User page of LBST.

After the LBST application is initiated, the lecturer can access the application through a web browser with the URL: http://localhost:5000/. The developed LBST application welcome page could be seen in **Fig. 8**.

After the authentication process (**Fig. 9**), the lecturer could start authoring by pressing the "create course" button at the LBST user page (**Fig. 10**). Then, the lecturer will be provided with an input form to create a new course (**Fig. 11**). The created course will be saved on the LBST database on a local machine.

To change the created course, the lecturer only scrolls down their home page until reaching the course list section (**Fig. 12**) and clicks the selected course. Then the lecturer changes the se-



Create Course

Course ID

Define your Course ID

Full Name

What your Course title?

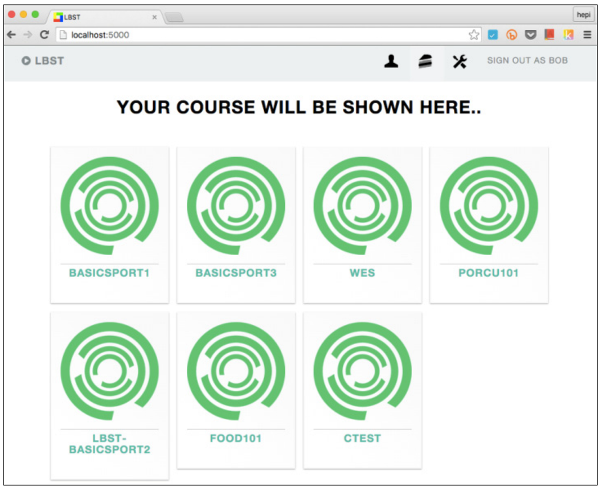
Short Name

Give it short

Descriptions

Tell us what your course about

Fig. 11 Create course on LBST.



YOUR COURSE WILL BE SHOWN HERE..

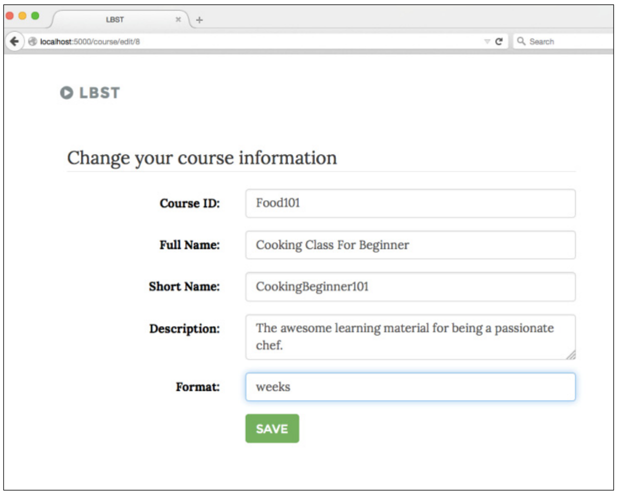
Fig. 12 Created course on LBST.

lected course into the desired value (**Fig. 13**). After a course is created, lecturer need to entry the course content. One course could have many course contents. To create a course content, the lecturer could start adding content (**Fig. 14**) through the course dashboard (**Fig. 15**).

As a result, the created course and the course content is shown on **Fig. 16**.

4.2 Interoperability Approach: From LBST to Remote LMS and Vice Versa

After providing the lecturer with an offline authoring tool using LBST, then it is turn the discussion into is turned to address the interoperability among LBST and the remote LMS. As mentioned on Section 3.2.2, it uses Moodle LMS and its web services as the LMS target.



Change your course information

Course ID: Food101

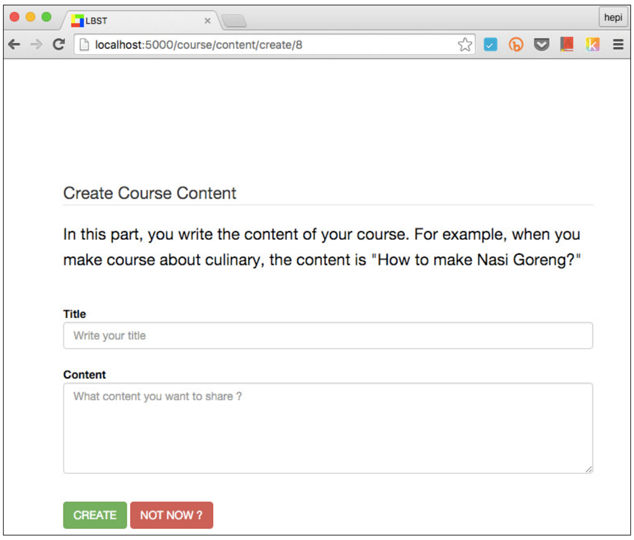
Full Name: Cooking Class For Beginner

Short Name: CookingBeginner101

Description: The awesome learning material for being a passionate chef.

Format: weeks

Fig. 13 Update created course.



Create Course Content

In this part, you write the content of your course. For example, when you make course about culinary, the content is "How to make Nasi Goreng?"

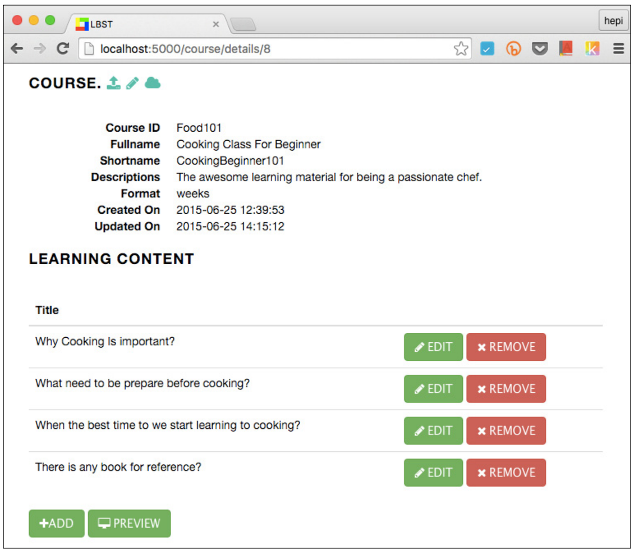
Title

Write your title

Content

What content you want to share ?

Fig. 14 Create course content on LBST.



COURSE.

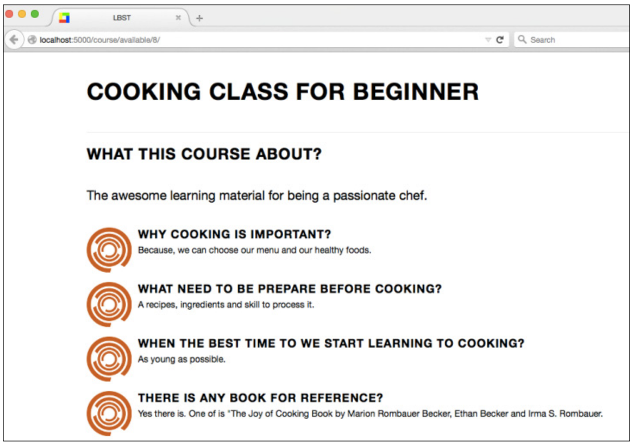
Course ID	Food101
Fullname	Cooking Class For Beginner
Shortname	CookingBeginner101
Descriptions	The awesome learning material for being a passionate chef.
Format	weeks
Created On	2015-06-25 12:39:53
Updated On	2015-06-25 14:15:12

LEARNING CONTENT

Title		
Why Cooking Is important?	EDIT	✖ REMOVE
What need to be prepare before cooking?	EDIT	✖ REMOVE
When the best time to we start learning to cooking?	EDIT	✖ REMOVE
There is any book for reference?	EDIT	✖ REMOVE

Fig. 15 Course dashboard on LBST.

Before LBST is able to upload, change, and delete created materials to the remote Moodle through its web services, lecturers need to set the server address and token of the remote Moodle server (**Fig. 17**).


LBST

localhost:5000/course/available/8/

COOKING CLASS FOR BEGINNER

WHAT THIS COURSE ABOUT?

The awesome learning material for being a passionate chef.

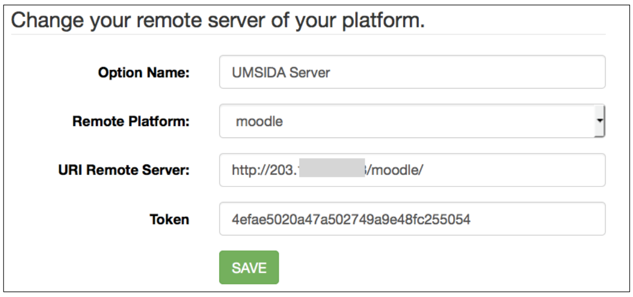
WHY COOKING IS IMPORTANT?
Because, we can choose our menu and our healthy foods.

WHAT NEED TO BE PREPARE BEFORE COOKING?
A recipes, ingredients and skill to process it.

WHEN THE BEST TIME TO WE START LEARNING TO COOKING?
As young as possible.

THERE IS ANY BOOK FOR REFERENCE?
Yes there is. One of is "The Joy of Cooking Book by Marion Rombauer Becker, Ethan Becker and Irma S. Rombauer.

Fig. 16 Created learning material on LBST.


Change your remote server of your platform.

Option Name: UMSIDA Server

Remote Platform: moodle

URI Remote Server: http://203.[redacted]/moodle/

Token: 4efae5020a47a502749a9e48fc255054

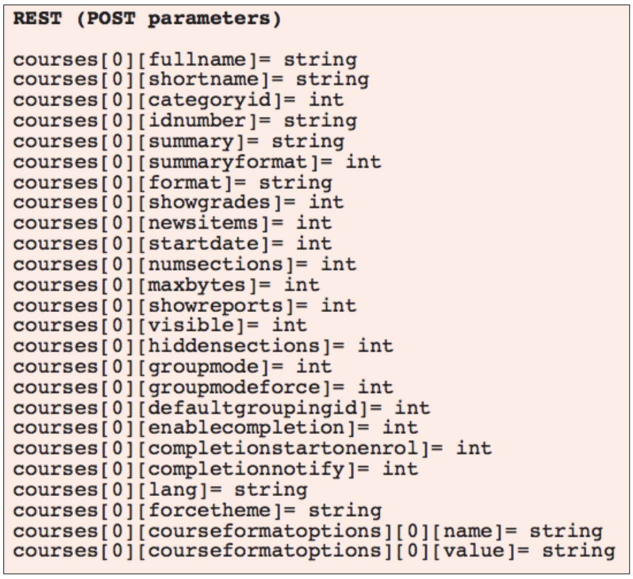
Fig. 17 URL and Token setting on LBST.

The above configuration will be stored at "optionPlatform" table on the LBST database. The value of this table was used to define: "*In which server the created course will be uploaded*?." Also, LBST will use these configurations to combine with the function call and its parameter. Then, LBST needs to the recall created course from the LBST database and transform its value into a single string value that is use as a URL to make a request to the Moodle web service. The iteration by LBST as its interoperability was described as follows:

0. Start.
1. Select course.
2. Get course record value ← course.fullname, course.shortname, course.description, course from local database.
3. Get Server Address and Token ← from optionPlatform Table.
4. Create URL ← LBST combine string value of: **remote address** + **token** + **function call** + **course record value**
5. Request to remote Moodle ← request(URL)
6. Read Response from remote Moodle ← Get course.moodleID from Moodle
7. Save course.moodleID ← insert into course table.
8. End.

The URL that is formed by the LBST, should be fit with the structure that is written on the Moodle API documentation (**Fig. 18**). Otherwise, Moodle web services will give a response with the "invalid parameter" status (**Fig. 19**).

Figure 20 shows the correct URL that is generated by LBST for uploading its course.


```
REST (POST parameters)

courses[0][fullname]= string
courses[0][shortname]= string
courses[0][categoryid]= int
courses[0][idnumber]= string
courses[0][summary]= string
courses[0][summaryformat]= int
courses[0][format]= string
courses[0][showgrades]= int
courses[0][newsitems]= int
courses[0][startdate]= int
courses[0][numsections]= int
courses[0][maxbytes]= int
courses[0][showreports]= int
courses[0][visible]= int
courses[0][hiddensections]= int
courses[0][groupmode]= int
courses[0][groupmodeforce]= int
courses[0][defaultgroupingid]= int
courses[0][enablecompletion]= int
courses[0][completionstartonenrol]= int
courses[0][completionnotify]= int
courses[0][lang]= string
courses[0][forcetheme]= string
courses[0][courseformatoptions][0][name]= string
courses[0][courseformatoptions][0][value]= string
```

Fig. 18 Function call parameter from Moodle API Documentation.

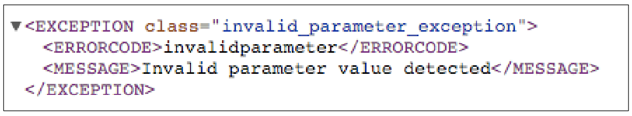

```
▼<EXCEPTION class="invalid_parameter_exception">
   <ERRORCODE>invalidparameter</ERRORCODE>
   <MESSAGE>Invalid parameter value detected</MESSAGE>
 </EXCEPTION>
```

Fig. 19 Invalid parameter response from Moodle web services.

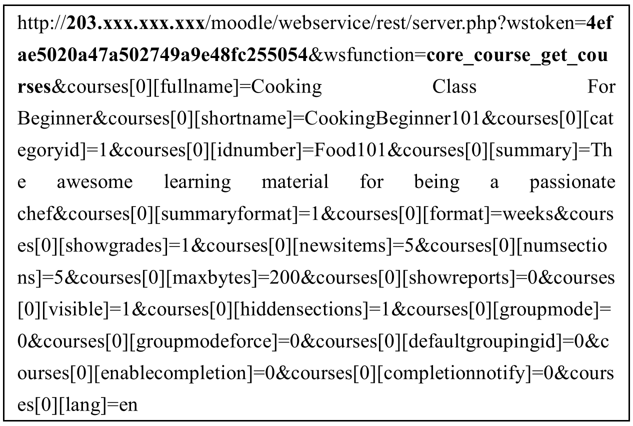

http://**203.xxx.xxx.xxx**/moodle/webservice/rest/server.php?wstoken=**4efae5020a47a502749a9e48fc255054**&wsfunction=**core_course_get_courses**&courses[0][fullname]=Cooking Class For Beginner&courses[0][shortname]=CookingBeginner101&courses[0][categoryid]=1&courses[0][idnumber]=Food101&courses[0][summary]=The awesome learning material for being a passionate chef&courses[0][summaryformat]=1&courses[0][format]=weeks&courses[0][showgrades]=1&courses[0][newsitems]=5&courses[0][numsections]=5&courses[0][maxbytes]=200&courses[0][showreports]=0&courses[0][visible]=1&courses[0][hiddensections]=1&courses[0][groupmode]=0&courses[0][groupmodeforce]=0&courses[0][defaultgroupingid]=0&courses[0][enablecompletion]=0&courses[0][completionnotify]=0&courses[0][lang]=en

Fig. 20 Complete URL generated by LBST for uploading a new course.

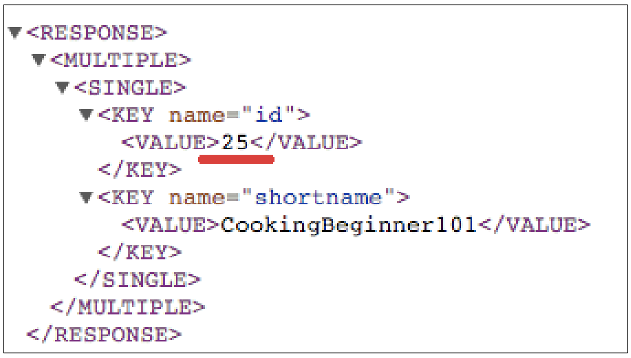
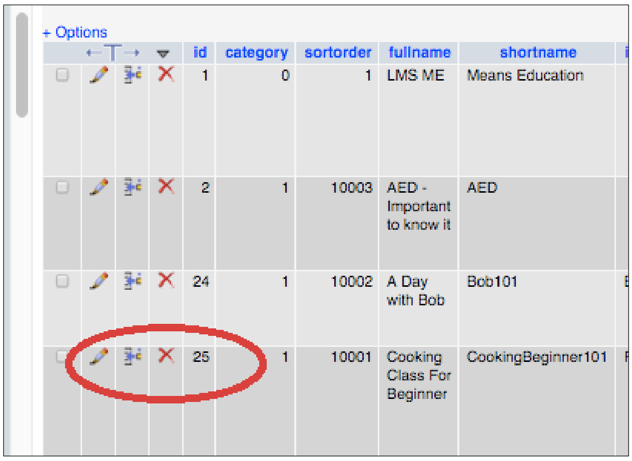

```
▼<RESPONSE>
  ▼<MULTIPLE>
    ▼<SINGLE>
      ▼<KEY name="id">
          <VALUE>25</VALUE>
        </KEY>
      ▼<KEY name="shortname">
          <VALUE>CookingBeginner101</VALUE>
        </KEY>
      </SINGLE>
    </MULTIPLE>
 </RESPONSE>
```

Fig. 21 Response from Moodle after a course is created.

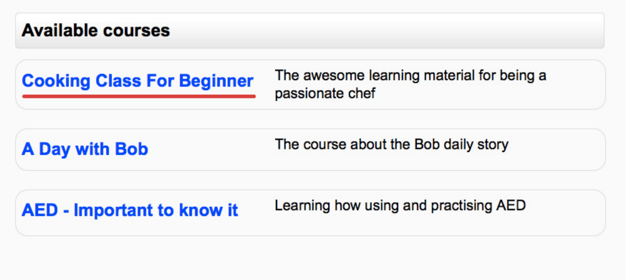
The important part after uploading a created course is to get the course ID from Moodle response (point 6, 7 from above iteration). Because this ID (that is) given by Moodle LMS must be the same course ID that is stored in the LBST database. To get course the ID, LBST needs to parse its value from Moodle response. **Figure 21**, shows the response from Moodle when the



+ Options

				id	category	sortorder	fullname	shortname
□				1	0	1	LMS ME	Means Education
□				2	1	10003	AED - Important to know it	AED
□				24	1	10002	A Day with Bob	Bob101
□				25	1	10001	Cooking Class For Beginner	CookingBeginner101

Fig. 22 Stored courseID on Moodle Database.



Available courses

Cooking Class For Beginner — The awesome learning material for being a passionate chef

A Day with Bob — The course about the Bob daily story

AED - Important to know it — Learning how using and practising AED

Fig. 23 Created course on Moodle LMS.

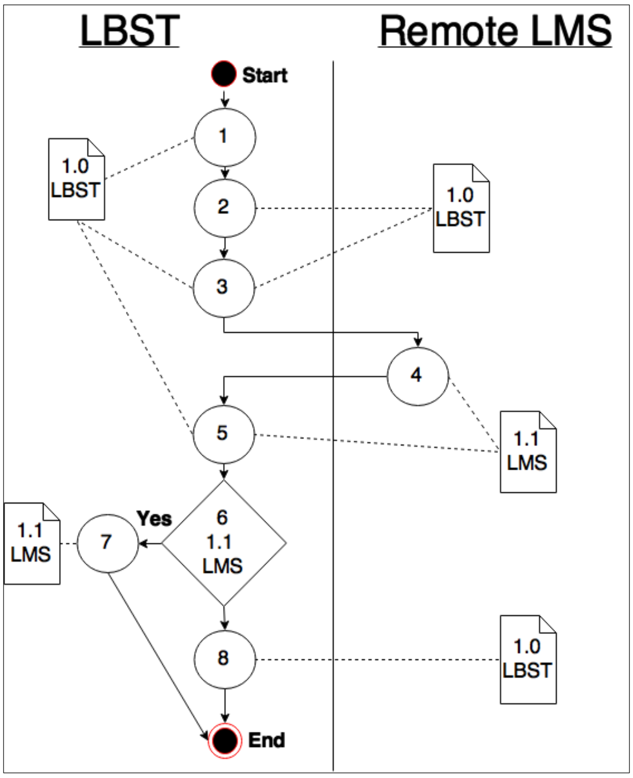


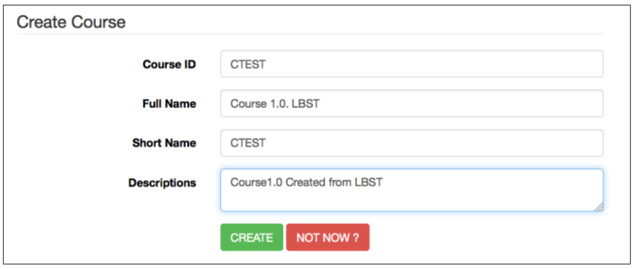
Fig. 24 The activity diagram for the interoperability simulation among LBST and a remote LMS.

course is uploaded. It shows the created course on Moodle stored with ID = 25. The value ID = 25 refers to the course ID that is stored on Moodle Database (**Fig. 22**). With this response, the course is successfully created on a remote LMS (**Fig. 23**).

To support the interoperability among LBST and a remote LMS, LBST has been provided with a course dashboard. The course dashboard was used to compare the created course on

Table 3 Detail of Activity Diagram.

Activity No.	Detail
1.	Create course on LBST with named **1.0. LBST**. (For experiment purposes, **1.0. LBST** means version 1.0. created from LBST). **Fig. 25.**
2.	**1.0. LBST** uploaded to a remote LMS. **Fig 26.**
3.	In LBST, the lecturer checks an available course on LBST and remote LMS. Shown on **Fig. 27.**
4.	The lecturer updates the course **1.0. LBST** into **1.1. LMS** through a remote LMS. **Fig 28.**
5.	In LBST, lecturer check available course on LBST and remote LMS. **Fig. 29.**
6.	The lecturer has options. Choose a newer version (**1.1. LMS**) or an old version course (**1.0. LBST**).
7.	If the lecturer decided to choose a newer version (**1.1. LMS**), the course on LBST would change into **1.1. LMS**. **Fig. 30.**
8.	If the lecturer decided to choose and older version, the course on a remote LMS would revert into **1.0. LBST**.



Create Course

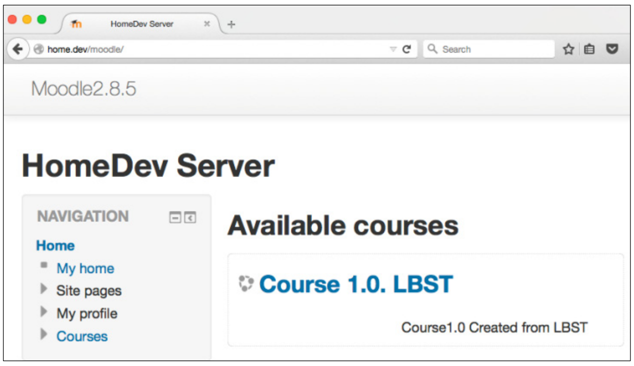
Course ID: CTEST

Full Name: Course 1.0. LBST

Short Name: CTEST

Descriptions: Course1.0 Created from LBST

Fig. 25 Create Course **1.0 LBST** from the LBST.



Moodle2.8.5

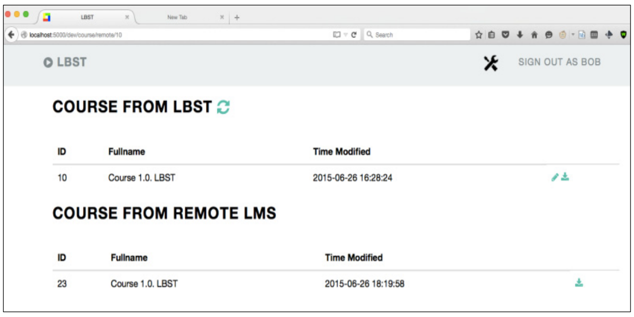
HomeDev Server

Available courses

Course 1.0. LBST

Course1.0 Created from LBST

Fig. 26 A course is uploaded to the remote LMS.



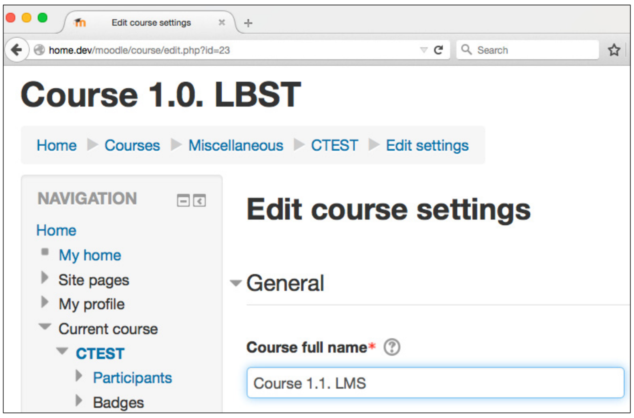
COURSE FROM LBST

ID	Fullname	Time Modified
10	Course 1.0. LBST	2015-06-26 16:28:24

COURSE FROM REMOTE LMS

ID	Fullname	Time Modified
23	Course 1.0. LBST	2015-06-26 18:19:58

Fig. 27 The lecturer checks an available course on the LBST.



Course 1.0. LBST

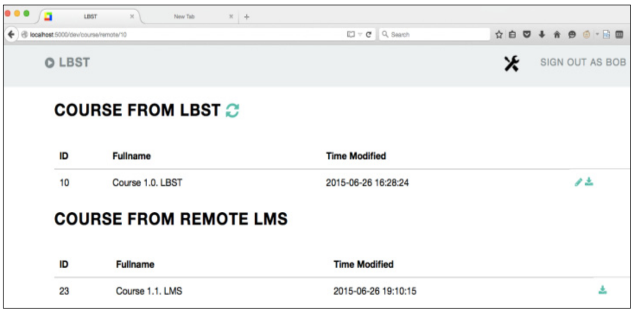
Home ▶ Courses ▶ Miscellaneous ▶ CTEST ▶ Edit settings

Edit course settings

General

Course full name* Course 1.1. LMS

Fig. 28 The lecturer updates to 1.1 LMS from a remote LMS.



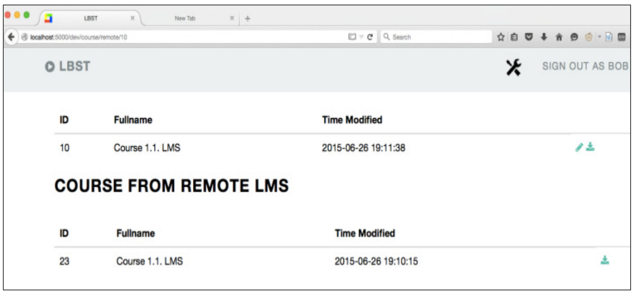
COURSE FROM LBST

ID	Fullname	Time Modified
10	Course 1.0. LBST	2015-06-26 16:28:24

COURSE FROM REMOTE LMS

ID	Fullname	Time Modified
23	Course 1.1. LMS	2015-06-26 19:10:15

Fig. 29 The lecturer checks the update course on the LBST.



ID	Fullname	Time Modified
10	Course 1.1. LMS	2015-06-26 19:11:38

COURSE FROM REMOTE LMS

ID	Fullname	Time Modified
23	Course 1.1. LMS	2015-06-26 19:10:15

Fig. 30 A course on the LBST is updated to a newer version, as same as on the remote LMS.

LBST and a remote server. The use of a course dashboard is shown on **Fig. 24**.

The above experiment activity, explained on **Table 3**.

From the above table, activities 7 and 8 show that the lecturer could use the LBST dashboard to choose the desired version of the created course.

5. Experiment and Evaluation

5.1 Respondent

35 Indonesian lecturers from various HEI participated as respondents for the LBST evaluation. 37% lecturers are from the engineering field and 20% from the educational field (including Educational Technology lecturer). **Figure 31** shows the percentage of background field of each lecturer as a respondent.

Before conducting an experiment, the respondent was requested to answer the questionnaire. **Table 4** shows the result of pre-experiment questionnaire.

From the above table, it shows that more than 50% respondents have an experience using LMS. And more than 77% their home university implemented LMS. Also, more than 82% lecturers are used to prepare a learning material on a daily lecture. Another condition is only 20% lecturers use internet while at class, and only 34% lecturers have an internet connection at their home.

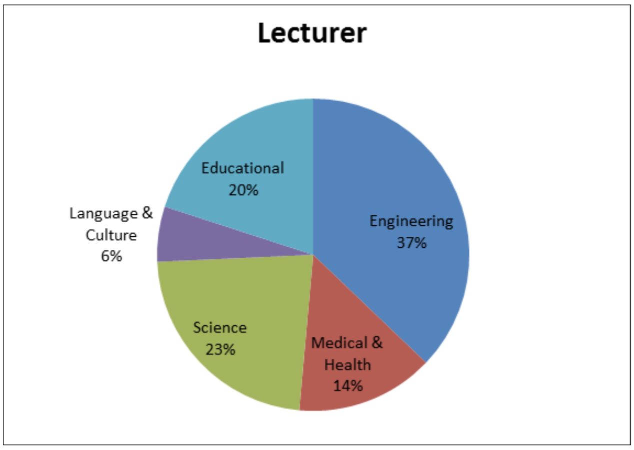


Fig. 31 The percentage of lecturers background field as respondents.

Table 4 Pre-experiment questionnaire.

Question	Answer	
	Yes	No
Have experience using LMS? (N=35)	21	14
Home University has implemented an LMS? (N=35)	27	8
Using an electronic media (such as LCD Projector and ppt files) during the lecture? (N=35)	29	6
Using internet connection while at class? (N=35)	7	28
Has internet connection at home? (N=35)	12	23

Table 5 Remote Moodle Server for Evaluation.

Parameter	Value
Server Name	UMSIDA Server
Moodle Version	2.6.1
URL	http://203.xxx.xxx.xx/moodle
Server Location	Indonesia

5.2 Experimental Scene

Because of the respondent's location on various cities in Indonesia, we deliver the LBST source code to lecturers and teach them how to run the LBST. Then the lecturer accesses the LBST through their local machine. Also, Moodle Server has been setup on a machine that accessible through internet. This server will be used in an experiment and as the LMS target for interoperability between LBST and Moodle LMS. Details of Moodle server for experiment are described as **Table 5**:

In this experiment we evaluate LBST with three experimental scenes:

1. **Moodle and LBST as authoring Tools**
   Lecturers create a course, modify, and delete on both Moodle and LBST. Then we questioned the lecturer for their experiences.
2. **Evaluate the interoperability on LBST and remote LMS**
   Lecturers create a course on LBST then upload to a remote

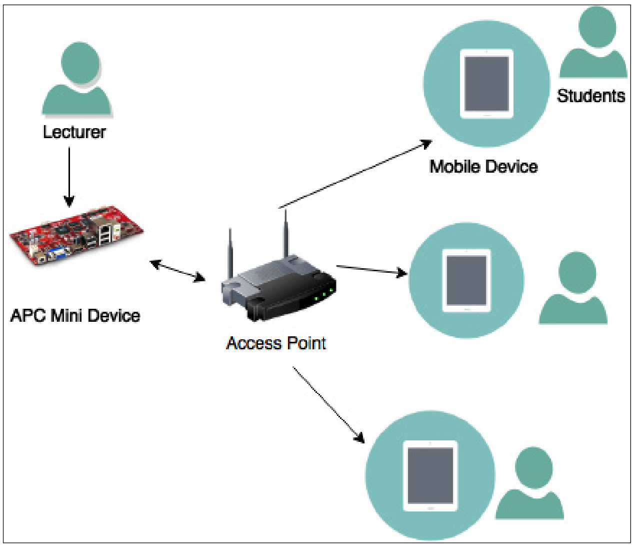
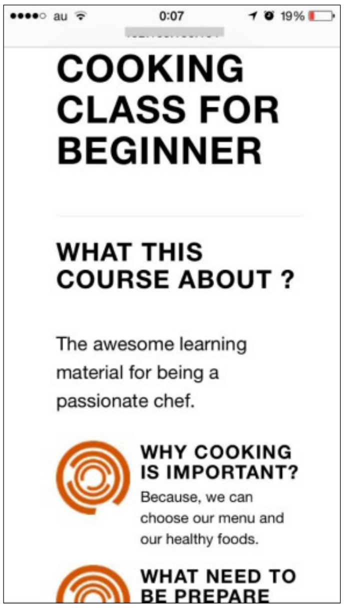


Fig. 32 Network Topology of an LBST Implementation on mini devices.



COOKING CLASS FOR BEGINNER

WHAT THIS COURSE ABOUT ?

The awesome learning material for being a passionate chef.

WHY COOKING IS IMPORTANT?

Because, we can choose our menu and our healthy foods.

WHAT NEED TO BE PREPARE

Fig. 33 Mobile view of LBST learning materials.

Moodle. A similar activity is described at Fig. 24 and Table 3, lecturers were asked to change the course from LBST then synchronized to the remote LMS. After authoring the materials on LBST in offline conditions, lecturers requested to connect their laptop to internet and upload created materials to a designated Moodle server (Table 5).

3. **Evaluate LBST in the class**
   To simulate the condition where no LMS is installed on a home university, an experiment has been conducted by first author at Universitas Muhammadiyah Sidoarjo (UMSIDA) with 2 classes. Each class with 25 students using their own smartphone or other electronic devices that have browser applications for accessing created materials on LBST. For this evaluation, LBST has been installed on a mini device [26] and uses the network topology that shown on **Fig. 32**. Students were requested to give their feedback for accessing instructed course materials on LBST as learning resources. Then we ask their feedback.

Table 6 Example course for experiment.

Course ID	Cooking 101
Course Title	Cooking Class For Beginner
Description	The awesome learning material for being a passionate chef.
Course Content	1. Why cooking is important ? Because, we can choose our menu and our healthy foods. 2. What need to be prepare before cooking ? A recipes, ingredients and skill to process it. 3. When the best time we start learning to cooking ? As young as possibles. 4. There is any book for reference ? Yes. One of is The Joy of Cooking Book by Marion Rombauer Becker, Ethan Becker, and Irma S. Rombauer.

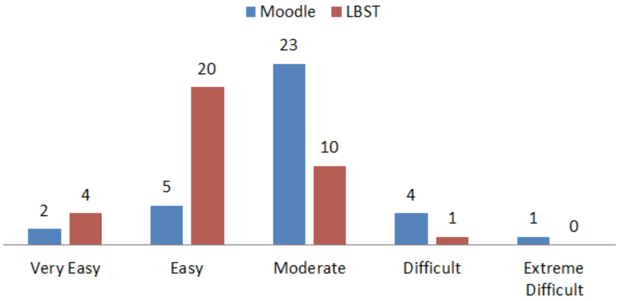


Fig. 34 Lecturers expression when creating a course in Moodle and LBST.

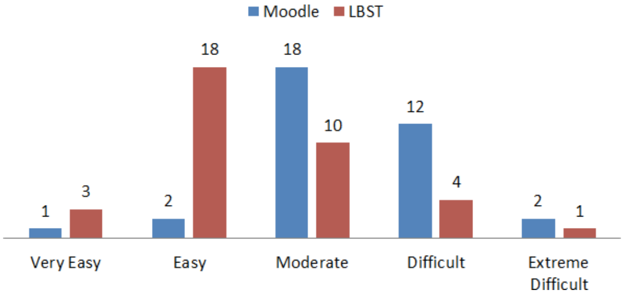


Fig. 35 Lecturers expression when modifying a course in Moodle and LBST.

There is no significant difference in the view from a PC and mobile browsers. Since LBST have been developed with responsive template engines [27], [28]. **Figure 33** shows the view of the LBST on Iphone5 devices using a safari browser.

5.3 Evaluation of Experiment Activities: Moodle and LBST as Authoring Tools

We requested respondents to create, modify and delete example course both on Moodle and LBST (**Table 6**). Then we ask their expression for experience authoring learning materials on both systems.

As result, shown on **Figs. 34, 35, 36**.

From Fig. 34, Fig. 35, Fig. 36, shows lecturer have "easy to

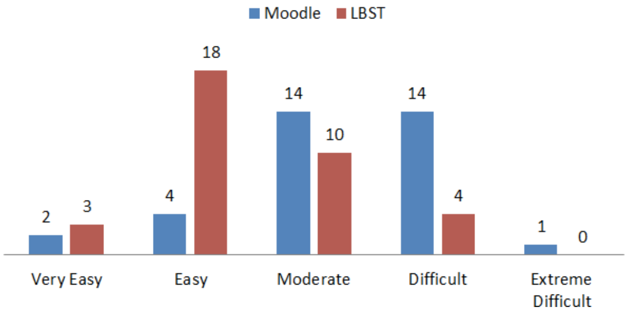


Fig. 36 Lecturers expression when deleting a course in Moodle and LBST.

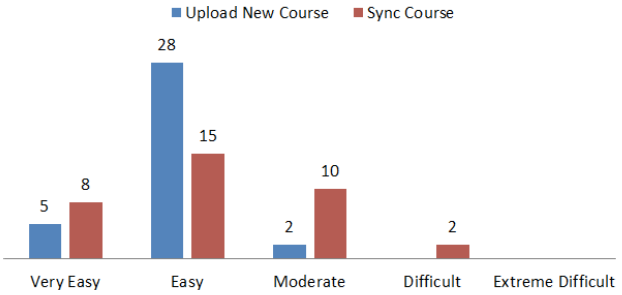


Fig. 37 Lecturers expressions when uploading and syncing materials to the remote LMS.

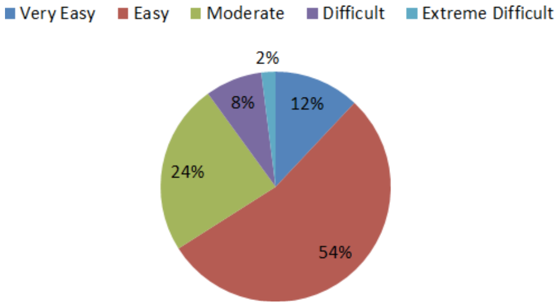


Fig. 38 Students expression use LBST in their class.

use" and less "difficult" expression when using LBST compared with Moodle.

5.4 Evaluation of Experiment Activities: Evaluate Interoperability on LBST and Remote LMS

Figure 37 shows lecturers have more easy expression with uploading a created course on remote LMS rather than synchronizing a course to a remote LMS. This is because, uploading activities are simpler. To synchronize course content, a lecturer needs to use LBST dashboard to manually compare created material.

5.5 Evaluation of Experiment Activities: Evaluate LBST in the Class

A result for evaluating LBST used in class in offline conditions, shows on **Fig. 38**.

More than 50% students reported "easy" expressions while accessing materials on their own devices.

5.6 Comments from Respondent

Few comments from respondents have been collected after the experience with LBST:

- It should open browser automatically after initiating LBST.
- Need to "add image" feature to the course content.
- It will be helpful if there is a collaboration feature such as editing document.
- It will be helpful if there is an option for automatic synchronization of learning materials.

6. Conclusions and Future Works

The developed LBST using Moodle web services for enhancing the learning content will represent a great advantage for many lecturers and HEIs that have already implemented Moodle LMS. Although, the proposed approach has been implemented only on Moodle web services, it will be possible to implement on other LMS (such as Chamilo LMS) through its web services. Moreover, using web services, the proposed approach will be more adaptive on numerous versions of existing LMS's.

The concept offered by LBST, made the lecturer the key person that enriches and controls the learning materials. This means, LBST brings the ownership of the materials back to the lecturer, not the institutions.

Since it is applicable on mini devices, LBST not only will be useful under normal condition but also in a condition where LMS has not been implemented or in an emergency condition when University LMS's are not accessible (i.e. natural disaster, war condition).

The above scenario will be suitable not only in Indonesia education environment which has a bandwidth limitation and where various LMS have been implemented, but it is also suitable for Japan which has already experienced using LMS on a daily basis.

As future works, the extended features of LBST need to be developed. For an example, the e-portfolio and the integration with an existing cloud storage when the lecturer is in online condition.

Acknowledgments All the studies were carried out in Centre for Management and Information Technologies (CMIT) of Kumamoto University. We gratefully thank all the CMIT staffs and all the members of Kumamoto University. The authors wish to thank Professor Tsuyoshi Usagawa from Kumamoto University for the valuable comments about this paper. Also, the authors would like to thank the lecturers and the students who participated in the experiments.

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