

# 國立交通大學

## 網路工程研究所

### 碩士論文

在 Moodle 學習管理平台上  
基於 Web services 的資訊交換服務與課程代理機制

Data exchange service and cross-institutional course content sharing  
environment for Moodle

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中華民國 九十九年六月

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## 摘要

Moodle - 一個開源碼的學習管理平台是現在最為廣泛被使用的平台之一，在其上使用  
者可以客制化需求功能與模組做教學使用。因為此特性，當與其他 Moodle 站台或是校務資  
訊系統這類平台整合時，開發人員必須配合不同版本或是客製化的服務做開發。我們希望  
開發人員能更方便地與 Moodle 互動，因此在基於 Moodle 2.0 中的網路服務架構上發展了  
一套課程資訊交換服務。另一方面，若是能讓不同地方的老師透過交換教材來提升教學品  
質，能讓合作式教學更具意義。我們並利用前述的服務開發了一個 OpenMoodle 模組，這  
個模組讓教學人員能建立資源分享的環境，來自不同地方的教學人員可以交換彼此的課程  
資料和進行合作式教學，同時也讓教學人員在交流資源之餘，也能自行掌握學生的學習狀  
況。學生也可以因此得到更多元的資訊。

# **Data exchange service and cross-institutional course content sharing environment for Moodle**

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## Abstract

Moodle open source LMS is one of the most popular learning management systems currently. Developers can customize functionality and modules for educating purpose. When integrating with other systems, developers have to deal with the barriers that come from Moodle servers with different version or administrative affairs systems. To solve these problems, a set of Course Communication services are built. With these services, developers can more easily build connection among Moodle servers and other systems. And furthermore, it will be valuable for allowing teachers who are at different places to exchange teaching materials. Therefore, we provide a Moodle module: OpenMoodle. With this module, instructors can establish a resource exchanging environment. Teachers can exchange course materials and teach collaboratively with other educators, meanwhile, control student's learning status by holding course materials locally. Students can acquire more diverse resources.

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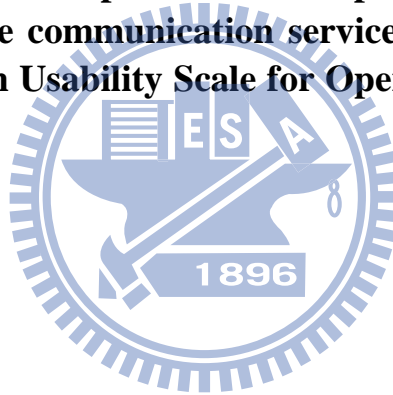
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# 1 Introduction

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## 1.1 Motivation

Nowadays the internet is becoming more indispensable to human being. Myriads of actions including teaching behavior can be performed over Internet. Educational model has gradually been transferred to online learning. Instructors can carry on teaching through Learning Management System (LMS) such as Moodle, Blackboard, and ATutor.

Moodle is a free open-source LMS and widely adopted around the world. It provides many resource and activity modules and mass of pedagogical activities can be performed on it. However it's not efficient for educators to integrate with other systems, e.g. student information system, another Moodle site, or other LMS. They have to customize each different kind data exchange services for different systems. Extending Moodle LMS to web services architecture can decrease the programming hardship and cost, lower maintenance costs, speed the time-to-market [22]. Providing a set of data exchange services will be valuable for Moodle.

In addition, multiple teachers may want to teach collaboratively via LMS but they are coming from different institutes. Mining Education Australia (MEA) is a consortium of three mining schools in Australia [21]. They group the staffs into each relevant course development teams and want to provide cross-institutional teaching. So they adopt one central LMS for cross-institutional enrollments and all students will attend the same course. However, this approach makes teachers lose control of autonomy and cannot hold some activities privately. Teachers may want to hold teaching materials and students' learning activities in local platform, meanwhile, obtain the benefit of collaborative teaching. Collaborative teaching can be also called

team teaching, is a pedagogy that offers several significant advantages for teachers including increased the opportunity for on-going conversation about teaching, and experience in learning how to improve technology capacity for teaching and practice [1]. Betty Robinson and Robert M. [2] indicated collaborative teaching can inspire educators to discover, share, and verify fresh ideas for constructing course sessions, and creating more effective assignment. Therefore, it will be valuable for teachers to cooperate with each other by sharing their respective teaching materials.

There are some tools such as MIT OpenCourseWare (OCW) and Community-hub in Moodle have been proposed to allow teachers sharing their own teaching materials for users. The concept of OCW is that users can freely download MIT's course content. If one institution also wants to adopt the concept, they can employ content management system like eduCommons<sup>1</sup> to build their own OCW for the purpose of sharing knowledge. There are many universities around the world also join this idea, provide some of their content, and formed an alliance: OpenCourseWare Consortium<sup>2</sup>. But they can only provide materials, no teaching activities and collaborative teaching mechanism. Besides, they do not provide a convenient mechanism of exchanging data except downloading manually. Community-hub is the new forthcoming releasing feature of Moodle. It also allows Moodle servers exchanging information. But that only help to open the new curriculum by loading the other users' template, as well as there is no continued cooperative teaching mechanism.

Educators should have the ability to easily set up a resource sharing environment. They can teach collaboratively or utilize others' resources to build a new course. Notification sent to

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<sup>1</sup> <http://cos1.usu.edu/projects/educommons/index.html>

<sup>2</sup> <http://www.ocwconsortium.org/index.php>

subscribers once there are new materials created. Teachers are given greater autonomy in their own sites and they can easily manage and choose adequate resources for students.

## 1.2 Objectives

In order to address the issues of collaborative teaching and sharing knowledge between teachers who are in different institutes, we want to provide educators with an environment to share information. Meanwhile, this environment can also provide many tools related to pedagogy. Hence, we choose an open source LMS: Moodle as the base platform and implement our ideas, rather than re-design a new LMS. Therefore, a Moodle plug-in: OpenMoodle module is proposed. Through this module, teachers are able to exchange teaching materials and activities, assist in preparing the new course content, teach collaboratively and hold data privately, and help to improve the quality of course.

Next, the Course Communication services for Moodle (CCM) are proposed. We are going to package Moodle's functionalities based on the web services architecture which is built in upcoming released Moodle package 2.0. Developers can adopt uniform rules for development and integration.

## 1.3 Outline of the thesis

In chapter 2, we discuss the background of Moodle LMS, web services, and related works. In chapter 3, we show a diagram of system overview and describe implementation details of some important components in OpenMoodle and CCM. Next, in chapter 4 presents the results of OpenMoodle and operations. The evaluation is in chapter 5 containing the comparison and an experiment for OpenMoodle module. Finally, the conclusion and future works for our proposed module are presented in chapter 6.

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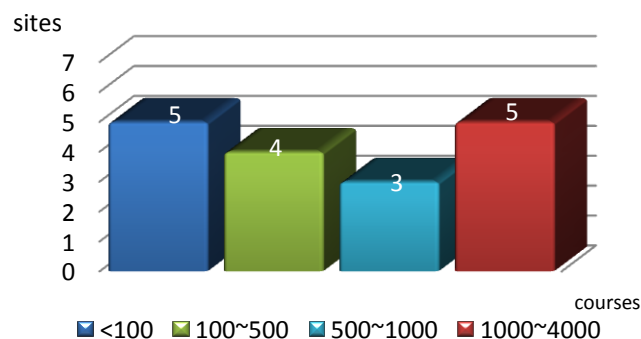
## 2 Backgrounds

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### 2.1 Moodle LMS

E-learning is a way of promoting teaching and learning through computer and network in which the learning content is available online. Learning Management System (LMS) is one kind of approach to e-learning and it is becoming a significant part of the manner for delivering online and flexible e-learning to enhance study. Nowadays, there are over 250 e-learning systems that cover commercial and open source software (OSS) project [4]. In OSS category, one of the famous products is Modular Object-Oriented Dynamic Learning Environment which is abbreviated as Moodle [3].

Moodle is proposed based on social constructionist pedagogy which is learner-oriented philosophy. It developed since 1999 and has been widely adopted over 200 countries, and has 49000 registered sites, and the number of courses is around 3,500,000. Most significantly, there are about 35,000,000 users joined the Moodle community [3] where educators can mutually exchange teaching experiences and developers can improve from feedback.



*Figure 2-1 the usage of adopting Moodle for higher education in Taiwan*

In our country, Moodle is popularly adopted as well especially in academic domain. Figure 2-1 shows the current usage of concerning higher education in Taiwan. Tunghai University [5], Ming Chuan University [6], and National ChiNan University [7] are the representatives. Tunghai's site holds over 35,000 users and 6,500 courses per year. Ming-Chuan's site has established over 90% of teaching materials. ChiNan's site has been integrated with the administrative affairs system. And National Cheng Kung University [8] had moved from BlackBoard to Moodle last year as well.

Graf and List [12] consider that adoption is pretty crucial for an e-learning system because of when designing a course via e-learning platforms should match students' need and desire as closely as possible, and adapt during course progression. They choose qualitative weight and sum (QWS) approach to analyze nine open source platforms and determine their ranking. The comparison is focused on four phase: adaptability, personalization, extensibility, and adaptivity capabilities. Table 2-1 shows that Moodle outperform all the other platforms and it can be view as the best one in adaptation aspect.

*Table 2-1 Evaluation of LMS's adaptation*

	Adaptability	Personalization	Extensibility	Adaptivity	Ranking
<b>Maximum values</b>	*	#	*	*	
<b>ATutor</b>		#	#		3
<b>Dokeos</b>		0	*	+	2
<b>dotLRN</b>	+	+	*	0	2
<b>ILIAS</b>	+	#	*	0	2
<b>LON-CAPA</b>	+	#	#		2
<b>Moodle</b>	#	+	*		1
<b>OpenISS</b>	#	#	#	0	2
<b>Sakai</b>	0	0	*	0	3
<b>Spaghettilearning</b>	+	#	+	0	3

QWS Levels: E = essential, \* = extremely valuable, # = very valuable, + = valuable, | = marginally valuable, 0 = not valuable

Ajlan and Hussein [4] make comparisons among Moodle 1.8, five commercial products that include Desire2Learn 8.1, KEWL, Blackboard Learning System (V.7), ANGEL Learning Management Suit (7.1) and eCollege, and four OSS that include Claroline 1.6, Dokeos 2.1.1, OLAT, and Sakai 2.3.1 to test and verify in three phases of their features and capabilities: Learner Tools, Support Tools, and Technical Tools. According to the result showed in Table 2-2, Moodle is one of the most excellent LMSs that meets 38 of 40 features and only misses two.

*Table 2-2 Comparison of Ten LMSs*

No	1	2	3	4	5	6	7	8	9	10
<b>Product</b>	Desire2Learn	KEWL	ANGEL	eCollege	Blackboard	Moodle	Claroline	Dokeos	OLAT	Sakai
	Total Features: 40 (Learner / Support / Technical Tools)									
<b>Available</b>	37	35	37	33	35	38	32	33	35	38
<b>Missing</b>	3	5	3	7	5	2	8	7	5	2

The overall excellences of Moodle are itemized as below [4][12][16].

- I. It is open source software.
- II. It can be introduced into nearly all servers which support PHP and run on any systems such as Linux, UNIX, Windows, MAC OS.
- III. It supports over 85 kinds of language.
- IV. Teachers can evaluate students' learning situation by employing its teaching resource and activity evaluation function.
- V. Students can increase their self-esteem and relationship between a teacher and students within Moodle.
- VI. Moodle has excellent documentations and user-friendly interfaces for educators to easily install, customize, and upgrade to the latest version.

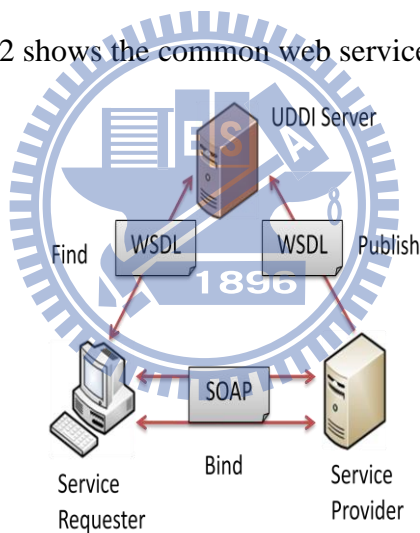


VII. Moodle is outstanding in the general and in the specific adaption aspects. It means Moodle can be easily extended to adaptive one.

## 2.2 Web Services

The proposed CCM is a kind of web services which redirect to Moodle's internal functionalities. So we introduce the basic concept of web services briefly.

Web services are application components that use XML-based protocols including Simple Object Access Protocol (SOAP) and Web Service Description Language (WSDL) over Hypertext Transfer Protocol (HTTP) to perform remote functions or execute business processes [17][18]. Besides, services are published and discovered using Universal Description Discovery and Integration (UDDI). Figure 2-2 shows the common web service architecture.



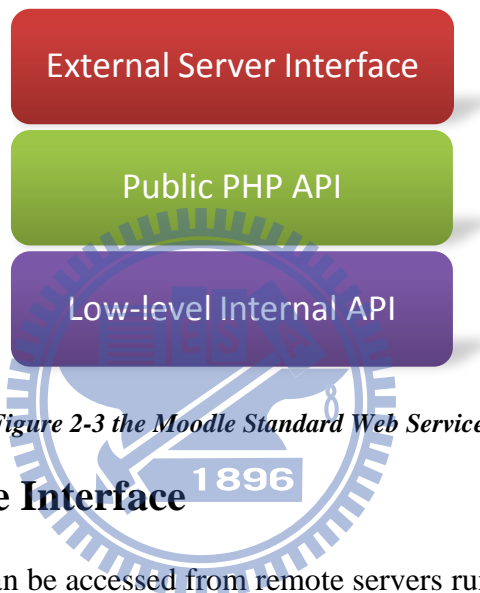
*Figure 2-2 the general web service architecture*

Web services are rapidly emerging as a well-accepted standard for sharing data and functionality among loosely-coupled, heterogeneous systems [20]. Web services can provide developers an effective abstraction mechanism for application on the Internet, independently of programming environment, execution platform and communication protocol [19]. Web services can be viewed as the approach to Service-Oriented Architecture (SOA). Adopting the concept of SOA into LMS can provide LMS with the ability to deliver internal functions as services as well

as the ability to integrate external applications as services [23].

## 2.3 Moodle Standard Web Services

Moodle standard web services is introduced in Moodle roadmap 2.0. It's a module that aims to support multiple web services protocols. The CCM that we developed are based on it. Figure 2-3 shows the composition of the standard web services layer. Next, we are going to introduce each layer separately.



*Figure 2-3 the Moodle Standard Web Services*

### 2.3.1 External Service Interface

Moodle core functions can be accessed from remote servers running somewhere on network. Moodle supports many kinds of protocols like SOAP, REST, XML-RPC, and AMF. This layer is responsible for dealing with tokens, emulating user session, parameter processing.

### 2.3.2 Public PHP API

As the name implies, this layer is the collection of web service functions that open up the avenue to low-level core function. All the core functions that can be accessed by the way of web services should be wrapped in web service description format. The available web service functions are declared at first, and then the corresponding external function is defined which are both located at each module folder. In fact, these web service functions are view as the

redirection to the external function. The client doesn't discern anything about the external function.

### **2.3.3 Low-level Internal API**

The low-level internal API is also called as core function. It's the foundation of the external function. The core functions will execute the request from external function and return the result. Developer can utilize existing core functions or rewrite them on their own. The core functions have no permission to access any global Moodle variables. It just does basic parameter validation, no access control

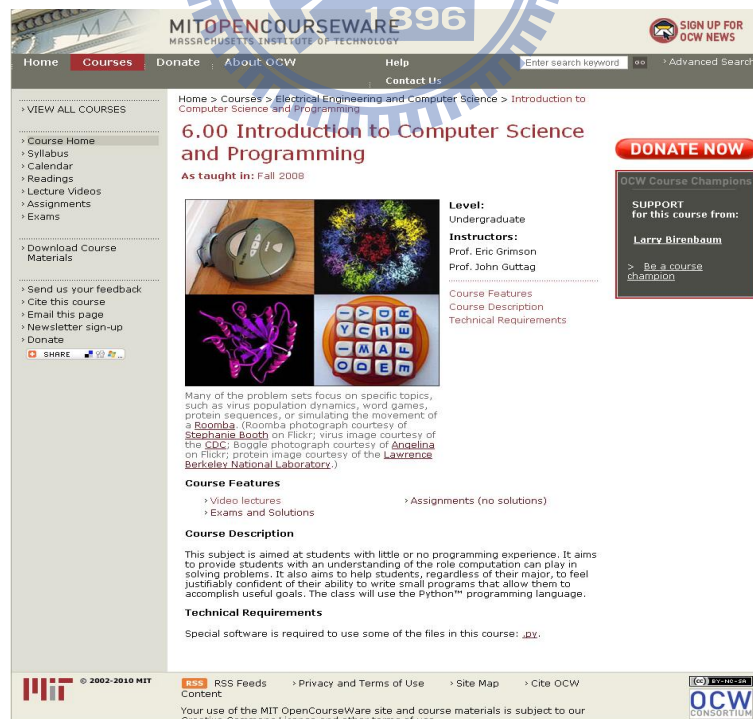


## 2.4 Related Works

In this section, we introduce two projects similar with our OpenMoodle module. The first one is OpenCourseWare proposed by MIT. The other one is Community-hub which is built in the forthcoming Moodle package 2.0. Both of these applications have their own characteristics, but also lack of some part.

### 2.4.1 OpenCourseWare

OpenCourseWare (OCW) project is announced by Massachusetts Institute of Technology (MIT). It's designed for putting all MIT course content online and freely available for everyone in the world in April, 2001[9]. They provide lecture notes, exams, and video of course, and there is no registration required [13]. The OCW adopt Creative Common licenses: attribution, noncommercial, and share alike which allow instructors to confidently use and incorporate their course [14].



The screenshot shows the MIT OpenCourseWare website interface. At the top, there is a navigation bar with links for Home, Courses, Donate, About OCW, Help, and Contact Us. A search bar is also present. The main content area displays the course title "6.00 Introduction to Computer Science and Programming" and indicates it was taught in Fall 2008. Below the title, there are four small images: a hard hat, a colorful molecular structure, a purple protein structure, and a keyboard. To the right of these images, the course level is listed as "Undergraduate" and the instructors are "Prof. Eric Grimson" and "Prof. John Guttag". A "DONATE NOW" button is prominently displayed. Below the course title, there is a "Course Features" section with links for "Video lectures", "Exams and Solutions", "Assignments (no solutions)", "Course Description", and "Technical Requirements". The "Course Description" section states that the subject is aimed at students with little or no programming experience. The "Technical Requirements" section mentions that special software is required to use some of the files in the course. At the bottom of the page, there is a footer with the MIT logo, copyright information, and links for RSS Feeds, Privacy and Terms of Use, Site Map, and Cite OCW.

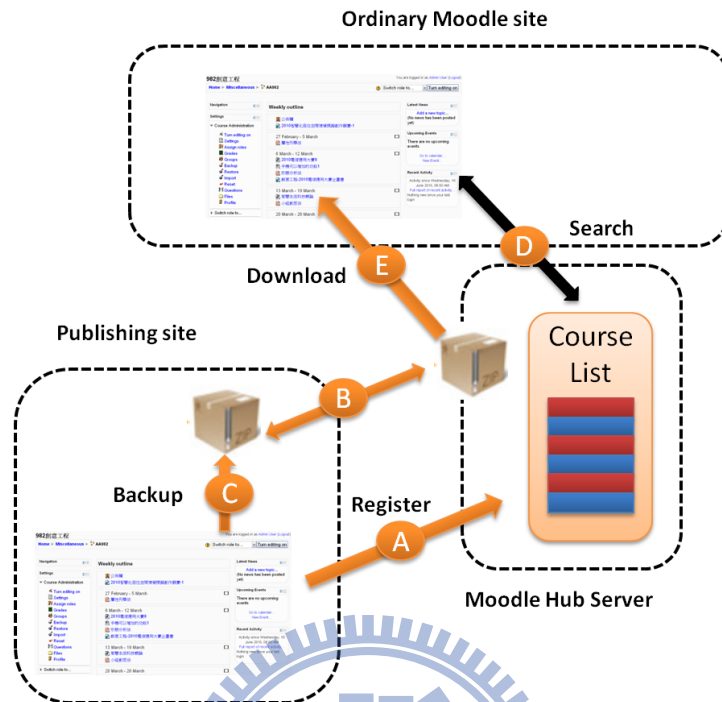
Figure 2-4 Screenshot of a computer science and programming course in OCW

Though OCW is one of the most well-know Open Courseware (OC) platform in the world [14] and there are one million visits per month, it has some limitations as well. They only offer course materials but no teaching activities. It cannot reflect complete content of the course. Besides, OCW cannot grant degrees or credit. For students and self-learners, the content of course is provided unilaterally by MIT's faculty, and it lacks diversity. Although there is an OpenCourseWare Consortium consisted of several institutes, users need to filter these sites and find proper content by themselves. In addition, they need to spend \$10,000 to \$15,000 USD on each published course. In 2006, they tried to lower the cost of creating course content in OCW by integrating with the LMSs provided by faculties for their students. However, there were some problems when integrating practically. Because making materials transforming automatically from existing LMS to OCW might put an unacceptable burden on faculties [10]. It means that even if educators want to adopt the concept of OCW, they have to spend extra cost on the integration of existing course site.

### **2.4.2 Community Hub**

With regard to Moodle, there's no capability of sharing course materials between sites built in currently released packages (till v1.9). In the developing roadmap (v2.0), they add a new feature named Community Hub that provides facilities for Moodle users to interflow with the other educators [15].

Allowing teachers to easily get course templates from other Moodle site so that they can share and learn from fine course patterns is one characteristic of the community hub. Sites can publish some courses and store the downloadable course zip files at a Moodle hub server. Moodle users can connect to a hub server search for specific courses and select one. Original server will trigger the process to download the file and the user can restore it. But after restoring the



*Figure 2-5 download course as template from a hub server*

templates, we cannot keep updating the latest content continuously. It only supports exchanging data in the beginning. Though course publisher can select which of course resources to publish, publisher is unable to trace usage of published materials.

In community hub, there is another functionality that allows users to enroll in external courses. In spite of teachers can let the students study on various subject at remote server to experience different perspective, they are unable to grasp student's study situation.

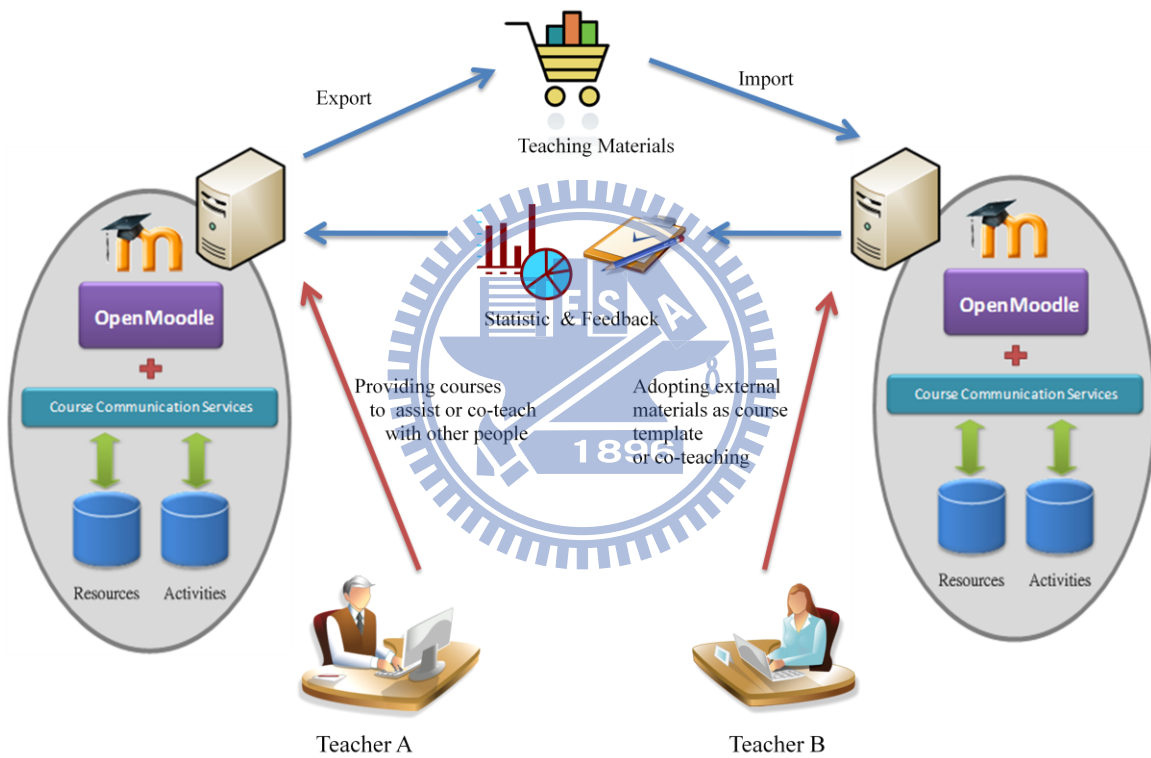
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# 3 System Design and Implementation

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## 3.1 OpenMoodle

### 3.1.1 Overview



*Figure 3-1 the overview of Moodle sites using OpenMoodle module*

The first part we proposed in this thesis is named “OpenMoodle” module. The OpenMoodle module is mainly designed for sharing course content and collaborative teaching. It allows teachers to cooperate with other like-minded instructors. Figure 3-1 depicts the overview of Moodle sites using OpenMoodle module. The educators who are at friendly Moodle site can export their course contents. The instructors who are at ordinary Moodle site can import the course materials that come from other friendly Moodle sites to create a new course or to enrich

the content of existing course. The learners can gain more plenteous and integrated resources than traditional way.

### 3.1.2 Configuration

Before proceeding to exchange content, users need to do some pre-tasks manually including setup the automatic mechanism and access capabilities for OpenMoodle module.

#### ■ Cron

OpenMoodle module allows teachers to exchange teaching materials between sites. For some cases, users may want the data synchronization done automatically. In OpenMoodle module, automation is initiated by data exporting-side site. As long as Moodle administrator has set up the cron , the automatic update mechanism can be put into the Moodle's regularly scheduled progress. In modole, cron progress runs periodically to assist Moodle's module to execute task. Since OpenMoodle module has installed, it will check the status of exported module per twelve hours and sync automatically if there is any update.

#### ■ Capabilities for OpenMoodle's user

Interactions between users and Moodle are controlled by capabilities. User should assign the appropriate capabilities for the web service account. They can inherit the standard role: teacher which has the most common permission, or create a new role and assign the essential capabilities which are exhibited in Appendix A. Besides, teacher specifies what kind of protocol he wants to provide for communicating and assign the capabilities to the role.



### 3.1.3 OpenMoodle Module

OpenMoodle is a block based module in Moodle. When using OpenMoodle, users must communicate voluntarily with each other by word-of-mouth. We utilize the course communication services that we developed in next section to support OpenMoodle. It consists of three major components: *OpenServer List*, *Importable Curriculum Admin*, and *Local Curriculum Export*. Figure 3-2 shows the component of OpenMoodle module.

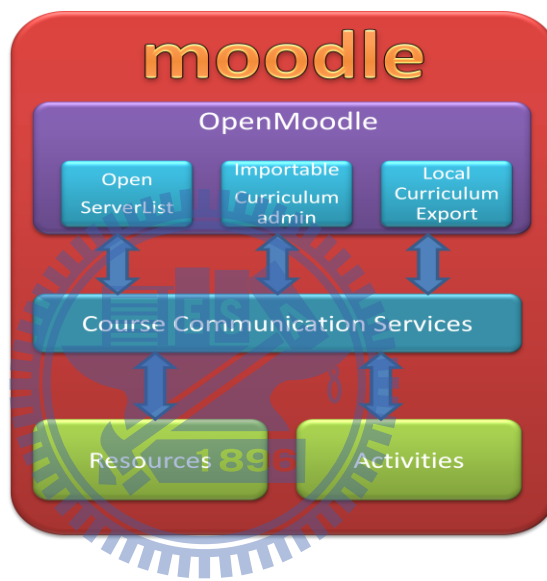


Figure 3-2: the component of OpenMoodle module

➤ OpenServer List

Before starting exchanging materials of course with other educators, the instructor who is native to local server should configure external servers first. OpenServer List component provides Moodle administrator an interface to enter the web service login account of both local and curriculum exporting-side sites, and to manage the list of Moodle sites which are willing to export their teaching materials.

These accounts are stored at first and used during the period of exchanging data. The curriculum importing-side site needs to get metadata information (e.g. available exported

courses list, available exported course content in a course) before importing course materials. Once a site has imported courses successfully, the curriculum exporting-side site has to record the login information of curriculum importing-side site so that if there is any change occurs, the curriculum exporting-side site will be able to notify these curriculum importing-side sites.

➤ **Importable Curriculum Admin**

The Importable Curriculum Admin component is used to manage and import external course content. The available exported curriculums will be listing here. By entering individual course, the resources and activities which are ready to export are shown. The instructor can choose what he wants among these exported Moodle course materials like url, page, lesson, resource...etc. After finishing selecting and clicking the “*Import*” button, the content of remote course will be delivered to local server right away. Local server will use these data to enrich an existing curriculum or establish a new curriculum.

In addition to import the resource and activity, instructor can set the synchronous option to make system enforce corresponding action when exporting-side site updated the content of curriculum. Three types of synchronous options are defined in the Importable Curriculum Admin component. They are “None”, “Only-inform”, “Auto-sync” synchronous options classified in Table 3-1.

**Table 3-1 Options of Synchronization**

<b>Option</b>	<b>Corresponding Action</b>
None	Do nothing
Only-inform	Notify instructor of the update message. Do not sync curriculum data automatically.
Auto-sync	Imported curriculum data will be synced automatically.

The “None” option represents that system does nothing when there is any up-to-date material being published. In this case, instructor can utilize the curriculum data from other educators as sample course without keeping following latest exported resources. If instructor prefers that the curriculum content entirely come from another teacher, he can adopt the “Auto-sync” option. The imported curriculum data will be sync no matter what things change at exporting-side site. The last option is “Only-inform”. Curriculum importing-side site only receive update message. The instructor can filter out that content and then import profitable and suitable materials.

➤ Local Curriculum Export

The instructor is able to share resource with other like-minded educators through this component. The system will record the permissible resources and activities list. External educators at other site can view and import the exported curriculum materials as long as they have entered the login information of corresponding exporting-side server.

In order to do so, we should provide an account for other educators to access our curriculum materials. This account is “Web services authentication”-based in Moodle and assigned the corresponding capabilities which are checked during the procedure of course content sharing.

Besides exporting data to outside server, the instructor can improve his teaching materials according to other user’s feedback. We record some statistics which are related to what kinds of materials are selected by other educator’s. We list the information about sites which had imported curriculum materials. Moreover, we also record usage of each exported module.

## 3.2 Course Communication services for Moodle

### 3.2.1 Overview



*Figure 3-3: the Course Communication services for Moodle*

The Course Communication services for Moodle (CCM) are a set of web services that provide external developers the avenues to Moodle's core functions. As mentioning in previous section, we need to encapsulate the Moodle core function to support CCM. Fig 3-2 shows the structure of the CCM.

There are two categories such as Moodle Built-in services, and Customized services in CCM. First of all, there are handful of services are already built-in at standard Moodle development version 2.0. These services are supported from the core development group and tend to global Moodle data usage. In addition to the standard built-in services, we refer to ten courses running in last two years. And considering the popularity and practicability of Moodle's resources and activities which are used in these courses, we choose four kinds of resources and five kinds of activities as our implementation goal in Customized services. There are four resources and two activities modules which are totally accomplished by ourself. The rest of three activities module

come from third parity but are fixed by us. We find these available services from DFWikiLABs<sup>3</sup>. DFWikiLABs is an open-source developing group in Spain. These services they implemented are quite good but don't work correctly. So we fixed some bug and make them suitable for the latest Moodle web service specification.

### 3.2.2 Implementation

In this section, we explain how we built a web service function for Moodle. In Moodle, components are packaged in separate folder. We can develop the web service functions for each module. When creating a web service function, three things have to be identified and explained in the following:

- Declare the web service function –

When creating a web service function, developers have to declare it first into a service php file which is located at db folder of each component. Table 3-2 enumerates the properties have to be identified. Listing 3-1 shows the example of declaring a web service function.

*Table 3-2 the property of web service function*

Property	Description
<b>web service function name</b>	It's arbitrary and served by the web service server. It just a redirection to external function.
<b>class name</b>	class holding the external function
<b>method name</b>	the external function name
<b>classpath</b>	file holding the class/external function
<b>description</b>	human readable description for the web service function
<b>type</b>	access type

<sup>3</sup> <http://www.dfwikilabs.org/>

```
Moodle_mod_choice_create_choices' => array(  
    'classname'    => 'Moodle_mod_choice_external',  
    'methodname'   => 'create_choices',  
    'classpath'    => 'mod/choice/externallib.php',  
    'description'  => 'Create choices',  
    'type'         => 'write',  
)
```

*Listing 3-1 example of declaring a web service function*

■ Define the web service description –

Since some web service protocol need the wsdl file to identify the function parameters and return value, Moodle request developers to define the description. The description does not apply to the web service function but the external function which is explained later. Because the web service function is just a kind of redirection to external function. These descriptions are defined in an externallib.php file which is located at each component folder as well. For each external function, two related functions are defined. Listing 3-2 shows the example of defining a web service description.

- parameter function: A function containing every parameter description of the external function called parameter function. It will return a parameter object which is initialized with an associative way that contains parameter elements. It is called in external function to validate the parameter.
- return value function: It returns the result object of external function. Moodle web service server parse the result of external function and return the required fields which are specified in this return value function. .

```

public static function create_choices_parameters() {
    return new external_function_parameters(
        array( 'choices' => new external_multiple_structure(
            new external_single_structure(
                array(
                    'course' => new external_value(PARAM_INT, 'Course Id'),
                    'name' => new external_value(PARAM_NOTAGS, ' '),
                    'intro' => new external_value(PARAM_CLEANHTML, ''),
                    'introformat' => new external_value(PARAM_INT, ''),
                    ...
                )
            )
        );
}

public static function create_choices_returns() {
    return new external_multiple_structure(
        new external_single_structure(
            array(
                'id' => new external_value(PARAM_INT, 'Choice id'),
            )
        )
    );
}

```

*Listing 3-2 example of defining a web service description*

- Define the external function

The external function is the spirit of web service function. The web service server will serve the request from client and redirect it to external function. In external function, programmer implements the actual operation including validating the parameters, doing security check, calling the core functions which are privately in Moodle, and returning the result if needed.

We implement several web service functions which are exhibited in Appendix B to support CCM. Table 4-3 only lists the available components for Moodle.

*Table 3-3 Available Component for CCM.*

Category	Component
Customized Services (Support by us)	Resource
	Url
	Page
	Label
	Choice
	Assignment
Customized Services (from third parity but fixed by us)	Forum
	Lesson
	Glossary
Moodle built-in	Course
	User
	Group
	Enroll
	File

### 3.3 Implementation Tools

In this program, we use a number of open source tools and libraries for developing the OpenMoodle and CCM as shown below.

*Table 3-4 Implementation Tools for OpenMoodle and CCM*

Name	Usage	Version	License
<b>Moodle package</b>	Core	2.0 dev	GPLv2
<b>PHP</b>	Programming	5.2.8	PHP License
<b>Apache HTTP Server</b>	Web server	2.2.8	Apache License 2.0
<b>MySQL</b>	Database	5.0.25	GNU GPL
<b>DhtmlxTabbar<sup>4</sup></b>	Navigation UI	2.5	GNU GPL
<b>REST, SOAP</b>	Web service protocol		

<sup>4</sup> <http://dhtmlx.com/>

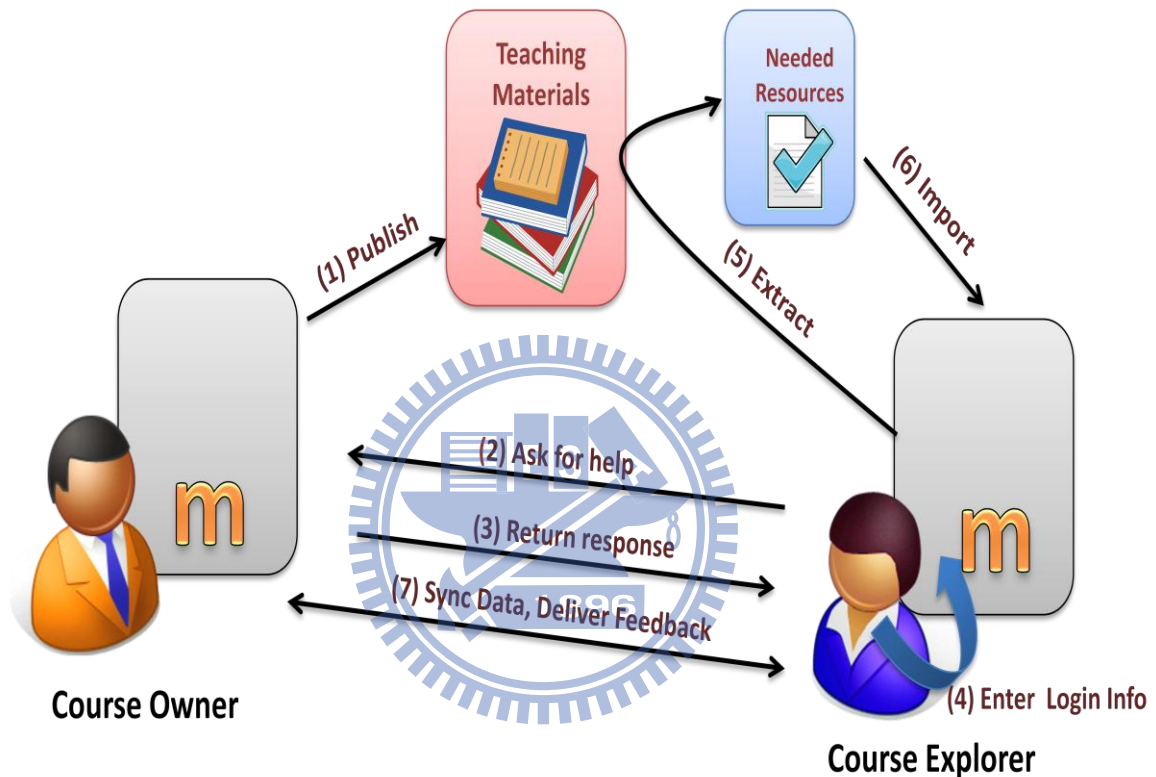


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# 4 System Demonstration

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## 4.1 System Flow Scenarios



*Figure 4-1 System Flow Diagram*

The scenario of the common system flow diagram is shown in Figure 4-1. In this diagram, according to the communication protocol between course owner and course explorer, initially, the course owner (1) publishes some teaching materials which are opened for public using. When a course explorer finds the course he wanted, he may (2) ask for the help. After approving the request, the course owner (3) returns the response to the explorer. Course explorer can (4) enter the related required information that is including the course owner site's login account and the local site's login account. Once everything is prepared, the course explorer is allowed to (6)

import the essence which is (5) extracted from published teaching materials. (7) The imported data will be synced based on course explorer's setting and course owner will get the feedback and exported module's statistics.

## 4.2 OpenMoodle interface

### 4.2.1 OpenServer List

Figure 4-2 shows the screenshot of OpenServer List interface. Teachers can configure the login info at (1). System will check and validate the external server status and the accounts are activated or not. New server is added only when all the information are correct. Teachers can supervise the status of these servers as well. Existing server list is maintained at (2).

The screenshot shows the 'OpenServer List' interface. At the top, it says 'Thesis' and 'You are logged in as Admin User (Logout)'. Below that is a breadcrumb trail: 'Home > OpenMoodle > Importable Curriculum Admin'. The main content area is titled 'OpenServer List' and contains a table of servers and a form to add a new server.

1. **Add a new Server** form:

Server URL:   
 External Account:  External Password:   
 Local Account:  Local Password:

2. **Existing Server List** table:

No.	Server URL	Status	Activate	ExportSide WS Account	Local WS Account	Delete
(1)	http://tl.csie.thit.edu.tw/moodle20	Online	Yes	admin	admin	<input type="button" value="Delete"/>
(2)	http://140.128.197.17:5050/moodle	Online	Yes	admin	admin	<input type="button" value="Delete"/>

At the bottom of the page, there is a link 'Moodle Docs for this page' and a 'Home' button.

*Figure 4-2 Screenshot of OpenServer List interface*

## 4.2.2 Local Curriculum Export

In Local Curriculum Export component, the available course modules are grouped and displayed according to different categories at (1) in Figure 4-3. The teachers can choose some materials and publish them at (2). In addition, who had utilized individual course and the popularity of each module are provided as reference at (3).

大華資工系測試站台 You are logged in as Admin User (Logout)

Home > OpenMoodle > Local Curriculum Export

OpenServer List Importable Curriculum Admin **Local Curriculum Export**

### Local Curriculum Export

課程: 982創意工程 AA982

已有 1 個site使用此課程資源 [按此觀看統計資訊](#)

**assignment**

Resource Title	Usage
<input checked="" type="checkbox"/> Homework1	已有 1 個site使用
<input checked="" type="checkbox"/> Homework2	已有 1 個site使用

**forum**

Resource Title	Usage
<input type="checkbox"/> 公佈欄	已有 0 個site使用

**resource**

Resource Title	Usage
<input checked="" type="checkbox"/> 2010智慧化居住空間情境模擬創作競賽-1	已有 1 個site使用
<input checked="" type="checkbox"/> 屬性列舉法	已有 1 個site使用
<input checked="" type="checkbox"/> 形態分析法	已有 1 個site使用
<input checked="" type="checkbox"/> 創意工程-2010電信應用大賽企畫書	已有 1 個site使用
<input checked="" type="checkbox"/> 小組創思法	已有 1 個site使用

**page**

Resource Title	Usage
<input checked="" type="checkbox"/> 手機可以增加的功能1	已有 1 個site使用

**url**

Resource Title	Usage
<input checked="" type="checkbox"/> 2010電信應用大賽8	已有 1 個site使用
<input checked="" type="checkbox"/> 智慧生活科技概論	已有 1 個site使用

[發佈教材 \(2\)](#)

(1) Available modules

(3) Statistic

已有 1 個Site 使用了此課程的資源  
來自 http://140.113.88.239:5050/moodle 的site已使用了此課程

Figure 4-3 Selecting and publishing Moodle modules

## 4.2.3 Importable Curriculum Admin

The servers which are willing to export teaching materials are listed at separated blocks (1). Teachers can choose which course they want and set up the corresponding sync option at (2). The course updating messages are display at (3). The meanings of status symbols are explained at (4). Figure 4-4 shows the Screenshot of Importable Curriculum Admin interface.

Thesis You are logged in as [Admin User \(Logout\)](#)

[Home](#) > [OpenMoodle](#) > [Importable Curriculum Admin](#)

OpenServer List **Importable Curriculum Admin** Local Curriculum Export

### Importable Curriculum Admin

1. (1) <http://tl.csie.thit.edu.tw/moodle20>

Course Name	Sync Option	Sync Status
2. 982創意工程	None	
智慧型裝置程式設計	None	
視窗程式設計	None	
演算法	None	
影像處理	None	
Java程式設計	Auto-sync	Confirm

4. **Status Symbol**

- => Nothing happened.
- => Newly exported module(s).
- => Newly exported module(s), system sync automatically.
- => Newly exported course.

3.

[Moodle Docs for this page](#)

You are logged in as [Admin User \(Logout\)](#)

[Home](#)

*Figure 4-4 Screenshot of Importable Curriculum Admin interface.*

As user enters a course link at (2), a page containing available Moodle modules within a course is shown. Figure 4-5 shows an example of demonstrating importing Moodle resources from external server. Teachers can choose modules what they are desirous and choose the course destination, and then click “*Import*” button. Data will be imported from external server right away.

## Import External Course

**982創意工程 AA982** External Course Title

Imported course destination

Course Destination: Create new courses  
url: (From http://tl.csie.thit.edu.tw/moodle20 )Java程式設計

智慧生活科技概論  
 2010電信應用大賽8

resource

屬性列舉法  
 2010智慧化居住空間情境模擬創作競賽-1  
 形態分析法  
 創意工程-2010電信應用大賽企畫書  
 小組創思法

assignment

Homework2  
 Homework1

page

手機可以增加的功能1

Available external modules

(From http://tl.csie.thit.edu.tw/moodle20 )982創意工程

Home ► Miscellaneous ► AA982

Navigation

Weekly outline

Settings

- 2010智慧化居住空間情境模擬創作競賽-1
- Homework2
- Homework1
- News forum

1 January - 7 January

- 屬性列舉法

8 January - 14 January

- 2010電信應用大賽8
- 形態分析法
- 創意工程-2010電信應用大賽企畫書
- 手機可以增加的功能1

15 January - 21 January

- 智慧生活科技概論
- 小組創思法

Imported course

Figure 4-5 Importing Moodle resources from Da-Hua Institute of Technology

## 4.3 Usage Patterns

Educators can develop different approaches to pedagogy via the OpenMoodle module.

We provide two usage patterns: teach collaboratively pattern and one-way supply pattern.

### ➤ Collaborative teaching pattern

As name implied, teachers can cooperate with another one to share teaching materials.

For example, there are two teachers, Alice and Bob. They teach on the same subject but they are coming from different schools. They want to give a course together. It means that they are in charge of separate scope and separately hold course data at their separate platform.

Figure 4-6 shows the flow chart of collaborative teaching pattern. They can use the following steps:

1. At first, they negotiate the common consensus of teaching scope.
2. Respectively send the login account and Moodle address to each other.
3. Respectively enter the login account and specify the external server address.
4. Respectively designate specific materials for receiving party and publish them.
5. Respectively choose the published materials and import from another person.
6. Respectively set up the “*auto-sync*” option. Data will be synced automatically if there is any resource updated.
7. System will filter out the redundant resources. Each of them can hold own teaching materials and get the benefit from another one.

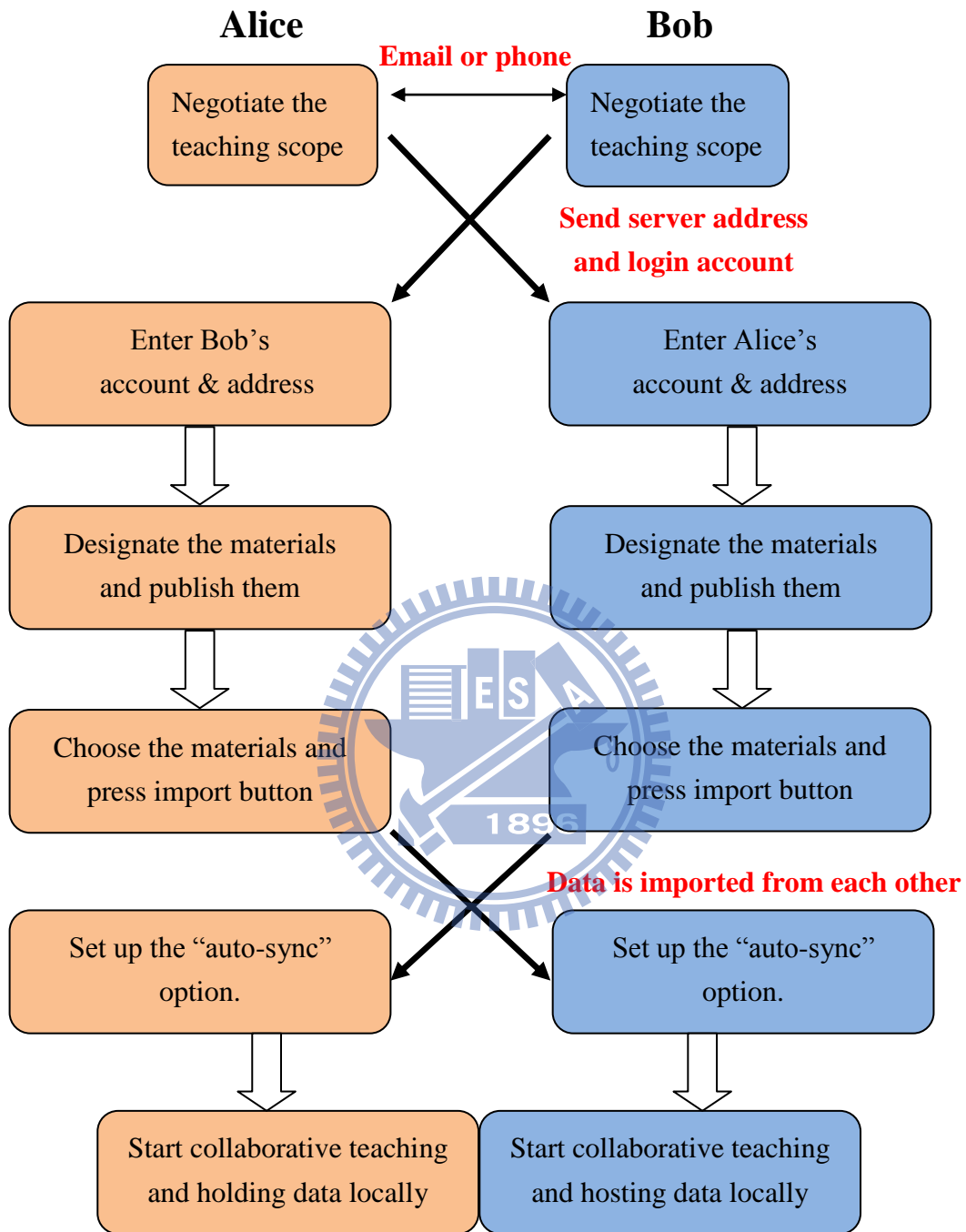


Figure 4-6 the flow chart of collaborative teaching pattern

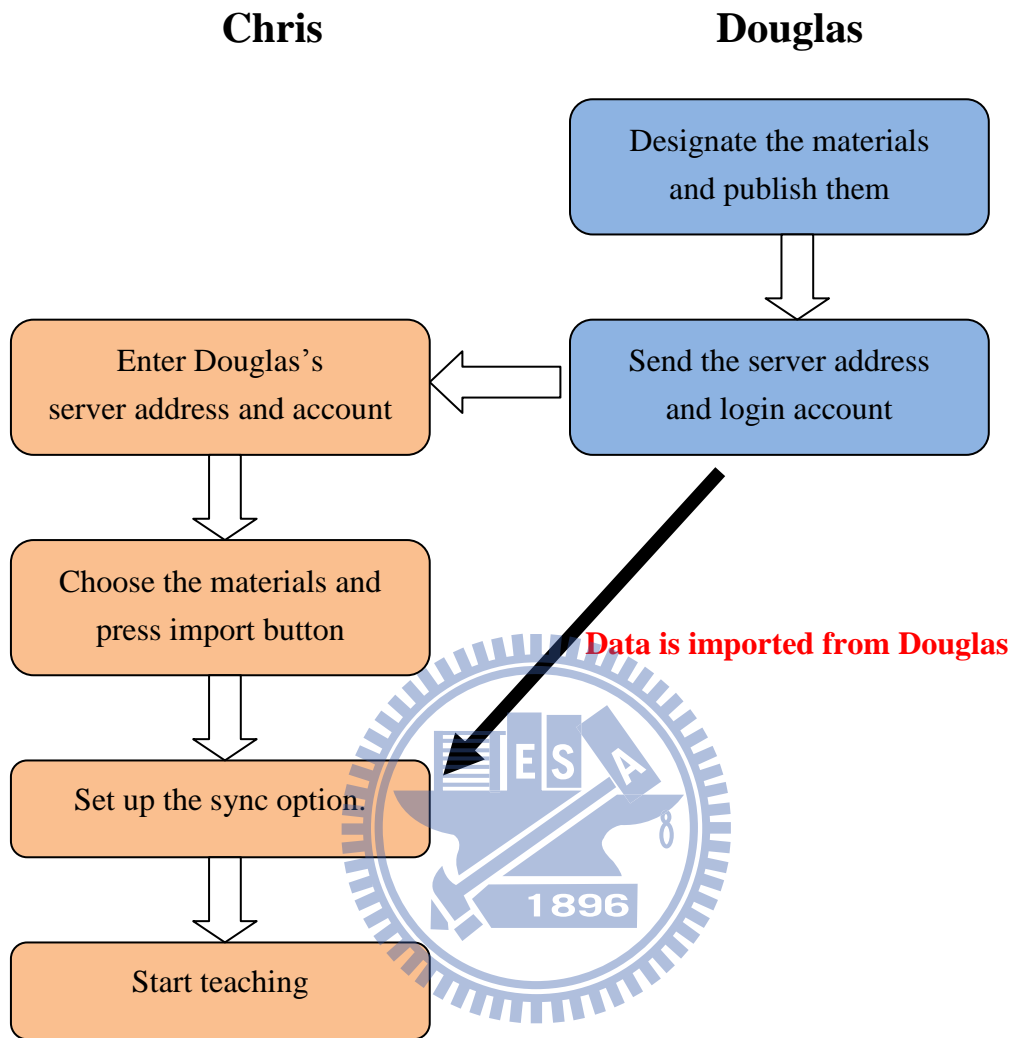
➤ **One-way supply pattern**

Teachers can delegate other external teachers to supply their local course content as well. For instance, an inexperienced teacher, Chris has to teach a unfamiliar course and is looking for help. He encounters an experienced guy Douglas had taught on the same subject for a while. Douglas can assist Chris via the following steps. Figure 4-7 shows the flow of collaborative teaching pattern.

1. Douglas designates the materials and publishes them.
2. Douglas sends his Moodle SERVER address and login info to Chris.
3. Chris enters the login info so he can view the resources published by Douglas.
4. Chris can choose the materials that he want and import them from Douglas's site.
5. Chris can start teaching with Douglas's help.

There are also two scenarios depended on setting up different sync option. If Chris chooses the “*Non*” option, it means that he consider the external content is just a kind of the course template. He can design teaching materials with his style. In the other hand, if he chooses the “*auto-sync*” or “*only-inform*” option, it means that he delegate Douglas to supply course materials entirely.





*Figure 4-7 the flow chart of one-way supply pattern*

# 5 Evaluations and Comparison

## 5.1 Comparison

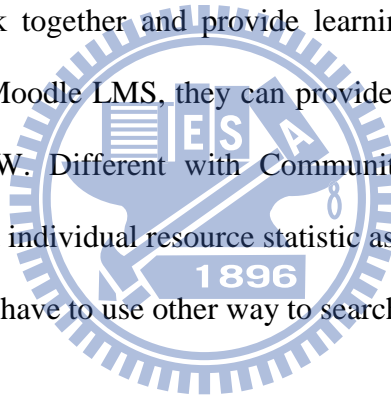
In this section, we compare OpenMoodle and other course content sharing system and results as shown in Table 5-1. Educators can create course template through our OpenMoodle module and Community Hub. But collaborative teaching with other like-minded teachers is only

*Table 5-1 Comparison with OpenCourseWare and Community Hub*

	OpenMoodle	OpenCourseWare (OCW)	Community Hub
<b>Expense</b>	Free / charge	Free	Free / charge
<b>Create course template</b>	Yes	Yes	Yes
<b>Teach collaboratively</b>	Yes	No	No
<b>Update latest content contiguously</b>	Automatic / Manual control	Manual control	No
<b>Provide teaching materials</b>	Yes	Yes	Yes
<b>Provide teaching activities</b>	Yes	No	Yes
<b>Course content source</b>	Any educator	Institute's faculty	Any educator
<b>Keyword Search</b>	No	Yes	Yes
<b>User Feedback</b>	Text comment & resources statistic	No	Text comment
<b>Integrated with each other</b>	Yes	No	Yes

allowed in OpenMoodle. Besides, users can keep following the latest content contiguously depend on different usage scenarios. In OCW, users have to do it manually and they do not provide such facility for users in Community Hub.

In here, we take the MIT OCW as sample. Although MIT is one of top universities, OpenCourseWare's course content is provided unilaterally by MIT's faculty. They have good quality of course content in OCW's courses but lack of diversity. Although there is an OpenCourseWare Consortium consisted of several institutes, users need to filter these sites and find proper content by themselves. And these OCW sites are not easily integrated together because of adopting myriads of content management system. In OpenMoodle, any educator, teacher, or lecturer can work together and provide learning content for students. Because of OpenMoodle integrate with Moodle LMS, they can provide not only teaching materials but also teaching activities than OCW. Different with Community Hub just provide text comment feedback, we provide that and individual resource statistic as well. The drawback of OpenMoodle is keyword-search. Educators have to use other way to search other people.



## 5.2 Experiment and result

An experiment to evaluate the OpenMoodle module has been undertaken among two universities. They are Tunghai University in Taichung, and Tahwa Institute of Technology in Hsinchu. We separately built Moodle server embedded with OpenMoodle module and made use of 15 courses within Department of Computer Science, Tunghai, and 12 courses within Department of Computer Science and Information Engineering, Tahwa. These courses are currently running in this semester. And we create a testing site for assembling purpose in National Chiao Tung University. All the integrated 27 courses were imported into testing site. As time goes on, it will follow faculty's footsteps to update the latest content. The teachers at Tunghai and Tahwa may communicate with each other, measure the quality of external materials, and choose the suitable resources for students.

A questionnaire survey in the view of OpenMoodle to IT personnel has been done. We adopt the System Usability Scale (SUS) [24] developed by John Brooke to evaluate the users' view of system's usability by providing a single reference score. The SUS is composed of five positive statements and five negative statements. Each of them has five-point scale that range from Strongly Disagree to Strongly Agree. We modified the original instrument in SUS and the questionnaire showed in Appendix C. Twelve IT personnel answered this questionnaire. We can get the score for each statement, however, individual scores for each statement is not meaningful and should not be analyzed or used for other purposes. So we only calculate the sum of scores for ten statements. The mean result was 83/100 with the lowest and highest values being 67.5/100 and 90/100 respectively.

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# 6 Conclusion and Future works

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## 6.1 Conclusion

Collaborative teaching is critical pedagogy that is good for both teachers and students. This inspires teachers to discover, share, and experiment with new thought when designing the teaching activities and creating assignments. Besides, it helps students to improve their social and communication abilities, relationship between teacher and students, and increase their learning effect. Although there are numerous learning management systems developed and are wildly adopted by educators, there was very few LMS integrated with collaborative teaching pedagogy. OpenMoodle module is hence proposed in this paper to cope with this critical issue.

OpenMoodle provides a chance to establish an environment for teachers who are not at the same place to make the interactions and teach collaboratively. Experienced teachers can make a short cut for novice teachers by supplying painstaking efforts. Teacher can collaborate with another one to teach in the same course but hold data separately to control the autonomy. They measure the data of course and choose the most appropriate materials for students. Students gets diversity of knowledge, view, and teaching style as well. Course publishers can benefit from user's feedback and usage statistics. Furthermore, the OpenMoodle is implemented based on the CCM. Other LMSs can easily integrated with the OpenMoodle.

Moodle is such a successful open-source LMS and is widely adopted around the world. Our CCM based on web services architecture can provide the unified approach to Moodle's resources and activities. Educators can develop custom-made services and integrate with other heterogeneous systems more easily.

## 6.2 Future work

There are some improvements for OpenMoodle module. Community-hub is a very important feature in Moodle 2.0 plan. It provides a way to make Moodle servers can be connected together. Because of OpenMoodle does no support search functionality; users have to use email or other way of communication to find other people who are willing to share their knowledge. We can improve the search functionality by integrating community-hub with our OpenMoodle module or developing an index server which allows sites to register on it. The course information may be obtained publicly.



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## Appendix A: Essential capabilities for OpenMoodle

Capability	Description
<b>Moodle/category:manage</b>	Manage categories
<b>Moodle/course:create</b>	Create courses
<b>Moodle/course:activityvisibility</b>	Hide/show activities
<b>Moodle/course:manageactivities</b>	Manage activities
<b>Moodle/course:managefiles</b>	Manage files
<b>Moodle/course:view</b>	View courses
<b>Moodle/course:viewhiddenactivities</b>	View hidden activities
<b>Moodle/course:viewhiddencourses</b>	View hidden courses
<b>Moodle/course:viewhiddensections</b>	View hidden sections
<b>Moodle/restore:uploadfile</b>	Upload files to backup areas
<b>webservice/rest:use</b>	Use REST protocol
<b>webservice/soap:use</b>	Use SOAP protocol
<b>webservice/xmlrpc:use</b>	Use XML-RPC protocol
<b>webservice/amf:use</b>	Use AMF protocol
<b>Forum</b>	Related capability for forum activity.
<b>Choice capabilities group</b>	Related capability for choice activity.
<b>Glossary capabilities group</b>	Related capability for glossary activity.
<b>Lesson capabilities group</b>	Related capability for lesson activity.

## Appendix B: Course communication services for Moodle

Component	Function name
<b>Resource</b>	moodle_mod_resource_create_resource
	moodle_mod_resource_get_resources
	moodle_mod_resource_delete_resources
<b>Url</b>	moodle_mod_url_create_urls
	moodle_mod_url_get_urls
	moodle_mod_url_delete_urls
	moodle_mod_url_update_urls
<b>Page</b>	moodle_mod_page_create_pages
	moodle_mod_page_get_pages
	moodle_mod_page_delete_pages
	moodle_mod_page_update_pages
<b>Label</b>	moodle_mod_label_create_labels
	moodle_mod_label_get_labels
	moodle_mod_label_delete_labels
	moodle_mod_label_update_labels
<b>Choice</b>	moodle_mod_choice_create_choices
	moodle_mod_choice_get_choices
	moodle_mod_choice_delete_choices
	moodle_mod_choice_update_choices
<b>Forum</b>	moodle_mod_forum_create_forums
	moodle_mod_forum_get_forums
	moodle_mod_forum_update_forums
	moodle_mod_forum_delete_forums
	moodle_mod_forum_create_discussions
	moodle_mod_forum_get_discussions
	moodle_mod_forum_delete_discussions
	moodle_mod_forum_create_posts
	moodle_mod_forum_get_posts
	moodle_mod_forum_update_posts

Component	Function name
	moodle_mod_forum_delete_posts
	moodle_mod_forum_get_firstpost_from_diss
<b>Lesson</b>	moodle_mod_lesson_create_lessons
	moodle_mod_lesson_get_lessons
	moodle_mod_lesson_update_lessons
	moodle_mod_lesson_delete_lessons
	moodle_mod_lesson_get_pages
	moodle_mod_lesson_delete_pages
<b>Glossary</b>	moodle_mod_glossary_create_glossaries
	moodle_mod_glossary_get_glossaries
	moodle_mod_glossary_update_glossaries
	moodle_mod_glossary_delete_glossaries
	moodle_mod_glossary_create_entries
	moodle_mod_glossary_get_entryids
	moodle_mod_glossary_update_entries
	moodle_mod_glossary_delete_entries
<b>Assignment</b>	moodle_mod_assignment_create_assignments
	moodle_mod_assignment_delete_assignments

## Appendix C: System Usability Scale for OpenMoodle

**Instructions:** For each of the following statements, mark one box that best describes your reactions to the website *todn14series*

	Strongly Disagree				Strongly Agree
1. I think that I would like to use OpenMoodle frequently.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I found OpenMoodle unnecessarily complex.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I thought OpenMoodle was easy to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I think that I would need assistance to be able to use OpenMoodle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I found the various functions in OpenMoodle were well integrated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I thought there was too much inconsistency in OpenMoodle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. I would imagine that most people would learn to use OpenMoodle very quickly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. I found OpenMoodle very cumbersome/awkward to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. I felt very confident using OpenMoodle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. I needed to learn a lot of things before I could get going with OpenMoodle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Please provide any comments about OpenMoodle**

This questionnaire is based on the System Usability Scale (SUS), which was developed by John Brooke while working at Digital Equipment Corporation. © Digital Equipment Corporation, 1986.