IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# A NOVEL LEARNING MANAGEMENT SYSTEM BASED ON MICROSERVICE ARCHITECTURE USING MOODLE

**[1]Rishabh Rai, [2]Surendra Gupta**

[1]Department of Computer Engineering,

[1] Shri Govindram Seksaria Institute Of Technology And Science Indore India

*Abstract:* **Most people's daily lives are growing increasingly dependent on information and communication technology. In today's world, most institutions use Modular Object-Oriented Dynamic Learning Environment (Moodle) as their online education platform's Learning Management System (LMS). Moodle is an information system for educational institutions that organises and analyses data. Institutions find it difficult to maintain or retain such vast amounts of data on their own. For this reason, most institutions begin storing information on users, courses, assignments, grades, quizzes, attendance, projects, and other topics in the moodle database.**

**Therefore, here designed and built a microservice architecture-based platform for department data collection, processing, and report production in this study. The microservice makes advantage of the moodle course management system to eliminate static data and provide the Department Information System the flexibility it needs. There has been sufficient research on the breakdown of microservices in terms of functional granularity and important quality measures. Apart from the research and design of the microservice, the whole development and testing of the microservice for the Department Information System was completed during this phase of work. The suggested work follows MVC and is based on microservice architecture. Angular framework for front-end, MySQL for database, and spring boot framework for back-end are the required tools and technologies. Finally, using a microservices architectural pattern, this project shows and assessed the technological enhancement of traditional e-learning prototype of the department information system e-learning platform.**

*Index Terms* - ***Department Information System, e-learning, Microservice, Moodle, ICT, Learning Management System, Database Design*.**

## I. INTRODUCTION

It is now unfeasible to consider the teaching and learning process without including information and communication technology (ICT). ICT is significant in education, with a particular focus on the instructional component, which is assisted by Learning Management Systems like Moodle [1].

Most institutions are transitioning to online Course Management Systems in the current environment. A Course Management System is a collection of software resources that enable institutions to create and manage courses, submit and receive assignments, post grades, track user progress, and administer exams online. There are a variety of cloud-based course management systems available today, including Google Classroom, Moodle, Schoology, Blackboard, Canvas, and others. Moodle is the most widely utilised platform for many institutions among all of these course management systems. Moodle is preferred by universities because of its constant innovation, great flexibility, and adaptability. Moodle may be used as an information system for organising and analysing university academic data. Moodle is a great free platform that aids in global education [2] [3].

Moodle is a free open source, scalable, and educational learning platform utilised by academic institutions and supported by a global community of over a million users from a wide range of organizations [4]. Moodle provides a full set of learning features with a collaborative environment to enhance teaching and learning for teachers, students, training managers, HR professionals, and other users. It has the ability to expand courses, enrol students, give tasks, provide quizzes, and grade hundreds of virtual institution students at once [5] [6].

Several examples of microservice architecture in e-education were examined. Some approaches look at migrating bespoke Learning Management Systems to a microservice architecture [7]. Others are considering improving existing e-learning platform's microservice architecture in order to create their own educational platform for remote access utilising microservices [8].

## II. OBJECTIVES OF THE STUDY

The following goals have been set to achieve the goal of establishing moodle management system:

a) To link moodle database with the DIS application's microservices.
b) To retrieve all grades, assignment, attendance, and quiz tables from the moodle database, accordingly.
c) For each sub-module, replace static data from the DIS application with dynamic data retrieved from the moodle database.

d) Designing the microservice layer based on relative and normal grading mechanisms, compute course work and sessional work marks for a specific course.
e) In CMS/DIS, to manage the activities of the teachers and students.
f) Designing the microservice layer to generate reports for grades, assignments, projects, assessments, quizzes, and attendance, among other things.
g) To develop an API-Gateway for the user to access the microservice architecture using DIS.

## III. REVIEW OF LITERATURE

This section gives an overview of recent initiatives and research contributions in online education using a variety of tools and methods, such as moodle. The following is a list of some of the work done in this field.

**Ana Milovanovi et al. [9]** suggested an idea with the goal of presenting a potential solution for a custom microservice architecture based on interaction with an existing LMS. Domain Driven Design was the method used to identify microservices. The Cloud Data Platform's integration into this architecture is also being studied.

A research of microservice-based learning management systems is undertaken by **Pia Niemel et al. [10],** concentrating on two systems in which the authors are involved: WETO and Plussa. The authors describe present state of these systems using microservice architecture and propose a synthesis of an ideal, decoupled learning management system.

The design and implementation of a Microservice Architecture for supporting current eLearning applications is examined by **Samuel Kapembe et al. [11].** With the development of mobile devices, it makes sense to investigate various methods for utilising their processing power for various purposes. Authors suggest that because these gadgets are so common, employing them to offer instructional information to students will make their lives simpler.

**M. Beránek et al. [12]** discuss the Parrot LMS platform's design concepts and the primary functions it provides. Reduced expenses and better productivity are among the advantages of cloud-based LMS systems, which offer complex course building options, online course delivery, and course access at any time and from any location. The authors opted to construct their own LMS platform after evaluating a variety of commercially available LMS platforms and their interoperability with university information systems.

The technological upgrade of an existing prototype of STIMEY e-learning platform based on a microservices architecture pattern is demonstrated and evaluated by **David Alessandro Bauer et al. [13].** The first way is to use page fragments technology, which allows for the integration of material from other microservices in a superordinate context but causes maintenance issues. The second solution groups all page fragments into a single microservice, with domain-specific microservices providing the specific data, making it easier to deal with them in the STIMEY platform because domain-specific designers may now be assigned to only one microservice.

**Mohamed El Kholy et al. [14]** describe a method for managing database splitting between Micorservices. While improving the answer to latency concerns, the suggested method retains data integrity and independent Microservice deployment. The results of the evaluation suggest that employing the proposed framework improves performance.

By developing a formal microservice extraction strategy to allow algorithmic selection of microservice candidates in a refactoring and migration scenario, **Genc Mazlami et al. [15]** address the difficulty of extracting microservices from existing monolithic code bases. A web-based prototype is used to implement the formal model. A performance review reveals that the proposed strategy delivers appropriate results.

The goal of the present friendly collaboration of the data science team, according to **Kehua Miao et al. [16]**, is to construct a data science and big data analysis application platform based on microservices architecture for education or nonprofessional research. The platform has a personal code experiment environment that integrates JupyterHub based on Spark and HDFS for multiuser use and a visualised modelling tool that follows the modular design of data science engineering based on Greenplum in-database analysis in a microservices-based environment.

## IV. PROPOSED SYSTEM

This section provides the detailed discussion about the proposed approach for solution of department management system respective addition of learning management system. Therefore the understanding of the problem domain and the detailed methodology of system design is presented.

### 4.1 Problem Identification

The problem is to design and develop microservices that are comprised of four sub-services such as grades, assignments, quizzes, and attendance for the Department Information System.

A course management system stores and manages all institution academics data on cloud-based storage. The four sub-services require a course management system as a resource for gathering and processing university academics data for the DIS application. The main aim of the project is to build microservices that integrate with Moodle database for gathering and processing academics data of institutions in the Department Information System. The microservices can act as a moodle course management system for the DIS application. The project can be used to replace static data management of grades, quizzes, assignments, projects, midterms and attendance from the DIS application with dynamic data management of academics obtained from moodle database. The project also improves the DIS application in terms of usability, flexibility, efficiency, and maintainability.

### 4.2 System Design

Though the design of DIS is based on a modular approach where each module follows the same design. Basic flow diagrams of DIS are given and next, Flow diagrams of Moodle Management has been shown.

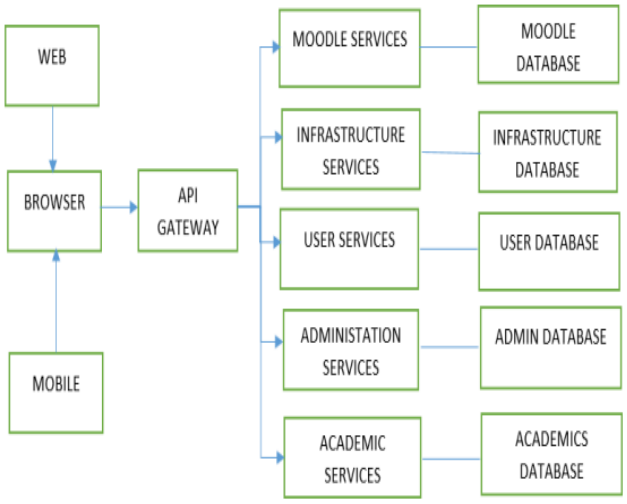


**Figure 1: Block Diagram of Microservice Architecture**

This is the block diagram of micro services that has been implemented. It is basically showing the flow of the process user can interact through web or mobile with help of browser. API gateway authenticates the user and then have access to the microservices and each microservice has its own database. API gateway act as routing and it is an entry point and helps to navigate towards different micro services.

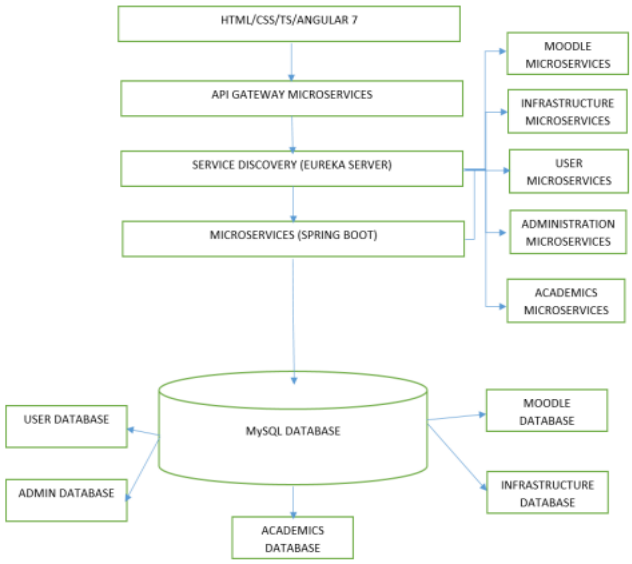


**Figure 2: Flow of DIS**

This figure shows the flow between frontend and backend of DIS. This frontend is designed using angular. The gateway API is the one which authenticate user and act as link between frontend and backend. Now to help this microservices to interact with each other and have used service discovery on which all the services are registered and each microservice is independently registered. ZUUL routing is used in gateway which navigates us to different microservices. These microservices are designed using spring boot which provides better modularity and rigidity to the system. This interacts with the database which has unique database for each microservices but still it is a centralized database as it is present in the same place

The flow of Moodle from front-end to Back-end via messaging service, while communicating with the database is shown in fig 3

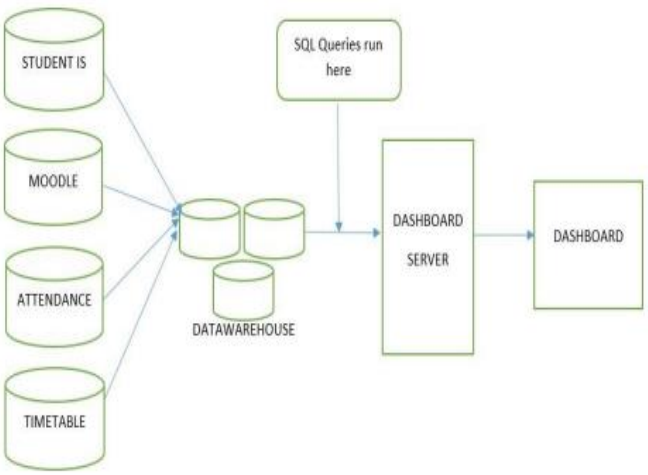


**Figure 3: Flow of Moodle**

This diagram shows the flow of moodle. It shows the performance of students his attendance marks, timetable on the dashboard all this is stored in the data ware house and then retrieved according to the need of the retrieved according to the need of the user.

### 4.3 Database Design

The process of creating a thorough data model for a database is known as database design. This data model provides all of the logical and physical design options, as well as physical storage parameters, that are required to create a design. So that here placed important database table which is created for storing DIS data for performing various function

There are following tables present in the Moodle database

**Table1: Moodle Assignment**

| S. No. | Table Name | Description |
|---|---|---|
| 1 | mdl_user | This tables stores all user data |
| 2 | mdl_user_enrolments | This table acts as a relationship table between user tables and enrol table. |
| 3 | mdl_enrol | This table stores information of all user enrolled in the courses |
| 4 | mdl_course | This tables store all course related information |
| 5 | mdl_assign | This table stores all assignment related information. |

**Table 2: Moodle Grades**

| S. No. | Table Name | Description |
|---|---|---|
| 1 | mdl_grade_grades | This tables store all information related to grades |
| 2 | mdl_grade_items | This table store all information related to grade items |
| 3 | mdl_tag | This table stores all the tag related information |
| 4 | mdl_course_module | This tables act as an relationship table between course table and tag table. |

**Table 3: Moodle Quiz**

| S. No. | Table Name | Description |
|---|---|---|
| 1 | mdl_quiz | This table stores all quiz related information |
| 2 | mdl_quiz_attempts | This table stores information related to all the user who attempted the quiz |
| 3 | mdl_quiz_slots | Thistable store quiz slot related information and map quiz table with question table |

| | | |
|---|---|---|
| **4** | mdl_question | This table stores all the question-related information for all quizzes |
| **5** | mdl_question_attempts | This table stores information related to questions attempted by all the users. |

**Table 4: Moodle Attendance**

| S. No. | Table Name | Description |
|---|---|---|
| **1** | mdl_attendance_student | This table stores student attendance details on daily lecturer basis of a particular course |
| **2** | mdl_attendance_teacher | This table stores attendance details data on daily lecturer basis of a particular course |
| **3** | mdl_attendance_student_bulk | This table stores student attendance data in bulk for a particular course |
| **4** | mdl_attendance_teacher_bulk | This table stores attendance details in bulk for a particular course |
| **5** | mdl_course | This tables store all course related information |

## V. RESULT DISCUSSION

The proposed project is implementation successfully and their output is demonstrated in this section. After successful run of various functionality in project the view of Teacher Perspective and Student Perspective some of important result is listed.

### 5.1 Teacher Perspective

### 5.1.1 GET GRADE ITEMS OF COURSE

This returns all the grade items (Assignments, Quizzes, etc.) of a given course. The API for this functionality is localhost:8087/grades/getGradeItemsOfCourse/courseid.

**Result**- "Grade Item list of particular course id is displayed successfully"

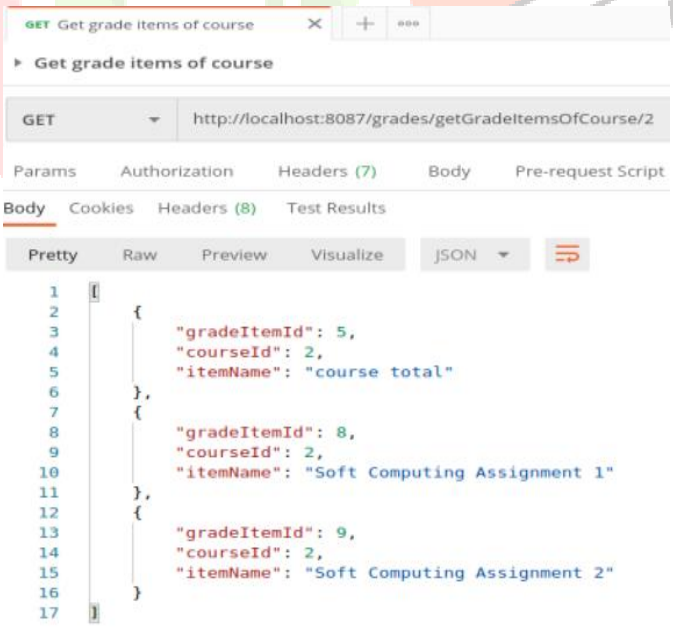


**Figure 4: Get grade item of course**

### 5.1.2 GET GRADE REPORT

- This returns a report of all students with respective to the given course and a given grade item (Assignments, Quizzes, etc).
- Here if "0" is requested in place of any item id, which returns the report for all the grade items and of all students of a particular course.
- The API for this functionality is localhost:8087/grades/getGraderReport/courseid/itemid.

Result- "Grader report of particular course with corresponding item is displayed successfully"

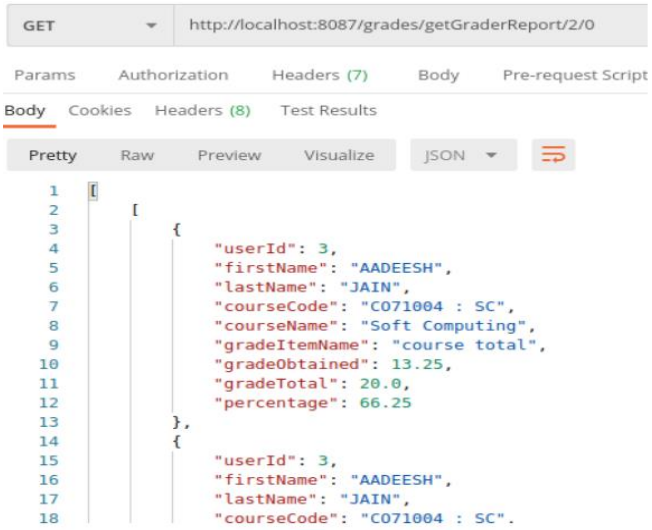


**Figure 5: Get grader report**

### 5.1.3 GET STUDENTS OF COURSE

This returns all the students enrolled in a particular course. The API for this functionality is localhost:8087/grades/getStudentsOfCourse/courseId.

**Result**- Display all the student enrolled list for a particular course.

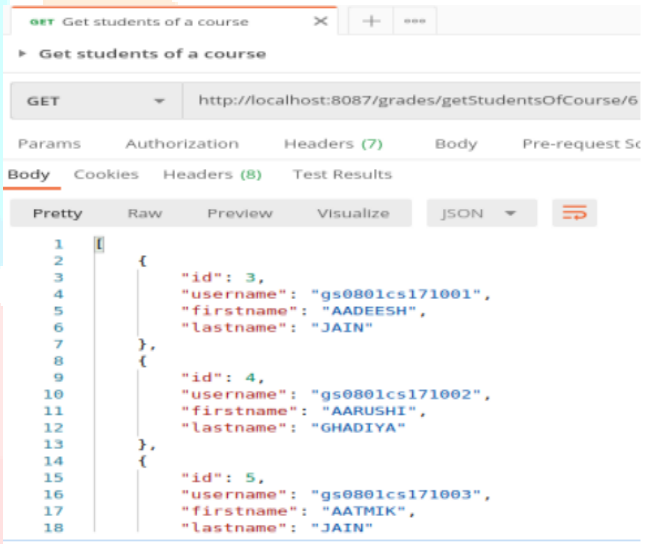


**Figure 6: Get Student of Course**

## 5.2 Students Perspective

### 5.2.1 GET STUDENT ATTENDANCE REPORT

- This returns attendance report of all courses for individual student.
- The API for this functionality islocalhost:8087/moodle/getIndividualStudentAttendance/.

**Result**- Display the overall attendance report of individual student for all courses.

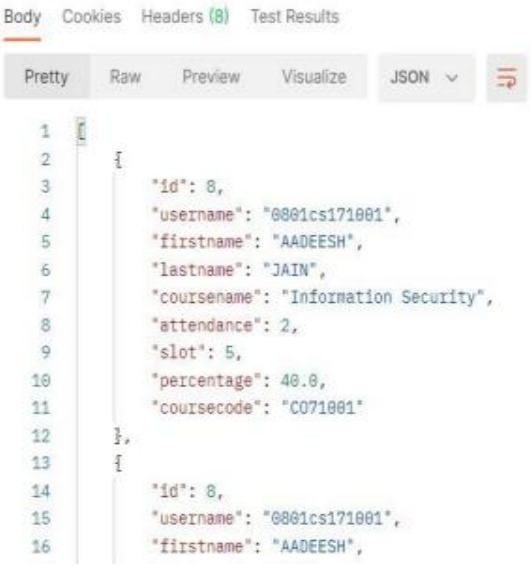


**Figure 7: Get overall attendance report of a student**

### 5.2.2 GET STUDENT QUIZ REPORT

- This returns quiz review report of particular quiz of particular course for a student.
- The API for this functionality is localhost:8087/quiz/getCompleteQuiz/quizid.

**Result**- Display the complete quiz review report of individual student for a particular course.

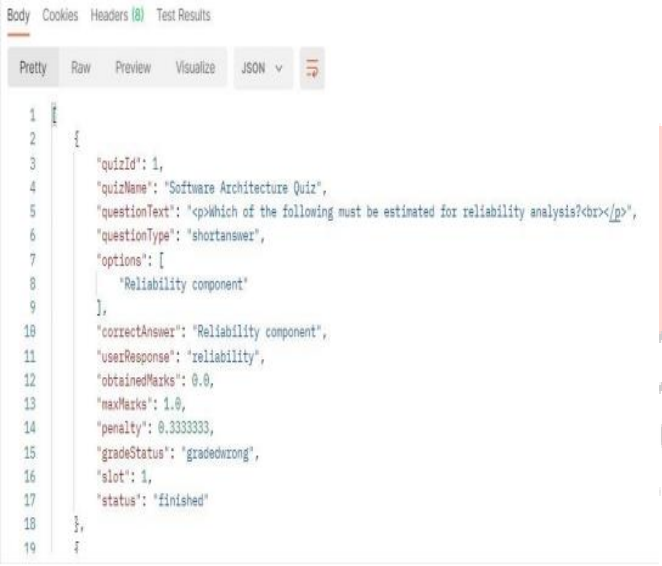


**Figure 8: Get Quiz Review report of a student**

### 5.2.3 GET STUDENT COMPLETE ACTIVITIES

- This returns the list of all the completed and submitted activity of particular course for a student.
- The API for this functionality islocalhost:8087/assns/getStudentSubjectReport/courseid.

**Result**- Display the complete activity list of individual student for a particular course.

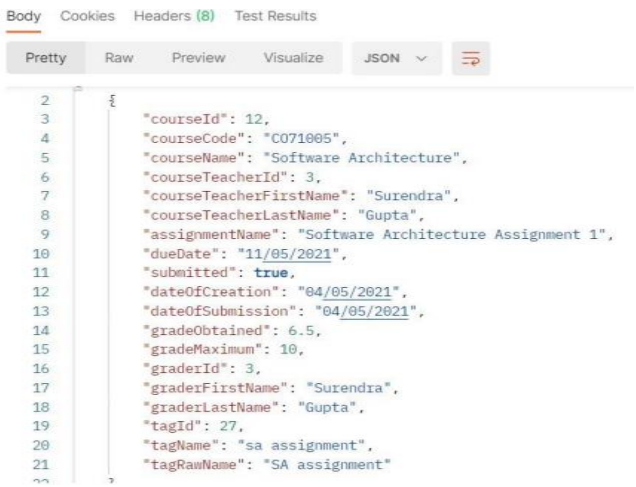


**Figure 9: Get complete activity list of a student**

## VI. CONCLUSION

Technology has several educational advantages. The flow of information has greatly enhanced as a result of the revolution in information and communication technology. In this work, customize the Moodle platform to ease the department management system for e-learning by designing and analyzing the primary functions and tools accessible. Then used microservice architecture and moodle features to construct the requested solution. Efforts have been made to manage and display the data related to academics of the moodle from student and teacher perspective in department information system such as showing results of quizzes, midterm marks and other activities etc.. Also, calculation of total course work and sessional work marks for a given course from teacher perspective, and generating report for quiz, assignment, attendances, grades etc.

## VII. FUTURE WORK

The Moodle management module has been completed and is currently in the beta testing stage. As of now report generation is done only in Moodle Management Module but in the future work the aim to provide options for generating report in other modules as well. The Moodle coursework module implemented in DIS can be used as a reference for implementing the coursework plug-in in the Moodle Course Management System. The Moodle Management Module can also be used as a reference for implementing various modules in the DIS Mobile Application.

## REFERENCES

[1] Zainuddin, N., Idrus, R., & Jamal, A. F. M. (2016). Moodle as an ODL teaching tool: A Perspective of Students and Academics. Electronic Journal of e-Learning, 14(4), pp. 282-290.
[2] Murillo, G. G., Novoa-Hernández, P., & Rodríguez, R. S. (2021). Technology Acceptance Model and Moodle: A systematic mapping study. Information Development, 37(4), 617-632.
[3] Niemelä, P., & Hyyrö, H. (2019). Migrating learning management systems towards microservice architecture. Joint Proceedings of the Inforte Summer School on Software Maintenance and Evolution (SSSME-2019), 11.
[4] Soufiane, O., Maha, K., Mohamed, E., & Mohamed, K. (2021). Implementation of the Moodle e-learning platform from server selection to configuration. GSC Advanced Engineering and Technology, 1(1), 016-027.
[5] Gunawan, G., Sahidu, H., Susilawati, S., Harjono, A., & Herayanti, L. (2019, December). Learning management system with Moodle to enhance creativity of candidate physics teacher. In Journal of Physics: Conference Series (Vol. 1417, No. 1, p. 012078). IOP Publishing.
[6] S. Newman, Building microservices : designing fine-grained systems,First Edition. O'Reilly Media, 2015.
[7] Kapembe, S., & Quenum, J. (2018, July). Lihonga—a Microservice-based Virtual Learning Environment. In 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT) (pp. 98-100). IEEE.
[8] Ulrikh, D. V., Timofeeva, S. S., & Timofeev, S. S. (2018, November). Choice of sorbents for the pretreatment in the complex technology of phytoremediation. In IOP Conference Series: Materials Science and Engineering (Vol. 451, No. 1, p. 012235). IOP Publishing.
[9] Milovanović, A. (2021, September). Microservice architecture in E-learning. In E-business technologies conference proceedings (Vol. 1, No. 1, pp. 105-108).
[10] Niemelä, P., & Hyyrö, H. (2019). Migrating learning management systems towards microservice architecture. Joint Proceedings of the Inforte Summer School on Software Maintenance and Evolution (SSSME-2019), 11.
[11] S. Kapembe and J. Quenum, "Lihonga — A Microservice-Based Virtual Learning Environment," 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), 2018, pp. 98-100.
[12] Beranek, M., Kovář, V., & Vacek, V. (2017). Design of a learning management system for small and medium sized Universities and Colleges. In Proceedings of the International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government (EEE) (pp. 22-25).
[13] Bauer, D. A., Penz, B., Mäkiö, J., & Assaad, M. (2018). Improvement of an Existing Microservices Architecture for an E-learning Platform in STEM Education. In AICT 2018: The Fourteenth Advanced International Conference on Telecommunications. IARIA.
[14] M. E. Kholy and A. E. Fatatry, "Framework for Interaction Between Databases and Microservice Architecture," in IT Professional, vol. 21, no. 5, pp. 57-63, 1 Sept.-Oct. 2019
[15] G. Mazlami, J. Cito and P. Leitner, "Extraction of Microservices from Monolithic Software Architectures," 2017 IEEE International Conference on Web Services (ICWS), 2017, pp. 524-531
[16] Miao, K., Li, J., Hong, W., & Chen, M. (2020). A microservice-based big data analysis platform for online educational applications. Scientific Programming, 2020.