



# INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION

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## Proposition for LMS Integration for Share, Exchange, and Spread of Online Lectures under Covid-19 Environment

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**Abstract**—There has been a movement to share and spread online lectures through OCW and MOOC systems. This movement would have been spread widely and adopted widely if those courses could be easily exchangeable with other platforms or services. If this function is available, learning activities, resources, learning outcomes can be accessed between different platforms and services. With this function, the credit exchange between different platforms or services will be easier. It also facilitates course sharing and circulation. Because the LMS is the basic platform for online classes, providing sharable and reusable learning activities, resources, and learning outcomes across the different LMSs is very demanding for online education. Analyzing LMS use in Korean universities, Moodle, Canvas, and domestic LMSs are founded to be the significant three kinds that are widely used in Korea. In this paper, a method of integrating Moodle, Canvas, and domestic LMS services is proposed. A central Moodle server is installed as the main LMS server, and the method to connect or complement with a central Moodle server is proposed for each different kind of LMS. LMS users can easily access a different kind of LMS as a form of imported course, tightly connected service, or log in as SSO. This proposition can be applied to various service fields such as KMOOC, KOCW, credit exchange, lecture exchange between universities, regional unification of online educational centers as a practical problem-solver.

**Keywords**— LMS; LTI; Moodle; network; canvas.

Manuscript received 4 Feb. 2021; revised 18 Apr. 2021; accepted 14 Jul. 2021. Date of publication 31 Dec. 2021. International Journal on Informatics Visualization is licensed under a Creative Commons Attribution-Share Alike 4.0 International License.



### I. INTRODUCTION

With the increase in demand for online lectures since the Covid-19 outbreak, it is necessary to devise a method to improve online lectures' quality. Instead of using their video, instructors can use lecture video content on YouTube or public services. This method can reduce the burden of video content development. But activities and resources other than the video contents are more important. The online course is better be equipped with good quizzes, forums, assignments, files, etc. Reuse of those resources and activities across the online platform is getting more necessary [1], [2], [3].

Globally, open or sharing services of various learning materials, activities, and services such as OCW or MOOC became phenomena. A movement to exchange academic credits through different universities and institutions by educational credit bank appears a big issue. This demand has been persisted but mostly has not had any practical

achievement. To facilitate academic credit exchange, the online course, which is based on each learning platform, must provide the ability to generate various interactive learning activities and to achieve learning goals efficiently [4], [5].

Looking at the LMS currently used in Korea, open-source LMSs such as Moodle and Canvas are widely used, along with domestic LMS, which is developed in Korea. Therefore, there is a need for the strategies to share LMS's learning activities by integrating or connecting services of these three learning platforms; Moodle, Canvas, and domestic LMS [6], [7]. This paper proposes a technical strategy and an implementation guideline for it. This guideline is not limited to Korea because Moodle and Canvas are used worldwide, and each country has its own domestic LMS. For sharing an online course, there can be three different cases. The first case would be the export/import of the online course; the whole course can be exported from one LMS and imported to the other LMS. The second case would be integrating LTI service,

one LMS serving as a service provider and the other LMS serving as service consumer. The third case would be SSO; two different LMS can be logged in using the same account.

## II. MATERIAL AND METHOD

An LMS stands for Learning Management System, which means a solution that creates virtually all learning activities and resources that occur in the real-world classroom, and provides learning and management/operation functions for classroom participants on the Internet. There have been many kinds of research to standardize the LMS systems. It would help review the LMSs and the eLearning standards before proposing methods for LMS course share or service connection.

### A. LMS

Moodle is the oldest LMS currently in use and has a development history of about 18 years, resulting from having extensive educational application functions. Moodle can support various class models and can be used in various ways; elementary, secondary, higher education, companies, and vocational training. Canvas is also an open-source LMS, even though it provides a commercial license. Somehow Canvas's market occupancy is growing in Korea. The others are domestic LMSs, which domestic eLearning companies develop. Moodle and Canvas observe eLearning standards well. It is even possible to import Moodle class to Canvas, as shown in Fig. 1, with a slight version incompatibility problem. Both of them preserve the LTI standard, which will be described in the later section in detail. But the most challenging problem exists for domestic LMS, which doesn't observe eLearning standards well enough to integrate or connect with other LMS, which should be addressed in this paper.

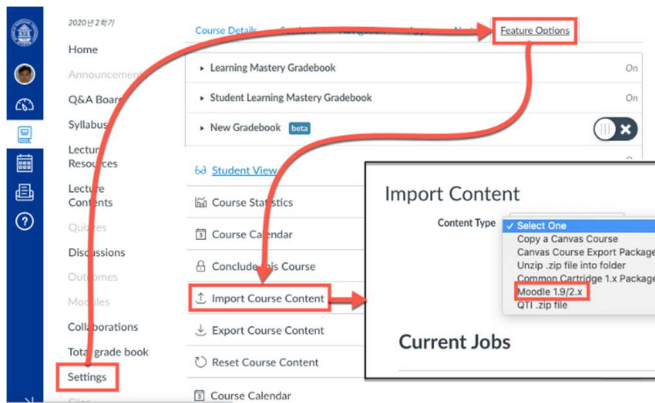


Fig. 1 The method to import Moodle course to Canvas

### B. SCORM, IMS CC, and xAPI

In e-learning, the SCORM attracted attention as a standard for sharing content between different learning platforms. But IMS CC, which can perform import/export functions, including learning activities and the contents, is extensively applicable. The shortcoming of SCORM is its limited applicability only to contents. Even though people can share the contents on different SCORM compliant LMSs, contents are just a part of LMS activities and resources. There are more learning activities like the forum, quiz, assignment, etc. IMS CC had an intention to circulate beyond the contents. In that

sense, IMS CC covers more significant areas than SCORM does. Because of its complexities and limitations, SCORM is not being used actively now in the domestic market [8], [9].

xAPI allows recording learning experience more broadly compared to SCORM. In SCORM, only contents can generate learning data, but in xAPI, any learning activities can generate learning data. These learning data is supposed to be collected by LRS (Learning Record System). xApi and LRS are now playing important roles in learning analysis.

### C. LTI

The most practical eLearning standard is LTI(Learning Tools Interoperability). LTI can integrate different learning services seamlessly. This technology has become widespread, making it possible to access and use services of the different system. Global open-source LMS usually adopts this LTI technology, and by configuring the server setting, different services between different LMSs can be connected. Moodle and Canvas can also utilize the LTI service with each other for integration.

However, domestic LMSs are often unable to support these standards. If this problem is solved, the various functions of Moodle can be utilized by most LMS. In other words, any LMS users can access different LMSs or use learning activities provided by Moodle by accessing them [10].

## III. RESULTS AND DISCUSSION

Based on the previous section's technology, we propose one Moodle LMS as a primary central LMS, with which courses can be shared and circulated. Different methods will be utilized for linking three types of LMS. As a method of linking Moodle and Moodle, if two different Moodle LMSs are registered using Moodle's "Community Hub" function, users of each service can freely use the two services. Furthermore, it is possible to import and use Moodle courses provided by one Moodle server by an instructor from another Moodle server. Canvas can be connected using Moodle and LTI settings. However, for the domestic LMS, a login module must be developed to provide such a service. The current service available can be described as TABLE 1. Moodle has no problem with connecting with Moodle in any case. For Canvas, the Moodle import is supported only for Moodle 2.x version courses. For domestic LMS, nothing is supported.

TABLE I  
INTEGRATION FUNCTIONS FOR MOODLE CENTRAL SERVER (AS-IS)

LMS/Function	Im/Export	LTI	Built-in SSO
<b>Moodle</b>	○	○	○
<b>Canvas</b>	△	○	×
<b>Domestic LMS.</b>	×	×	×

TABLE II  
INTEGRATION FUNCTIONS FOR MOODLE CENTRAL SERVER (TO-BE)

LMS/Function	Im/Export	LTI	Built-in SSO
<b>Moodle</b>	○	○	○
<b>Canvas</b>	△	○	×
<b>Domestic LMS.</b>	×	○	○

We provide SSO function so that the domestic LMS vendors can develop the module and provide a course sharing service. For this case, the users can access the central Moodle server to use the shared course without an additional login process. The implementation of the module is as shown in Fig. 2. The methods for each case are described as follows.

*A. Moodle to Moodle integration*

If an organization uses Moodle as the LMS system, it can be integrated with central Moodle LMS by setting up Moodle network and Moodle Hub Server. They allow the organization's Moodle server to be connected with the central Moodle server. Moodle network, also represented as MNet, can be set up for each server to be connected as SSO (Single Sign-On). MNet needs xmlrpc and OpenSSL module. After setting the MNet login environment, a user can access another Moodle server without a login procedure, which means the client Moodle server user can access the central Moodle server, and the course in the central Moodle server is available directly [11]. The other way to share a course is for Moodle course to be exported and imported between different Moodle servers. The courses can be easily ported to the other server and be created as a new course on its server. Fig. 4 shows the process of backup and restore of Moodle course. When it is backed up, the zipped course data can be restored either by download or restored from its server. Moodle course needs to be backed up to be available as a zipped file on

Moodle server either directly deployable on the server or downloadable for other servers.

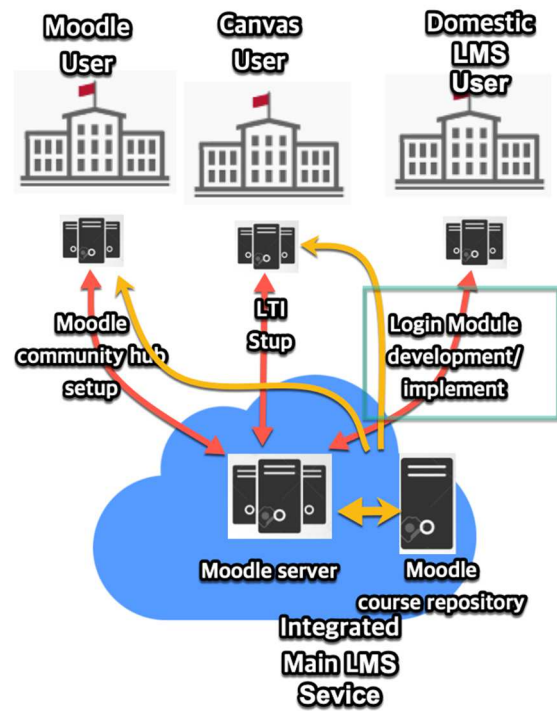


Fig. 2 Course sharing block diagram for each LMS

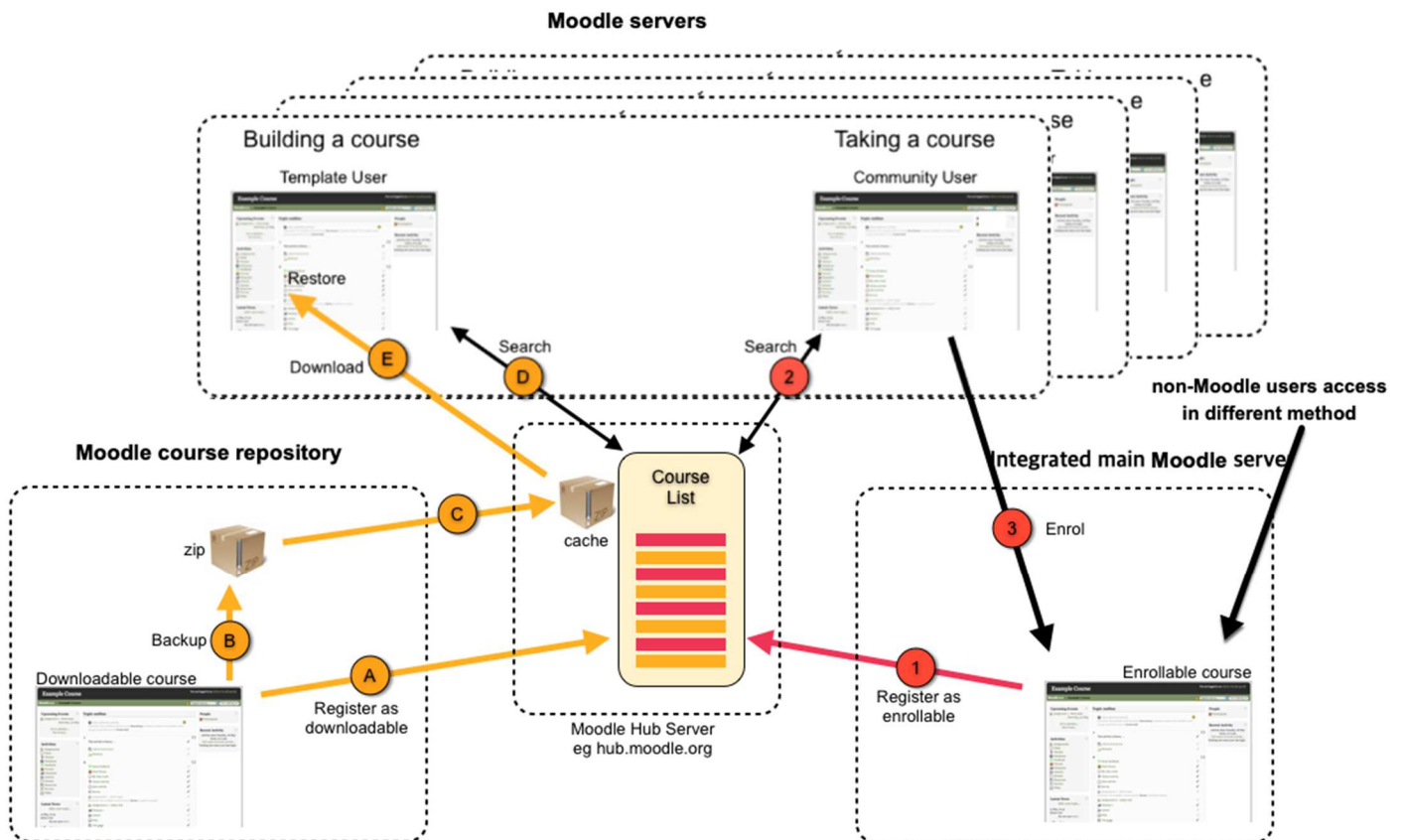


Fig. 3 Moodle Community Hub

Moodle Hub Server is another exciting higher level of course sharing function already available for Moodle servers. As described in Fig. 3, Moodle Community Hub provides the complete process of sharing courses by restoring in the local Moodle server or enrolling and taking on the central Moodle server. Each organization's Moodle server can search for downloadable ① or enrollable courses ②. Once the course is found, it can either be download and restored to be served as a local Moodle server class ③ or enrolled and taken on the central Moodle server ④. Of course, it would have been registered either as a downloadable course ① or an enrollable course ②. It executes an internal process of backup ⑤ or caching ⑥ automatically. The user can access the course either in the local Moodle server or central Moodle server without noticing the exact login process. Moodle already provides the course sharing concept perfectly. The problem is that there are organizations, which are using other than Moodle system.

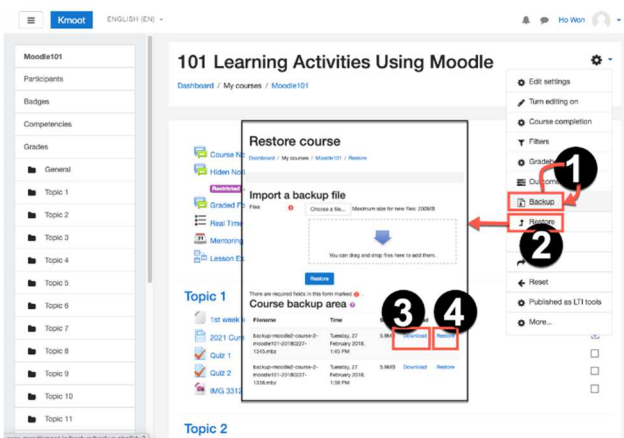


Fig. 4 Backup and restore of Moodle course

### B. Canvas to Moodle integration

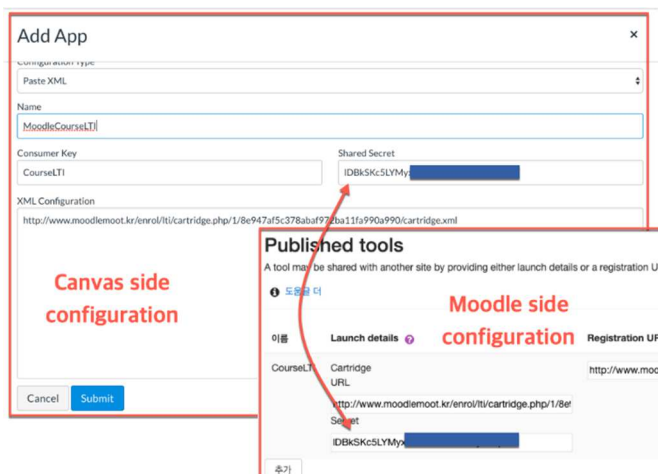


Fig. 5 Canvas LTI configuration with Moodle

Canvas also provides some ways to share Moodle course. As shown in Fig. 1, the problem is that the importable Moodle course format is limited to version 2.x now. Even with the 3.x Moodle course, it was possible to partly import the course activities, which needs investigation more about this

limitation [12], [13], [14]. That is the reason why it is marked as  $\Delta$  in the table.

The LTI function is fully supported, and the Moodle course activities and resources are accessible as a service from Canvas [15], [16], [17]. Fig. 5 shows how the LTI configuration is declared for these two LMSs. After activating the LTI key on Moodle side, the key-value needed to be input at the "Shared Secret" field of external App configuration. In this way, the specific activities and resources or the whole course were able to be accessed.

### C. Domestic LMS to Moodle

In general, Moodle course activities and resources are not accessible from domestic LMSs. So, to use LTI functions, an LTI consumer plugin needs to be integrated into domestic LMSs. We developed an LTI consumer module in OKMindmap. OKMindmap is a service freely available at <http://okmindmap.com>. The service has developed using the Java programming language. It is a mindmap drawing service. Because most of the domestic LMS is developed by Java programming language, we can assume the OKMindmap as one of the LMS software. With OKMindmap's LTI module, any domestic LMS conceptually can be turned into an LTI consumer. Fig. 6 shows how to configure OKMM to access a shared moodle activity using the LTI standard. Reversely, OKMindmap needs to be configured like Fig. 7. Just like the case of Canvas, both sites (OKMindmap and Moodle) share the same "Shared secret".

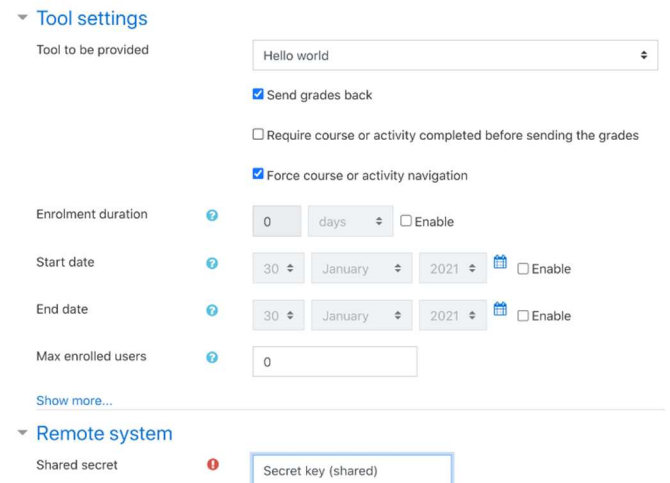


Fig. 6 Moodle LTI configuration for OKMindmap

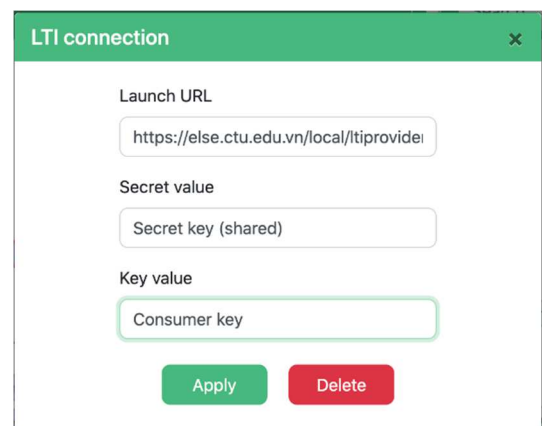


Fig. 7 OKMindmap LTI configuration for Moodle

As presented in the previous section, the MNET includes an authentication plugin that makes SSO between Moodle possible. A user logs in to his own Moodle server and clicks on a link to take him to another Moodle server page without an additional login process.

To make SSO between domestic LMS and Moodle possible, we propose developing an SSO module that connects domestic LMS to Moodle. The module includes an authentication plugin for Moodle (OKMindmap\_auth) and a MoodleService package for domestic LMS. We experimented with this function on OKMindmap and Moodle.

Fig. 8 shows how to log in to Moodle using a user account on OKMindmap. This feature works similarly to Moodle SSO using MNet. Behind the scenes, when a user clicks on the link corresponding to OKMindmap, the Moodle service on OKMindmap first checks whether any user has logged in OKMindmap. If it is not the case, it redirects to the login page of OKMindmap. If there is a logged-in user, the MoodleService of OKMindmap then creates a launch message (e.g., a form POST) and returns to the browser, which automatically submits to Moodle. The OKMindmap\_auth plugin in Moodle site establishes a fully authenticated session for the logged-in user of OKMindmap, as shown in Fig. 8. So, SSO between OKMindmap (or other LMS) and Moodle becomes possible [18], [19].

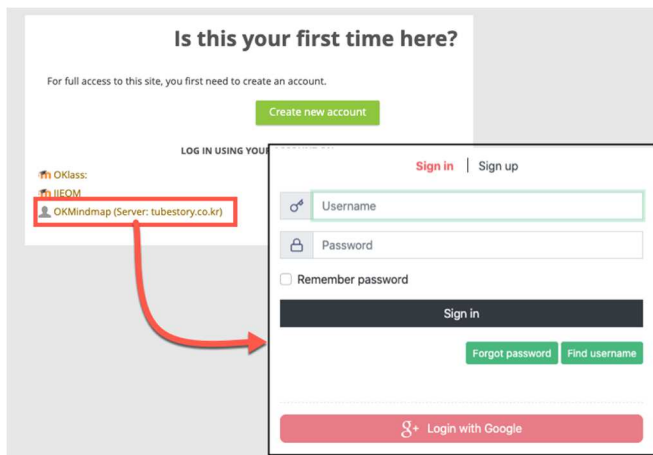


Fig. 8 Log in to Moodle using the OKMindmap account.

In the configuration phase, both of OKMindmap and Moodle share a secret key. For authentication, all parameters of the launch message are signed by the secret key using OAuth 1.

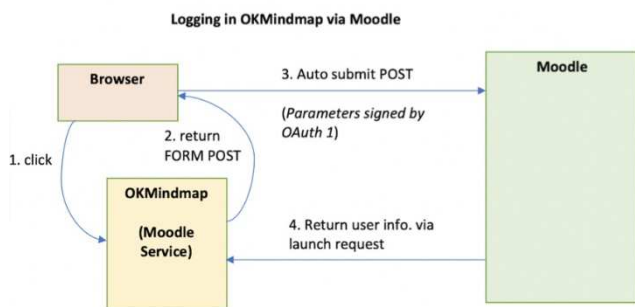


Fig. 9 SSO between OKMindmap and Moodle using OAuth.

We present hereafter another application of SSO between domestic LMS and Moodle to share a Moodle course. In

OKMindmap, we can create a map and link it to a Moodle course. Fig. 8 shows an example of sharing a Moodle course in OKMindmap. Activities and resources of the shared course are linked to OKMindmap nodes (marked by Moodle icon).

A user with the username Bob logs in to OKMindmap using his OKMindmap account as usual. He then opens the linking mindmap and clicks on a linking node that takes him to the linked activity/resource page on the Moodle server. SSO has automatically established a fully authenticated session for Bob on the Moodle site.

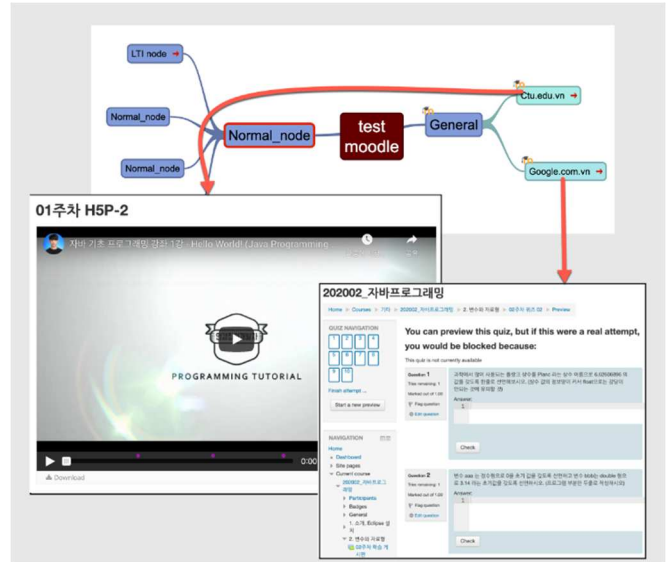


Fig. 10 Sharing Moodle course in OKMindmap

Technically, when a linking map is opened, the MoodleService of OKMindmap creates a launch message including necessary parameters (e.g., course's id), signs it, and sends it to Moodle. The OKMindmap\_auth plugin authenticates, processes, and returns data in JSON format to the MoodleService of OKMindmap. Then, linking nodes with correspondent parameters are created. In this case, there is no SSO, but LTI like launch message is used instead.

Conversely, when a user clicks on a linking node, a launch message is also created and sent to Moodle. Then, SSO is established, and the linked activity/resource page is redirected to the browser. Now, users can access the linked activity/resource without login into Moodle [20].

#### IV. CONCLUSION

In this paper, the method of integration between different LMSs is addressed. If the organization is already using Moodle, it supports a wider range of integrating services than the other two cases. For this Moodle to Moodle case, courses can be exported and imported, and even users can log-in to other Moodle systems freely. For Canvas to Moodle case, LTI can be set up between Moodle courses on the central Moodle server. With this setup, users can access Moodle service from Canvas as web links. The last case is to provide an SSO plugin so that users can log-in to the central Moodle server and access the course directly. With the central Moodle server, various LMS can be integrated with the appropriate method under its own unique circumstances. For Canvas LTI setting configuration, the course export/import is possible 100% for

Moodle 2.x version. The current Moodle version is 3.x, and the course import/export level is not fully supported, but LTI is supported fully. This paper's contribution is to show ways to integrate Moodle to Moodle and Moodle and Canvas and more significantly develop and share the OKMindmap integration architecture design with Moodle to domestic LMS case. This methodology enhances online lecture quality and efficiency by sharing Moodle courses with rich activities, resources, and services. The classes can be duplicated and shared among instructors. With this, instructors can reduce the time and effort required for the course development. Sharing of quality online classes will eventually build up trust between different organizations. Courses can be standardized to meet the learning goals and quality control.

#### REFERENCES

- [1] D. H. Lee *et al.*, "A Design and Development of the Learning Contents Management based on the Personalized Online Learning," *International Journal on Advanced Science, Engineering and Information Technology*, Vol. 8, No. 4, pp.1321-1326, 2018, DOI: 10.18517/ijaseit.8.4.5724.
- [2] M. Yaghmaie and A. Bahreinejad, "A context-aware adaptive learning system using agents," *Expert Systems with Applications*, Vol. 38, Issue 4, pp.3280-3286, 2011, DOI: 10.1016/j.eswa.2010.08.113.
- [3] S. A. Nikou and A. A. Economides, "Mobile - Based micro - Learning and Assessment: Impact on learning performance and motivation of high school students," *Journal of Computer Assisted Learning*, Vol. 34, Issue 3, pp.269-278, June 2018, DOI: 10.1111/jcal.12240.
- [4] S. Rakic *et al.*, "Student Performance on an E-Learning Platform: Mixed Method Approach," *International Journal of Emerging Technologies in Learning*, Vol. 15, No. 2, p187-203, 2020, DOI: 10.3991/ijet.v15i02.11646.
- [5] J. Leem and B. Lim, "The Current Status of E-learning and Strategies to Enhance Educational Competitiveness in Korean Higher Education," *The International Review of Research in Open and Distributed Learning*, Vol. 8, No. 2, 2007, DOI: 10.19173/irrodl.v8i1.380.
- [6] C. B. Mpungose and S. B. Khoza, "Postgraduate Students' Experiences on the Use of Moodle and Canvas Learning Management System," *Technology, Knowledge and Learning*, Sept. 2020, DOI: 10.1007/s10758-020-09475-1, [Online].
- [7] C. D. Medio *et al.*, "MoodleREC: A recommendation system for creating courses using the moodle e-learning platform," *Computers in Human Behavior*, vol. 104, Oct. 2019. DOI: 10.1016/j.chb.2019.106168, [Online].
- [8] A. Ternauciuc *et al.*, "Development of a Moodle Extension for Improving the Management of the Educational Process," *eLearning & Software for Education*, Vol. 4, pp. 363-371, 2019, DOI: 10.12753/2066-026X-18-265.
- [9] P. Sintija *et al.*, "Definition and Validation of the Subset of SCORM Requirements for the Enhanced Reusability of Learning Content in Learning Management Systems," *Applied Computer Systems*, Vol. 25, Issue 2, pp.134-144, 2020, DOI: 10.2478/acss-2020-0015.
- [10] C. Severance *et al.*, "The coming functionality mash-up in Personal Learning Environments," *Interactive Learning Environments*, Vol. 16, No. 1, pp. 47-62, 2008, DOI: 10.1080/10494820701772694
- [11] T. Y. Aikina and L. M. Bolsunovskaya, "Moodle-Based Learning: Motivating and Demotivating Factors," *International Journal of Emerging Technologies in Learning*, Vol. 15 Issue 2, p239-248, 2020, DOI: 10.3991/ijet.v15i02.11297.
- [12] D. S. Judge *et al.*, "Bethany Murray, Student and Faculty Transition to a New Online Learning Management System," *Teaching and Learning in Nursing*, Vol. 12, Issue 4, pp. 277-280, 2017, DOI: 10.1016/j.teln.2017.06.010.
- [13] R. Marachi and L. Quill, "The case of Canvas: Longitudinal datafication through learning management systems," *Teaching in Higher Education*, Vol. 25, No. 4, pp. 418-434, 2020, DOI: 10.1080/13562517.2020.1739641.
- [14] A. H. Duin and J. Tham, "The Current State of Analytics: Implications for Learning Management System (LMS) Use in Writing Pedagogy," *Computers and Composition*, Vol. 55, 2020, , DOI: 10.1016/j.compcom.2020.102544, [Online].
- [15] S. J. Baldwin and Y. H. Ching, "Online Course Design A Review of the Canvas Course Evaluation Checklist," *International Review of Research in Open and Distributed Learning*, Vol. 20, No. 3, pp. 268-282 July 2019, DOI: 10.19173/irrodl.v20i3.4283.
- [16] N. Fathema and M. H. Akanda, "Effects of instructors' academic disciplines and prior experience with learning management systems: A study about the use of Canvas," *Australasian Journal of Educational Technology*, Vol. 36, No. 4, pp. 113-125, 2020, DOI: 10.14742/ajet.5660.
- [17] D. H. Lee *et al.*, "Learning Window Design and Implementation based on Moodle-based Interactive Learning Activities," *Indian Journal of Public Health Research & Development*, Vol. 9, No. 8, pp.626-632, Aug. 2018, DOI: 10.5958/0976-5506.2018.00803.3.
- [18] B. L. Diem *et al.*, "Towards a new open educational resource model using OKMindmap," *Can Tho University Journal of Science*, Vol. 11, No. 1, pp. 42-48, 2019, DOI: 10.22144/ctu.jen.2019.006.
- [19] W. Ho *et al.*, "Development of Convergent IOT Managing Mindmap System," *Journal of the Korea Convergence Society*, Vol. 10, No. 1, pp. 45-51, Jan. 2019, DOI: JKCS.2019.10.1.045.
- [20] J. F. Herrera-Cubides *et al.*, "Towards the Construction of a User Unique Authentication Mechanism on LMS Platforms through Model-Driven Engineering (MDE)," *Scientific Programming*, Vol. 2019, 2019, DOI: 10.1155/2019/9313571, [Online].