Integration Model of Academic Information Systems and Learning Management Systems with REST Web Services Using External Databases

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Abstract

ICT products like Academic Information Systems (AIS) and LMS are commonly utilized in Indonesian universities. These two ICT tools will be of tremendous use to higher education institutions in managing their academic business procedures. The two systems are still not connected in many higher institutions, nevertheless, for example when it comes to handling academic data. If the management and integration process is carried out conventionally, it will be challenging and inefficient due to the massive volume of data and complexity of these two systems. Observing these issues, the researcher plans to study the two REST-based Web Service systems' connection and make use of the External Database functionality, which will be utilized to synchronize data in real-time from AIS to E-Learning. It is hoped that the integration model resulting from research can be a solution for integration between AIS and LMS and can be implemented in many higher education institutions.

Keywords: AIS, External-database, Integrations, LMS, Web-Services

1. Introduction

The current paradigm calls for students to be active learners and to be provided with the necessary resources to be applied in Indonesia's educational system, particularly in higher education given the availability of information and communication technologies (ICT). ICT is crucial in creating a variety of teaching and learning materials that are easier for students to understand, have highly interactive components, and are much more engaging to follow [1]. E-learning is one of the ICT tools that is frequently utilized in universities.

E-learning is not well-known or utilized in Indonesia, particularly in rural regions. Vice President Ma'ruf Amin went so far as to clarify that just over 20 of Indonesia's 4,741 postsecondary institutions had adopted electronic learning, or e-learning [2]. E-learning saw a spike in use until after the Covid-19 pandemic, when the government advised doing activities for teaching and studying at home.

Moodle is one of the extensively used E-Learning solutions, sometimes known as the Learning Management System (LMS). not just in Indonesia but globally as well. As seen in the graphic below, there are approximately 250,000,000 registered users and approximately 251 nations that are already using Moodle. When it comes to continuing the necessary teaching and learning activities, even during the Covid-19 pandemic, the use of the Moodle for LMS is a very beneficial answer. circumstances in which everyone must maintain social isolation [3]. A solution for distance learning is Moodle, since it has all the features needed for instructional and learning activities. The Moodle software itself can be used on a wide range of hardware, including mobile phones, with varying screen resolutions, platforms, and operating systems. Thus, proper fulfilment of activities for teaching and studying can be achieved through fair access to teaching resources [1].

Sites	Courses	Users	Enrolments
199,000	33,000,000	250,000,000	1,387,000,000
Forum posts	Resources	Quiz questions	Countries
568,000,000	265,000,000	3,523,000,000	251

Figure 1. The Statistics of Moodle LMS Usage [4]

An additional ICT product that is frequently utilized in universities is the Academic Information System (SIA) as it is more commonly called. A tertiary institution's use of SIA, a data management system, is essential for processing data related to student grades, courses, lecturers, faculty/department administration, and other topics [5]. It is crucial for higher education institutions to adopt SIA since failing to do so would result in the following outcomes:

1. Wasteful of human resources
2. Difficult to divide schedules and classes
3. Difficult to control
4. Difficult to handle data for staff, students, and lecturers
5. Will require a lot of paper papers, etc.

The two ICT products—E-Learning and SIA—will be of tremendous assistance to higher education institutions in managing their academic business operations. Of course, if the two work effectively together, particularly in terms of handling current academic data. The two systems are still not integrated at many higher education institutions, though, for example in the administration of academic data. Particularly

since these two systems undoubtedly include a large amount of data and complexity, which will make traditional methods of management and integration challenging and ineffective.

The researcher plans to carry out an integration design between the SIA and the E-Learning system after realizing this issue. Real-time data synchronization from SIA to E-Learning will be facilitated by the External Database functionality, which will be leveraged in the Web Service REST-based interface of the two systems.

2. Literature review

2.1. Research Review

Numerous scholars have studied the integration of LMS and SIA. The primary source of information for researchers undertaking study is a review of prior studies, which is provided below:

There were various issues with the initial prior study. The first issue is that the program needs to be updated each time there is a modification to the SIA data format pertaining to lectures or an upgrade to the LMS system itself because it needs to adapt to the new structure once more. The second issue is that human work is required at both the SIA and the LMS when there is a change in data in the middle of the semester, such as when a user modifies their passwords, lecturers, or student Study Plan Cards. This forces lecturers to manually backup their content on the LMS before the current semester ends so that it can be used again in the following semester, in addition to other issues with the disappearance of all teaching and learning activity data when the LMS will be used again in the following semester. To synchronize and transfer data in real time from the Academic Information System and/or to the LMS, researchers utilize the External Database capability [6].

The application of the LMS (Moodle) and Academic Information System for the issue of managing current data is still not integrated in the second prior study. In Moodle, data entry is still done by hand rather than automatically scheduled. These two systems contain vast and complex amounts of data, which will undoubtedly make management and integration challenging and ineffective. By using a data integration paradigm between the Academic Information System and the Moodle-based e-learning system, researchers can solve these issues. Because it can integrate systems and databases, the web service REST (Representational State Transfer) method is the most suitable approach used by researchers [7].

Several issues were present in the third earlier research, including the professors' practice of creating courses each semester, manually enrolling and disengaging students, and registering new students for online courses. Because course data for e-learning can be derived from already-existing course data in the Academic Information System, as well as student and lecturer data from already-existing SSO data, the presence of these issues would undoubtedly result in extremely inefficient data management. In order to solve the issue, researchers include Moodle features or

web service modules that can be utilized as instruments for data integration with other systems already in place [8].

It was clarified in the fourth previous research that the LMS's use will be inextricably linked to the SIA. The two applications had not been integrated when they were implemented in the teaching and learning environment, which made it difficult for users—in this case, students—to take advantage of both systems at the research site where the researcher conducted his study. Researchers developed SIA plus E-Learning applications and other applications as a solution to the current issues. PHP is a programming language used in the design and development of additional applications, also known as bridge apps [9].

It was discovered in the fifth earlier survey that many higher education institutions still do not have Academic Information Systems and e-learning integrated. The procedure demonstrates that when new student information is uploaded into the Academic Information System, it is not immediately registered in the e-learning system. This leads to additional issues and renders administrative tasks like manually entering data into the e-learning system ineffective. It may increase the likelihood of data redundancy, data entry errors, and other issues. In the research that was done, researchers employed the data level integration method. The goal of this data level integration is to share the same data among multiple apps by focusing on data transfer between applications. A new database structure that unifies the two applications is created by merging the databases of the two current systems [5].

The researcher will perform research that is broadly like the research conducted by Ajib Hanani in 2020 [7] and the research conducted by Muhammad Bunyamin and Ahmad Syazili in 2019 [6] based on literature reviews from prior studies with similar themes. Researchers will design the integration between the SIA and the e-learning system. Real-time data synchronization from SIA to E-Learning will be facilitated by the External Database functionality, which will be leveraged in the Web Service REST-based interface of the two systems. Researchers will, however, create a more comprehensive integration of the two systems, for example, integrating Moodle value data that may be entered into the SIA value data.

2.2. Basic theory

2.2.1. Web Services REST

According to Gottschalk and Eric Kurniawan, Web Services are interfaces that specify groups that are reachable across a network by utilizing a common XML message format. Web services carry out duties. A common XML notation type called services description is used to define web services [12]. A web server designed particularly to meet the requirements of other websites or apps is called a web service. Application Programming Interfaces (APIs) are used by client programmers to talk to Web services. An API, in general, exposes a collection of functions and data to allow computer programmers to communicate with one another and share information. The Web API is the face of the Web Service; it directly receives and processes requests

from clients, as seen in Figure 2.4. The technical description of the operation of the World Wide Web* is called Representational State Transfer, or REST. REST explains how the Web became so popular. If there is a "operating system" for the Web, it is the REST architectural style. Modern online services usually use APIs that are designed using the REST architectural approach. REST API is a Web API that complies with the REST architectural style [10].
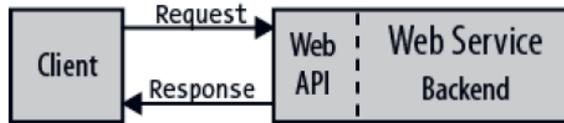
Figure 2. Web API [10]

Any Web Service that has a REST API is considered "RESTful." The REST API is made up of a collection of connected resources. REST API model resources are the collections of resources that go by this name. The use of web services by client developers can be encouraged by a well-designed REST API. In the current competitive industry, where Web Service rivals vie for users' attention, visually appealing REST API designs are an essential component [10].

Resource	Method			
	Get	Post	Put	Delete
/api/student	Get a list of all students	Create a new list of students	Update a list of students	Delete all student
/api/student/1	Get a student by student's ID	Treat as a collection. Create a new student in it.	If student exists, update the student. If student does not exist. Create a new student.	Delete the student.

Table 1. Example of REST API [11]

The utilization of REST Architecture has the following five benefits. [12]:
1. Light RESTful for Web Services
2. RESTful simplicity
3. RESTful architecture is closer in design to the Web
4. Scalability
5. Expose API as HTTP Service

2.2.2.   Moodle External Databases

The Moodle LMS has a functionality called External Database that is helpful for syncing user and enrolment data with databases hosted outside of Moodle. This capability allowed Moodle to read information from other databases that it had mapped [6]. The graphic below shows an example of how to register teaching participants at a university utilizing an external database in Moodle.

External database Moodle account first run
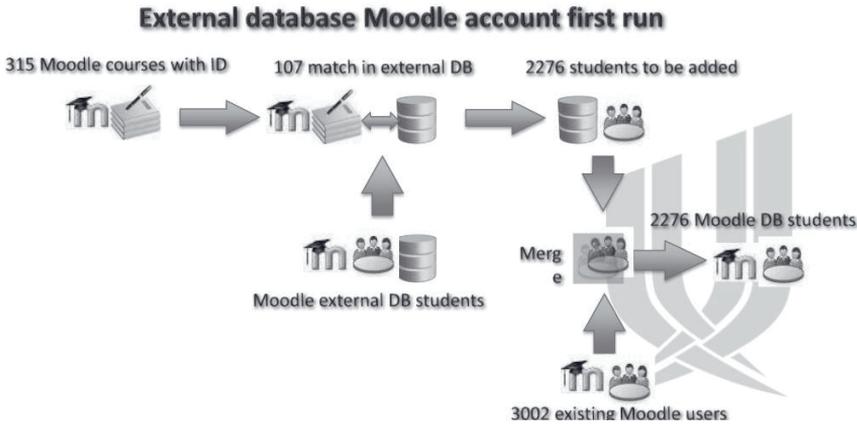
Figure 3. External Database Moodle account first run [13]

External database courses enrolment
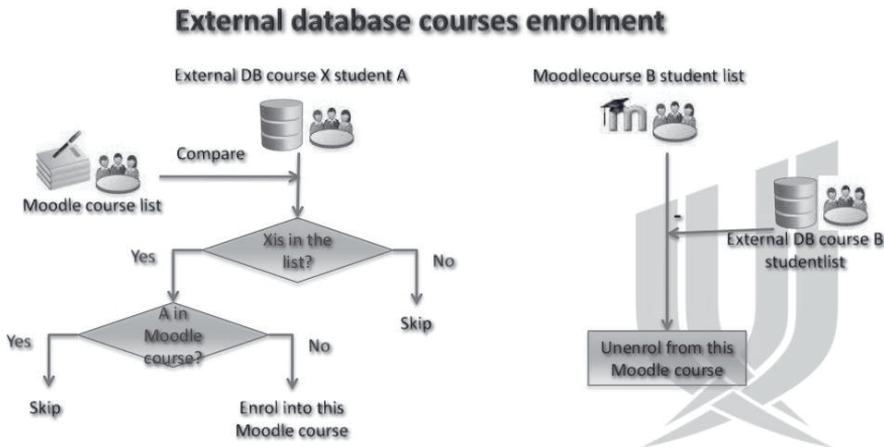
Figure 4. External database course enrolment [13]

3.   Research Methods

3.1.   Web service REST method

In several studies, researchers integrated AIS with Moodle LMS utilizing the Web Service REST technique. Web service servers and web service clients make up REST

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web services [7]. An architectural methodology for creating network applications is called REST. The concept is that simple HTTP can be used to carry out machine-to-machine communication in place of more complicated techniques like CORBA, RPC, or SOAP. RESTful apps retrieve data (by making queries, for example), write data (by creating and/or updating data), and remove data via HTTP requests. Consequently, REST use HTTP for each of the four CRUD (Create, Read, Update, and Delete) actions [12].
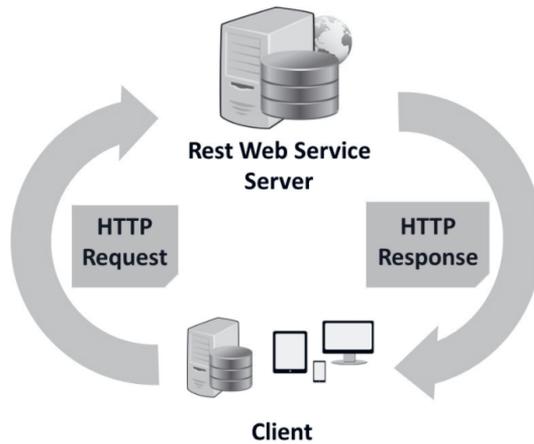
Figure 5. Architecture of REST [12]

REST is an architecture for software applications that is based on how data is accessed, changed, and represented online. It is a distributed hypermedia system architectural style. Data and functionality are viewed as resources in the REST architecture, and they can be accessed using a Uniform Resource Identifier (URI), which is typically a web link [14].
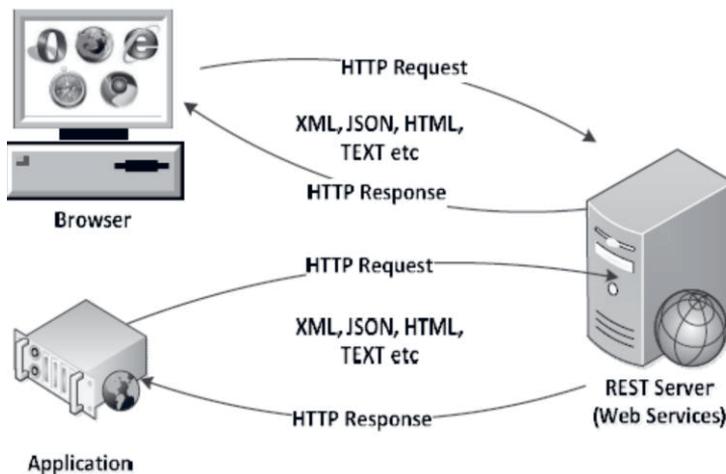
Figure 6. Architecture of RESTful Web Service [14]

3.2.   Research Stages
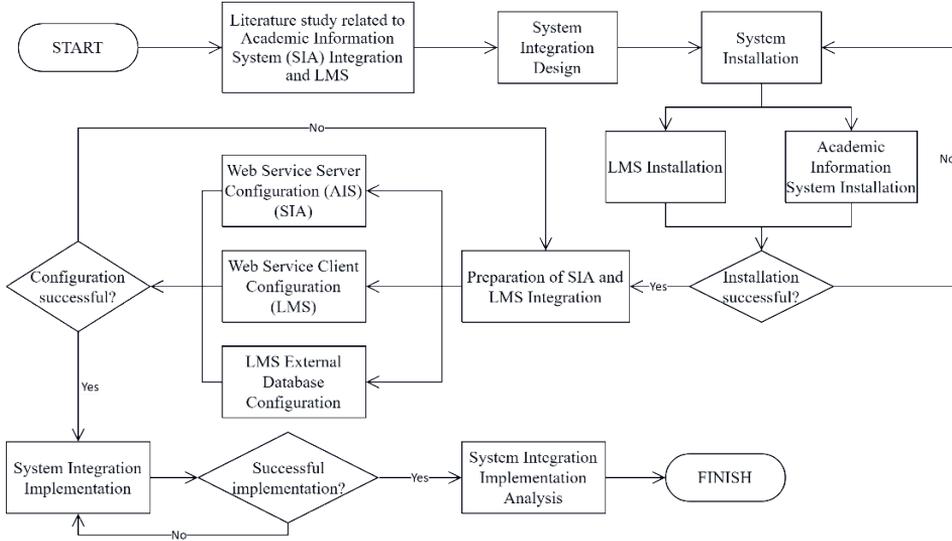
Figure 7. Research Stages Flowchart

4.   Results And Discussion

4.1.   System Integration Design

4.1.1.   Design of Web Services Architecture
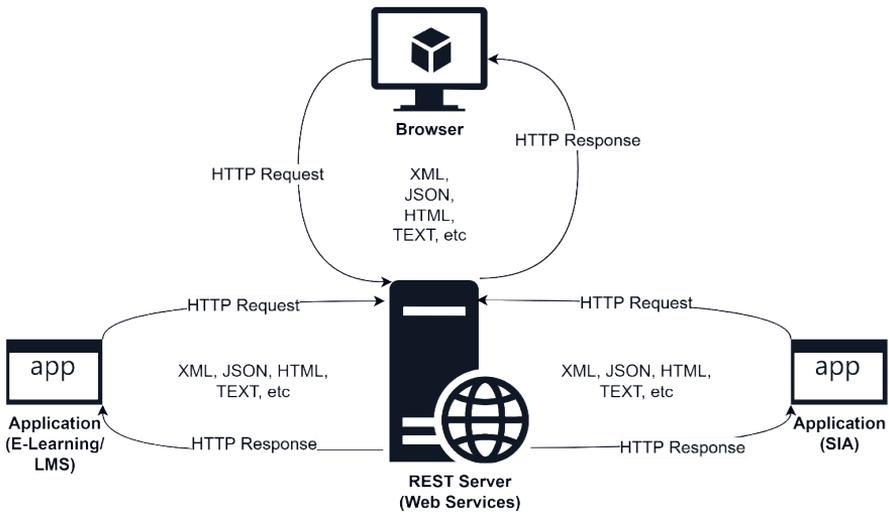
Figure 8. Design of Web Services Architecture

The Architecture of Web Services in Figure 8 is an example of the key architectural designs that will be used in integration. The Web services that are utilized include REST, which use plain HTTP for data publishing, reading, and deletion when facilitating communication between devices or applications.

4.1.2. External Database Architecture Design for System Integration.

An early version of the External Database Architecture, which would serve as a tool for the LMS and SIA systems' integration, is shown below. There are two applications, the SIA application and the LMS application, as shown in Figure 9 below. By an external database built on REST Web Services, the two applications can communicate.
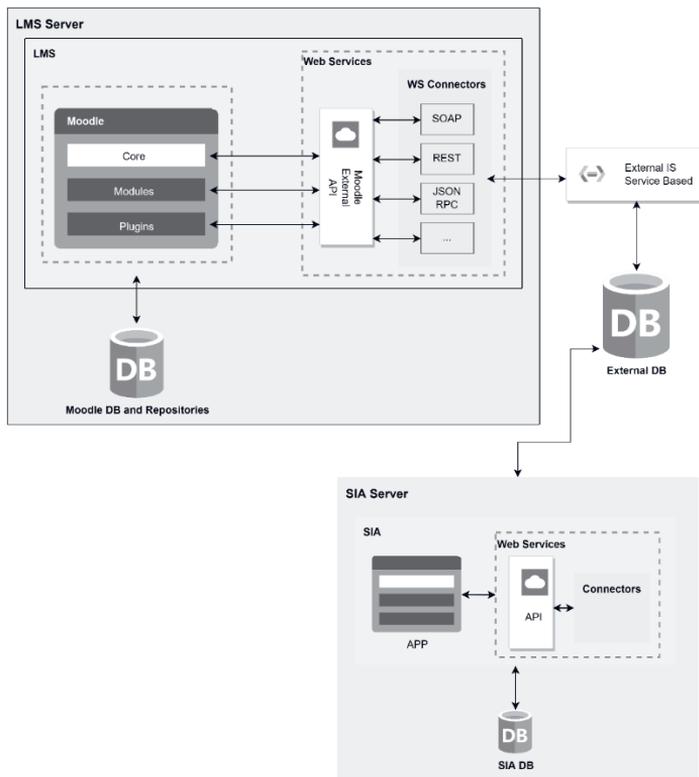
Figure 9. External Database Architecture Design for System Integration.

The following are a few ways that the External Database is used in system integration:
1. Link current LMS users with the SIA and LMS apps.
   There won't be any duplicate users with the same identity thanks to this integration; if there are, a merger procedure will be initiated. There will always be a procedure to verify if a new user is registering or entering the system for the first time, using the technique depicted in Figure 10 below.
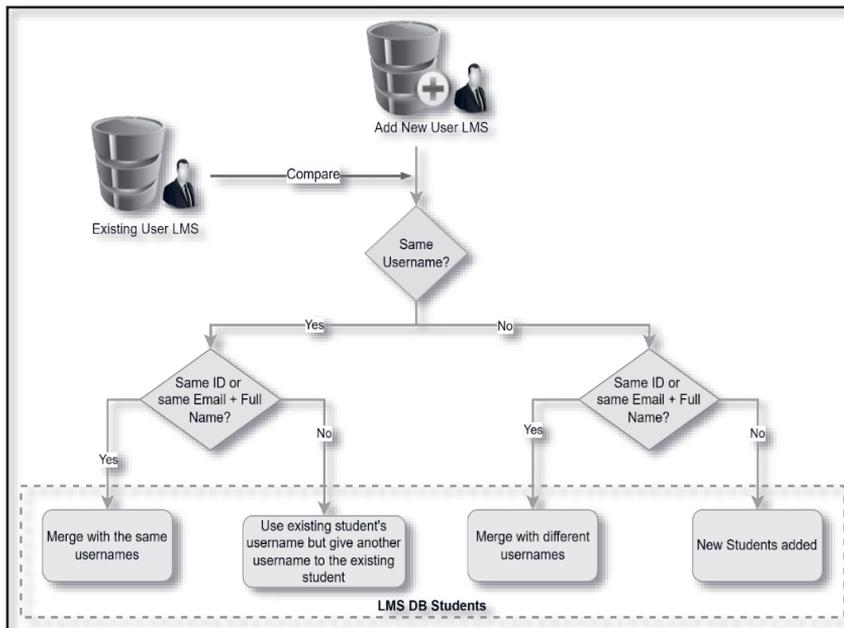
Figure 10. Integration of existing LMS users in the SIA and LMS applications

2. Controlling Enrolments and Un-enrolments
    When the student user logs into the LMS, the External database enrolling event will take place. According to the information in the external database, the LMS plugin will attempt to automatically register student users in all courses and classes. It may also create empty courses and classes in which the user student is not enrolled. If the student user's data is no longer in the database, this step will also terminate their registration. However, this plugin for an external database can only unenroll student users who have already registered with it. Figure 10 below illustrates the enrolment and unenrollment control system.

5. Conclusions And Recommendations

5.1. Conclusion

From the research that has been carried out, some research conclusions are obtained as follows:

1. The Academic Information System and LMS have an integration design that can serve as a prototype for system integration and a point of reference for its implementation.
2. The fact that the Academic Information System and LMS are integrated via REST Web-Service and the External Database functionality allows for real-time data synchronization between the two systems.
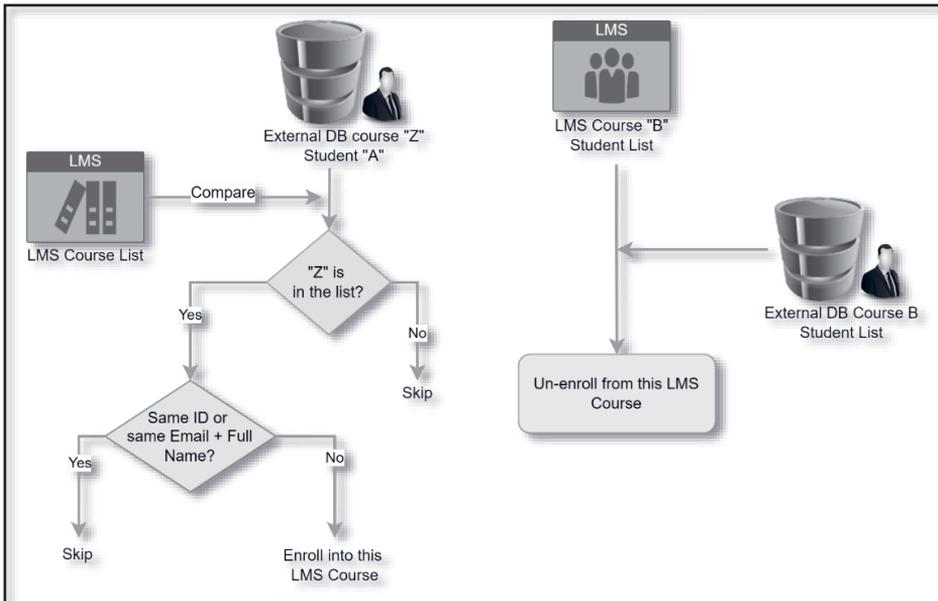
Figure 11. Controlling Enrolments and Un-enrolments

5.2. Suggestion

To obtain the best possible outcomes from this preliminary research, integration between the LMS and AIS platforms must be implemented. It will be possible to test whether real-time, delay-free data synchronization between the LMS system and AIS is possible after system integration is achieved. It will also be possible to identify potential obstacles to this process.

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