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THE INTERNATIONAL UNIVERSITY
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EVALLOS: Leveraging an IT Platform for Enhanced Academic Quality Assurance Through Learning Outcome Evaluation.

By
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EVALLOS: Leveraging an IT Platform for Enhanced Academic Quality Assurance Through Learning Outcome Evaluation.

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Abstract

In the evolving landscape of higher education, the necessity for measurable and transparent learning outcomes has become paramount to ensure educational quality and alignment with labor market demands. This study introduces EVALLOS, a comprehensive platform designed to support the assessment of Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) within Vietnamese higher education institutions. Building upon established frameworks such as Outcome-Based Education (OBE) and international accreditation standards from organizations like FIBAA, AUN-QA, and ABET, EVALLOS aims to bridge the gap between educational objectives and student performance through an integrated, data-driven approach.

The research begins by delineating the critical need for quantifiable learning outcomes, emphasizing their role in curriculum development, instructional strategies, and assessment methodologies. A thorough literature review compares existing systems, notably those developed by Ton Duc Thang University (TDTU) and Lac Hong University (LHU), highlighting their functionalities, strengths, and limitations. This comparative analysis underscores the necessity for a more advanced, user-friendly, and automated system, paving the way for the development of EVALLOS.

Methodologically, EVALLOS employs a robust combination of modern technologies, including MongoDB for database management, React.js and Tailwind CSS for front-end development, and Node.js with Express.js for backend operations. The system integrates Bloom's Taxonomy to categorize and evaluate learning outcomes systematically. Additionally, EVALLOS leverages artificial intelligence, specifically the Llama3 large language model, to automate report generation, providing detailed insights through customizable and interactive visualizations using D3.js. The platform's architecture ensures scalability, security, and ease of use, facilitating seamless data collection, processing, and analysis.

Implementation of EVALLOS at International University demonstrated its efficacy in managing and assessing CLOs and PLOs across various levels—from exam teams and individual classes to entire courses and programs. The system's ability to generate comprehensive reports, highlight areas for improvement, and align educational outcomes with institutional goals received positive feedback from educators and accreditation experts. Comparative evaluations revealed that EVALLOS surpasses existing systems in terms of functionality, user interface design, and automated capabilities, particularly in its integration of AI-driven insights and customizable reporting features.

The conclusion of this study affirms that EVALLOS significantly enhances the assessment and management of learning outcomes, fostering a data-driven culture that supports continuous improvement in educational practices. Future work will focus on optimizing system performance, expanding functionalities to include individual Student Learning Outcomes (SLOs), and collaborating with additional universities to refine and standardize best practices in learning outcome assessment. Ultimately, EVALLOS aims to elevate the quality of higher education in Vietnam, ensuring that graduates are well-equipped with the necessary skills and competencies to thrive in their professional careers.

Contents

Glossary

BOD Board of Directors. 31

CLO Course Learning Outcome. 12–14, 28

EVALLOS Evaluation Learning Outcomes System. 13

OBE Outcome based education. 11

PLO Program Learning Outcome. 13, 14, 28

QAC Testing and Quality Assurance Center. 31

SLO Student Learning Outcome. 12, 13

TDTU Ton Duc Thang Course Learning Outcome Management System. 4, 19

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Chapter 1

Introduction

1.1 The Need of Measurable Learning Outcomes

1.1.1 What is Learning Outcomes definition?

Learning outcomes delineate the quantifiable skills, competencies, knowledge, or values that students are expected to exhibit upon the completion of a course. They are student-centered rather than teacher-centered, since they delineate the actions of the pupils rather than the instruction provided by the educator [1].

Goal of qualify learning outcomes Learning outcomes are essential components of higher education, serving as the primary objectives of student learning and underpinning curriculum development, instruction, and assessment. According to Akari Software [2], Outcome based educations (OBEs) prioritizes the essential skills and knowledge required for student success, compelling institutions to evaluate their courses and programs based on their efficacy in equipping students for future careers, rather than solely the quantity of content presented. This student-centered approach promotes active participation and engagement during the learning process. Clearly articulated and quantifiable learning outcomes are crucial for fostering a student-centered education, since they emphasize learning rather than teaching and assist educators in developing curricula and instructional practices that improve engagement and facilitate personalized learning experiences. The significance of learning outcomes in higher education is substantial, providing a framework for students' academic paths, enhancing pedagogical methods, matching educational goals with professional aspirations, and augmenting employability and career preparedness.

1.1.2 Some Methods for Evaluating Output Standards

Student learning measurements are primarily categorized into two types [3]: summative assessment and formative assessment, each serving distinct roles and purposes in enhancing and evaluating learning outcomes.

Summative assessment is an evaluation, such as a test, quiz, or graded exercise, that quantifies student learning outcomes. This assessment is usually conducted at the conclusion of a unit or course, serving to summarize and evaluate students' comprehension following the learning process. This strategy is crucial for assessing the extent to which students have met learning objectives, exemplified by individual grading systems in each course.

Formative assessment is conducted during the learning process to furnish feedback and suggestions for student improvement. Feedback may be delivered through in-person

talks, written remarks on assignments, rubrics, or email correspondence. Instructors may require students to document the key points or the most perplexing material following each class. Evaluating this feedback aids teachers in comprehending student mastery and offers a chance to modify pedagogical approaches. Simultaneously, pupils can recognize and enhance deficiencies in their learning process.

Summative and formative evaluations are crucial, and educators should integrate several direct and indirect assessment techniques to obtain a holistic understanding of student learning and facilitate their ongoing development. Furthermore, when developing assessment methods, it is essential to examine variables such as alignment with learning outcomes, feasibility regarding time and resources, and the application of results for course enhancement.

1.2 Problem Statement

Higher education institutions in Vietnam have to delineate explicit learning outcomes to govern the input and output standards of training programs across various levels. As per Circular 08/2021/TT-BGDDT [4] regarding the promulgation of regulations on university training and Circular 17/2021/TT-BGDDT [5] concerning standards for training programs, universities are mandated to formulate and transparently disclose Student Learning Outcomes (SLOs) to ensure that graduates possess the requisite knowledge and skills for the labor market. To fulfill these standards, numerous universities are currently emphasizing the evaluation of Course Learning Outcomes (CLOs) via student learning outcomes in examinations and assessments. This measurement assists educational institutions in aligning topic training objectives with the program's overall output standards, while adhering to the criteria for educational quality assessment as per existing rules.

This technique has shortcomings, as it fails to adequately represent the learning process and the competency levels of students concerning the program's overarching objectives. Evaluating SLOs exclusively through course-level learning outcomes frequently yields a limited perspective, as SLOs include a broader spectrum of abilities, competencies, and learning objectives that may not be well represented by course-level evaluations.

The 2022 enrollment report from the Ministry of Education and Training indicates that Vietnam has 330 higher education institutions and teacher training colleges. As of October 31, 2023, only 207 colleges were acknowledged as fulfilling quality criteria, and the remaining 123 institutions were either unaccredited or did not satisfy these standards in Figure 1.1 [6]. This situation underscores the necessity of establishing a more efficient mechanism to guarantee uniform evaluation and enhancement of educational quality across all training institutions.

A more comprehensive and holistic methodology for evaluating student learning outcomes (SLOs) is necessary, transcending dependence on quantitative metrics such as test scores. Incorporating qualitative and experiential assessment techniques, including direct observation, portfolios, and stakeholder feedback, can offer a more comprehensive perspective on students' attainment of program-level learning objectives. This will assist universities in making more evidence-based and data-driven decisions on curricula, teaching, and assessment techniques, so ensuring the quality and long-term relevance of their programs.

The purpose is to create a cohesive system that automates the collecting, processing, and reporting of various SLO assessment data, providing universities with enhanced insight into students' mastery of program-level learning objectives. This technology will

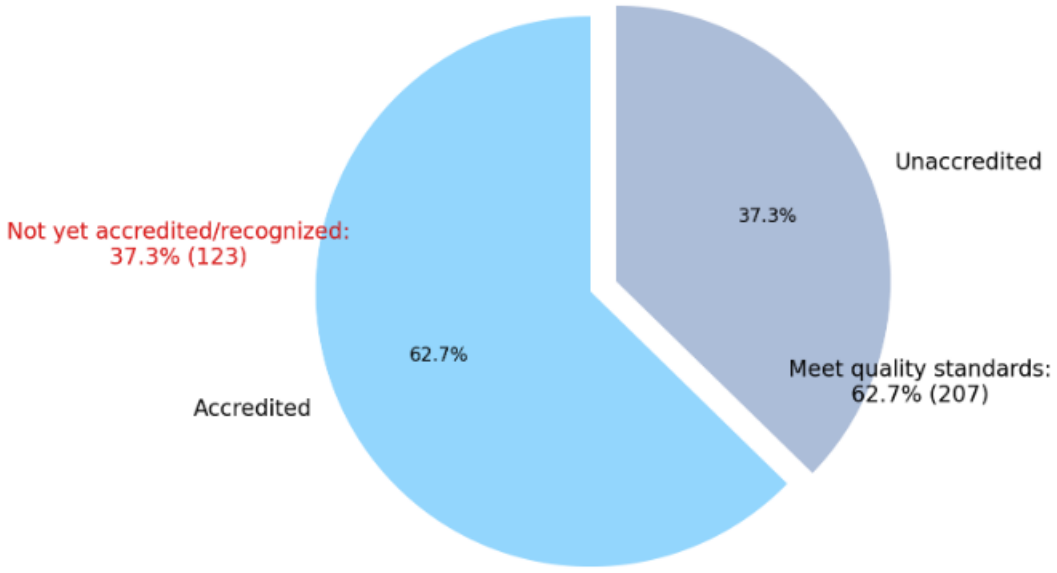


Figure 1.1: Higher education institutions accreditation rates for educational quality.

facilitate curriculum adjustments and enhance training programs, thereby elevating the level of higher education in Vietnam.

Researchers have developed an effective assessment framework for evaluating outcome standards at the student and subject levels, based on a review of student and subject outcome measurement methodologies [7] (Figure 1.2). This stream will be utilized to design the Evaluation Learning Outcomes Systems (EVALLOSs) system.

1.3 Scope and Objectives

The assessment process for SLOs is a crucial component of the analytical framework, designed to evaluate the attainment of SLOs throughout the program by correlating them with the CLOs, which are derived from student learning outcomes and performance metrics.

This evaluation technique not only emphasizes particular subjects but also offers a holistic perspective on students' attainment of the program's educational objectives. Data from several subjects will be consolidated and examined to evaluate student learning outcomes, ultimately elucidating the efficacy of the training program. This analysis identifies the curriculum's strengths and weaknesses while offering a dependable database to inform modifications and enhancements to the program, ensuring alignment between instructional content, methodologies, and fundamental learning objectives, thereby enhancing the quality of training in a comprehensive and sustainable way.

1.3.1 Goal of EVALLOS

The platform seeks to evaluate the extent of Program Learning Outcomes (PLOs) attained in relation to student learning outcomes. The platform analyzes the completion levels of CLOs to identify areas for enhancement and apply updates, ultimately improving the effectiveness of CLOs and facilitating the attainment of PLOs. This guarantees that the curriculum is tailored to the training objectives and addresses the learners' needs, while

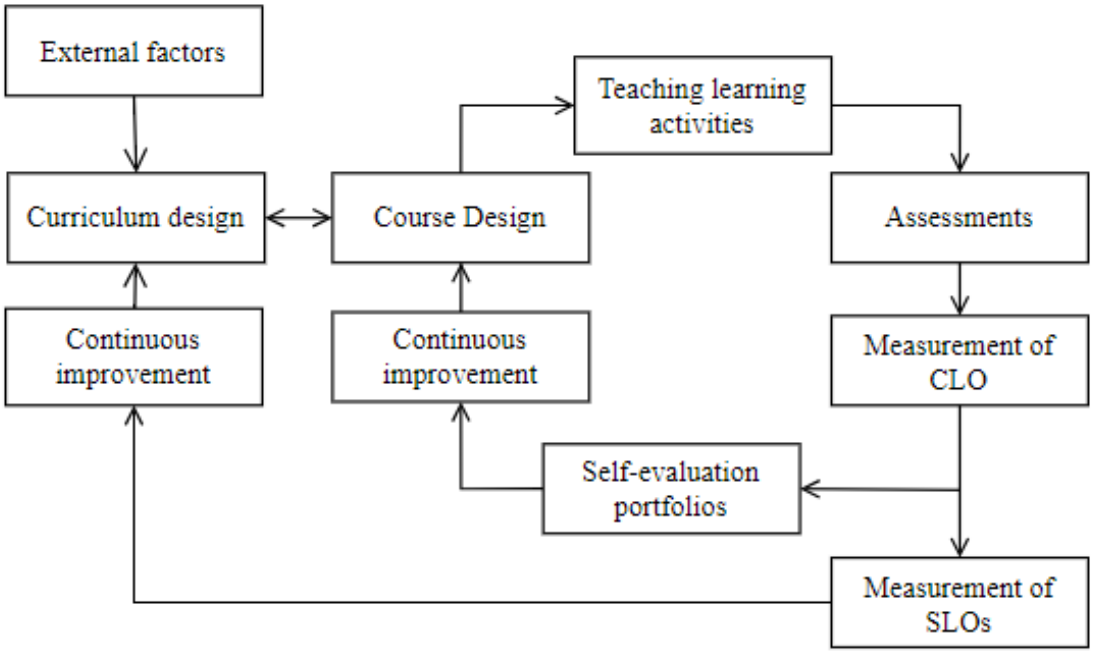


Figure 1.2: Learning outcome flow.

supplying crucial data that connects course content to educational goals.

EVALLOS is designed as a comprehensive system that automates data analysis and produces actionable reports, primarily focused on student performance and learning outcomes. The assessment of PLOs is incorporated into the comprehensive analysis process, which entails quantifying the extent of PLOs achieved by aggregating and evaluating CLOs across several courses. Course-level data will be consolidated to offer an extensive perspective on student mastery of curricular objectives, thereby informing decisions regarding curriculum modifications.

The platform aids lecturers and educational institutions in generating reports for assessing educational quality while also fostering the holistic enhancement of training program quality, hence preserving the relevance and sustainability of the higher education system.

1.3.2 System Actors and Basic Functions

In the analytical framework, principal stakeholders significantly contribute to the evaluation process, including the Training Department, the Testing and Quality Assurance Center, educators, and Board of Directors. Each stakeholder possesses distinct responsibilities and functions to guarantee the assessment procedure is conducted efficiently and transparently.

The Training Department oversees the management of the system and supervises associated duties. Primary responsibilities encompass overseeing student rosters, organizing examination timetables, preserving legal documentation, and conducting assessments. The Training Department collaborates closely with other units to guarantee effective data management and utilization.

Testing and Quality Assurance Center is crucial in overseeing educational quality by monitoring and analyzing reports on the accomplishments of PLO, SLO, and CLO. Responsibilities encompass assessing outcomes, scrutinizing data, and producing reports

to facilitate decisions aimed at enhancing educational quality within the institution.

Lecturers are tasked with overseeing and instructing subjects, and they play a crucial role in the evaluation process. Lecturers' responsibilities encompass inputting test scores, validating answers, analyzing score distributions, and utilizing the system's analytical capabilities to assess student performance and Course Learning Outcome (CLO) attainment.

Board of Directors may efficiently assess and comprehend the overall performance of the institution through the reports and visual charts generated by the system. This assists leaders in making data-driven strategic decisions to enhance educational quality and optimize training objectives.

By explicitly delineating the roles and duties of each stakeholder, the analytics system facilitates seamless coordination and unambiguous accountability in the evaluation process. The technology facilitates seamless data administration and offers a dependable foundation for data-driven decision-making, hence enhancing the quality of instruction at the school.

1.3.3 Structure of Thesis

Chapter 1: Introduction to EVALLOS - A platform to support the assessment of course output standards (CLO).

Chapter 2: Overview of advanced related research and systems in assessing educational output standards.

Chapter 3: Detailed presentation of the technical aspects of the EVALLOS platform, including software architecture design, technologies used, computational theory in assessing output standards and the AI Generating Report feature to support automatic report generation.

Chapter 4: Discussion of the implementation and application of the EVALLOS platform in educational institutions.

Chapter 5: Evaluation of the effectiveness and achievements of the EVALLOS platform.

Chapter 6: Summary of key findings and conclusions on the study of the EVALLOS platform.

Chapter 2

Background and Related Works

2.1 Background

2.1.1 International Accreditation Standards for Evaluating Educational Outcomes

International quality standards are essential in establishing and guaranteeing the quality of higher education programs worldwide. They offer extensive methodological frameworks to assist educational institutions in evaluating, quantifying, and enhancing Program Learning Outcomes (PLOs) and Course Learning Outcomes (CLOs). This section will delineate the methodologies and criteria employed by prominent accreditation organizations, like FIBAA, AUN-QA, and ABET, to evaluate and quantify educational learning outcomes, emphasizing their distinctive approaches and contributions to the assurance of worldwide education quality.

2.1.1.1 Foundation for International Business Administration Accreditation (FIBAA)

The Foundation for International Business Administration Accreditation (FIBAA) [8] is an international organization that specializes in the quality accreditation of higher education, particularly in the fields of business administration, social sciences, and law. Its primary objective is to guarantee that educational programs meet the requirements of the labor market, are consistent with international standards, and achieve clear output standards.

The FIBAA accreditation process commences with the completion of a self-assessment report by the institution, which provides detailed information on the design and implementation of learning outcomes. Subsequently, an external review by a team of independent experts includes site visits, interviews with faculty and students, and analysis of student performance data. This comprehensive set of quality standards covers a variety of topics, including program structure, teaching methods, assessment of learning outcomes, and quality management.

Educational institutions are able to improve their reputation, attract international students, and guarantee that their training programs adhere to international quality standards by being accredited by FIBAA. Additionally, the accreditation process fosters continuous improvement, ensuring that the programs remain pertinent to the real needs and trends of the global labor market.

2.1.1.2 ASEAN University Network (AUN)

AUN-QA (ASEAN University Network - Quality Assurance) [9] is an effort by the ASEAN University Network aimed at enhancing and ensuring the quality of higher education in the area. This organization prioritizes the synchronization of educational standards among ASEAN nations and the matching of training programs with labor market requirements.

AUN-QA employs an extensive array of evaluation criteria, encompassing aspects such as program objectives, organization and content, pedagogical approaches, student assessment, and facilities. The AUN-QA accreditation procedure commences with the institution doing a self-assessment, succeeded by an external evaluation conducted by a team of independent experts. Experts will conduct interviews with stakeholders, examine instructional activities, and evaluate the degree of alignment between educational outcomes and teaching and assessment methodologies [10].

The AUN-QA framework assists universities in the region in elevating their educational standards, while fostering collaboration and mutual recognition among ASEAN nations. This certification procedure promotes ongoing enhancement, assisting educational institutions in addressing the requirements of students and the global workforce.

2.1.1.3 Accreditation Board for Engineering and Technology (ABET)

ABET (Accreditation Board for Engineering and Technology) [11] is a non-profit entity that accredits educational programs in applied science, computer, engineering, and technology. ABET's principal objective is to guarantee that educational programs equip individuals with the requisite skills and knowledge to fulfill the demands of business and society.

ABET implements a framework of standards that emphasizes program objectives, student learning outcomes, ongoing enhancement, and support services. The certification procedure comprises three primary steps: institutional self-assessment, expert peer evaluation, and ongoing monitoring to guarantee continuous improvement and quality maintenance of the program. The assessment team of ABET concentrates on evaluating student learning outcomes using both qualitative and quantitative evaluation techniques.

ABET accreditation is internationally acknowledged and serves as a significant assurance of educational excellence. This provides graduates a significant advantage in securing employment and advancing their careers. The ABET accreditation procedure simultaneously promotes the ongoing enhancement of educational institutions to adapt to evolving technical and technological demands.

2.1.1.4 Impact of AUN-QA, ABET, and FIBAA Standards on EVALLOS Development

The AUN-QA and ABET standards have significantly influenced the creation of EVALLOS, particularly in guaranteeing educational quality and evaluating learning results. AUN-QA emphasizes the alignment of educational objectives, course learning outcomes (CLOs), and program learning outcomes (PLOs), which are immediately included into EVALLOS via tools that correlate CLOs with PLOs, so assuring coherence in the training program. EVALLOS is intended to gather feedback from stakeholders, including professors, students, and employers, to enhance the quality of training programs and fulfill regional standards, particularly in ASEAN countries. EVALLOS adopts a data-driven methodology for evaluating learning efficacy, utilizing performance indicators to assess student competencies, in accordance with ABET criteria. This guarantees that the sys-

tem delivers objective evaluations while facilitating instructional enhancement selections grounded in empirical outcomes.

The FIBAA standard, via its holistic methodology and emphasis on the applicability of educational programs, has influenced the quality management operations of EVALLOS. FIBAA underscores the importance of ongoing enhancement via self-evaluation and independent accreditation, a principle mirrored in EVALLOS through its self-assessment and reporting instruments. Moreover, FIBAA prioritizes the alignment of educational curricula with labor market demands. EVALLOS is designed to assess graduate employment data, enabling educational institutions to modify their teaching objectives to enhance employability. EVALLOS, utilizing FIBAA's multidisciplinary approach, guarantees adaptability across various industries, addressing the varying requirements of educational institutions globally.

2.1.2 Global methodologies for evaluating educational output standards

2.1.2.1 Outcome-Based Education (OBE)

The Outcomes-Based Education (OBE) [13] approach emphasizes the explicit delineation of learning outcomes and the alignment of all educational activities, including curriculum design and evaluation, to fulfill those outcomes. This methodology is extensively employed in international accrediting standards, including ABET and AUN-QA. OBE highlights the strong connection between Program Learning Outcomes (PLO) and Course Learning Outcomes (CLO), fostering a continuous improvement cycle via data collection and analysis, while engaging stakeholders including lecturers, students, and businesses to guarantee the practicality and relevance of training objectives.

2.1.2.2 Performance Indicators and Benchmarking

Performance indicators (PIs) [14] are quantitative and qualitative metrics employed to evaluate the attainment of established learning objectives. Performance Indicators (PIs) are frequently utilized in institutions like Lac Hong University (LHU) to assess and analyze the congruence between Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs), hence offering insights for curriculum enhancement. Benchmarking is frequently utilized to evaluate an institution's performance against peer institutions or worldwide standards, fostering ongoing improvement and quality improvements.

2.1.2.3 Rubrics for Competency Assessment

Rubrics [15] are comprehensive evaluation frameworks that delineate standards for measuring student achievement on particular assignments. They ensure transparency and uniformity in evaluation and deliver explicit feedback to pupils. Rubrics are especially useful in evaluating soft skills like communication and teamwork, which are crucial for graduate employability.

2.1.2.4 Summary

Three methodologies, namely Outcome-Based Education (OBE), Performance Indicators (PI) with Benchmarking, and Competency Assessment Rubrics, have substantially influenced the evolution of EVALLOS. The OBE framework establishes a robust connection

between Course Learning Outcomes (CLOs) and Programme Learning Outcomes (PLOs), assuring coherence and fostering ongoing data-driven enhancement. Performance Indicators and Benchmarking facilitate the system's assessment of learning outcomes in depth, enable comparisons with global standards, and furnish dependable data for enhancing the training program. Rubrics facilitate open and consistent evaluation of competencies, particularly in soft skills like communication and teamwork, hence enhancing employability and equipping students to fulfill practical demands. Combining all three methods, EVALLOS becomes a comprehensive system, supporting lecturers and students to optimize learning outcomes and ensure educational quality according to international standards.

2.2 Related works

This literature review examines recent research on student learning outcomes evaluation systems, related research in assessing educational output standards, and their implications for informing curriculum development.

2.2.1 Studies on Ton Duc Thang Course Learning Outcome Management Systems (TDTUs)

a) Overview

TDTUs is intended to efficiently facilitate academic administration and learning evaluation processes. The system incorporates essential functions, including the management of student academic infractions, faculty oversight, the importation of answer formats and test scores in accordance with course outcome standards (CLOs), score visualization and printing, processing of multiple-choice test results, the locking and unlocking of test groups, and the establishment of rules and permissions based on roles. TDTUs fulfill the requirements of academic management while guaranteeing transparency and efficiency in evaluating educational quality.

b) Some Basic Functions of the System

Managing Student Violations: A key aspect of TDTU's CLOs system is its capacity to oversee student infractions of academic regulations (Figure 2.1). This function is intended to address instances of student violations of school regulations [16] efficiently. Lecturers can administer this list for each academic year and examination, utilizing it to compute academic scores, sanctions for infractions, and so on. This list can be saved to an Excel file for analysis, record-keeping, or addition of data. Students who violate the guidelines will have points deducted from their actual exam scores.

Manage answer structure for exam: Instructors can input answer formats for essay and multiple-choice assessments, with the option to associate each question with one or more pertinent course learning goals (CLOs) (Figure 2.2). Course Learning Outcomes (CLOs) are established for each course, facilitating the management and monitoring of the attainment of educational objectives. This feature enhances lecturers' ability to organize instruction efficiently and elevates the quality of student learning outcomes assessment.

Scoring Faculty Administration: Function to allocate lecturers for inputting CLO scores (Figure **??**). The technology enables faculty administration to designate individual teachers to input their answer sheet format and associated CLOs for each examination. This is a crucial system feature that enables users to regulate lecturers' authority to modify CLO scores and reduce the arbitrary input of CLO scores. The system incorporates numerous filters to facilitate users in easily accessing subject codes and names for score entry.

Thao tác:

Figure 2.1: TDTU manages student violation views.

Figure 2.2: TDTU manages answer structure.

Locking/Unlocking Exam Groups: The essential exam group locking/unlocking in Figure 2.3 functionality enables administrators to restrict or permit data editing associated with that exam group. This capability functions as a safeguard for exam-related data, including scores and student information, against illegal alteration or access. Upon the locking of exam groups, the system guarantees the integrity and security of documents and examination results, thereby establishing a secure environment for the assessment process. This functionality is crucial for ensuring system stability and trust, providing administrators with assurance regarding the confidentiality of sensitive examination data.

c) Advantages The system analyzed in the article offers an extensive array of capabilities that markedly enhance the administration of CLO score parameters and lecturer activities. Functions include the management of student infractions, lecturer assignments, the importation and deletion of violations, data exportation to Excel, score importation, viewing and printing, the locking and unlocking of examination groups, and regulatory management establish a robust framework for the design and execution of EVALLOS.

These characteristics fulfill practical purposes and align closely with the requirements essential for the development of EVALLOS. The administration of input CLO score parameters is essential for the precise and transparent evaluation of students' learning outcomes. The system's capacity to efficiently execute these procedures serves as a significant reference for the EVALLOS development process. The evident decentralization aspect in lecturer management fosters accountability and transparency, establishing a robust framework for the execution of the new system.

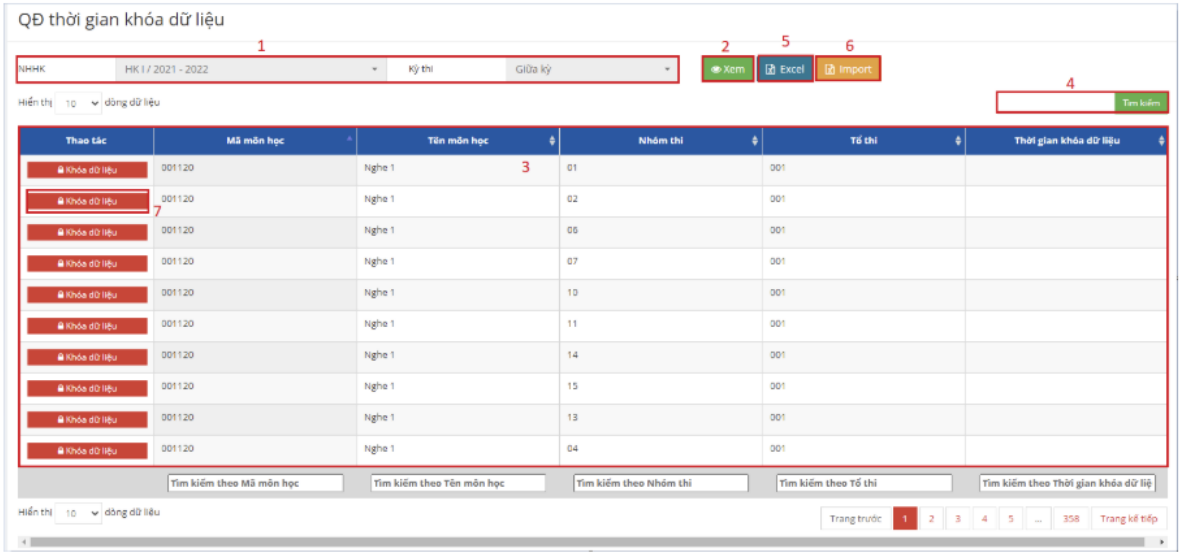


Figure 2.3: DTU Locking/Unlocking Exam Group View.

The dependability and adaptability of the research system provide it an exemplary reference model for the creation of EVALLOS. The new system can adopt optimized operations, enhanced data management capabilities, and robust security measures. EVALLOS will be created to efficiently control CLO parameters and thoroughly assist teaching and faculty administration.

d) Limitations Obsolete User Interface: The reference system's user interface requires upgrading to conform to contemporary requirements. The existing layout hinders user navigation and comprehension of the system, thus impacting the entire experience.

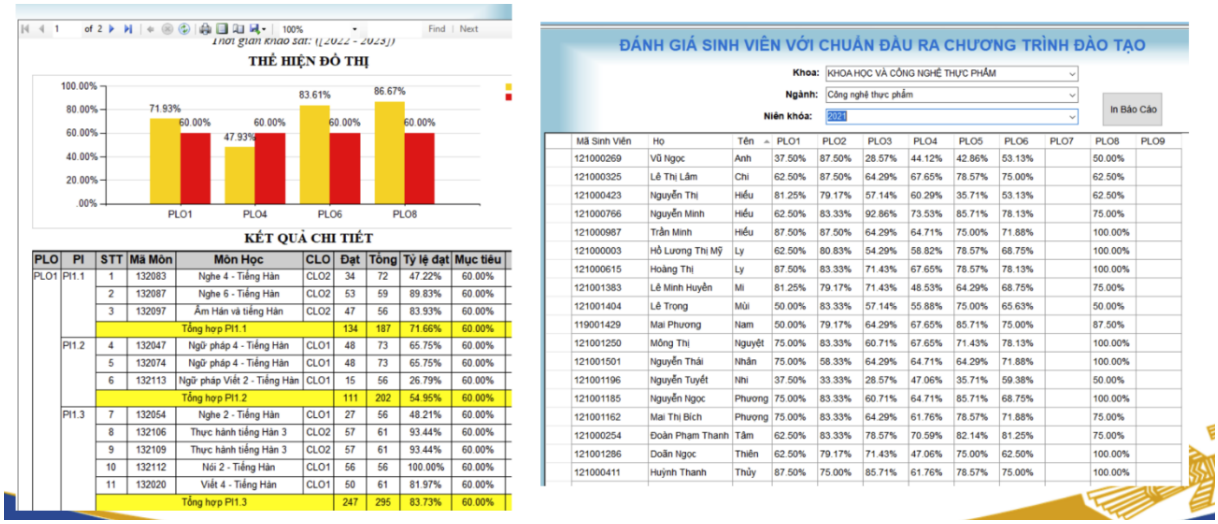
Redundant Views: Certain views inside the system are repeated, resulting in confusion and complicating the identification and retrieval of essential information. Optimizing and removing duplicate views will enhance usability and improve the user experience.

Minimal Pertinence to Global Universities: Certain functions, such as managing "cheat" assessments or multiple-choice questions (MCQs), may be unsuitable or redundant in an international framework. These characteristics may require modification or removal to more effectively satisfy certain requirements.

Scalability and Performance: The reference system may exhibit constraints when managing substantial data volumes or elevated concurrent user counts. This is particularly significant for international universities comprising numerous faculties and departments. To fulfill practical objectives, it is essential to guarantee that the system possesses robust scalability and consistent performance.

2.2.2 Output measurement software built by Lac Hong University

a) Overview Lac Hong University (LHU) has established a student output measuring system utilizing Performance Indicators (PI) to assess the attainment of Program Learning Outcomes (PLOs) in relation to Course Learning Outcomes (CLOs). This system functions through a rigorous evaluation sequence from PEOs to PLOs, then to Courses, and finally to Teaching and Learning Methods, guaranteeing that all CLOs are connected to PLOs and that teaching and assessment methods are explicitly delineated. The software is crucial in assisting educational institutions to enhance the quality of training



PLO	PI	STT	Mã Môn	Môn Học	CLO	Đạt	Tổng	Tỷ lệ đạt	Mục tiêu
PLO1	PI1.1	1	132083	Nghe 4 - Tiếng Hàn	CLO2	34	72	47.22%	60.00%
		2	132087	Nghe 6 - Tiếng Hàn	CLO2	53	59	89.83%	60.00%
		3	132097	Âm Hán và tiếng Hàn	CLO2	47	56	83.93%	60.00%
				Tổng hợp PI1.1		134	187	71.66%	60.00%
	PI1.2	4	132047	Ngữ pháp 4 - Tiếng Hàn	CLO1	48	73	65.75%	60.00%
		5	132074	Ngữ pháp 4 - Tiếng Hàn	CLO1	48	73	65.75%	60.00%
		6	132113	Ngữ pháp Viết 2 - Tiếng Hàn	CLO1	15	56	26.79%	60.00%
				Tổng hợp PI1.2		111	202	54.95%	60.00%
	PI1.3	7	132054	Nghe 2 - Tiếng Hàn	CLO1	27	56	48.21%	60.00%
		8	132106	Thực hành tiếng Hàn 3	CLO2	57	61	93.44%	60.00%
		9	132109	Thực hành tiếng Hàn 3	CLO2	57	61	93.44%	60.00%
		10	132112	Nói 2 - Tiếng Hàn	CLO1	56	56	100.00%	60.00%
		11	132020	Viết 4 - Tiếng Hàn	CLO1	50	61	81.97%	60.00%
				Tổng hợp PI1.3		247	295	83.73%	60.00%

Mã Sinh Viên	Họ	Tên	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
121000269	Vũ Ngọc	Anh	37.50%	87.50%	28.57%	44.12%	42.86%	53.13%		50.00%	
121000325	Lê Thị Lâm	Chi	62.50%	87.50%	64.29%	67.65%	78.57%	75.00%		62.50%	
121000423	Nguyễn Thị	Hiếu	81.25%	79.17%	57.14%	60.29%	35.71%	53.13%		62.50%	
121000766	Nguyễn Minh	Hiếu	62.50%	83.33%	92.86%	73.53%	85.71%	78.13%		75.00%	
121000987	Trần Minh	Hiếu	87.50%	87.50%	64.29%	64.71%	75.00%	71.88%		100.00%	
121000003	Hồ Lương Thị Mỹ	Ly	62.50%	80.83%	54.29%	58.82%	78.57%	68.75%		100.00%	
121000615	Hoàng Thị	Ly	87.50%	83.33%	71.43%	67.65%	78.57%	78.13%		100.00%	
121001383	Lê Minh Huyền	Mi	81.25%	79.17%	71.43%	48.53%	64.29%	68.75%		75.00%	
121001404	Lê Trọng	Mùi	50.00%	83.33%	57.14%	55.88%	75.00%	65.63%		50.00%	
119001429	Mai Phương	Nam	50.00%	79.17%	64.29%	67.65%	85.71%	75.00%		87.50%	
121001250	Mông Thị	Nguyệt	75.00%	83.33%	60.71%	67.65%	71.43%	78.13%		100.00%	
121001501	Nguyễn Thái	Nhân	75.00%	58.33%	64.29%	64.71%	64.29%	71.88%		100.00%	
121001196	Nguyễn Tuyết	Nhi	37.50%	33.33%	28.57%	47.06%	35.71%	59.38%		50.00%	
121001185	Nguyễn Ngọc	Phương	75.00%	83.33%	60.71%	64.71%	85.71%	68.75%		100.00%	
121001162	Mai Thị Bích	Phương	75.00%	83.33%	64.29%	61.76%	78.57%	71.88%		75.00%	
121000254	Đoàn Phạm Thanh	Tâm	62.50%	83.33%	78.57%	70.59%	82.14%	81.25%		75.00%	
121001286	Doãn Ngọc	Thiên	62.50%	79.17%	71.43%	47.06%	75.00%	62.50%		100.00%	
121000411	Huỳnh Thanh	Thủy	87.50%	75.00%	85.71%	61.76%	78.57%	75.00%		100.00%	

Figure 2.4: Student Learning Outcomes Evaluation

programs and assess student learning efficacy.

b) Some Basic Functions of the System The output standard measurement system at LHU provides a series of powerful functions to meet the needs of evaluating and improving the quality of education:

Mapping of Teaching and Learning Methods and Program Learning Outcomes: The system facilitates the association of Teaching and Learning Methods (TL) with designated Program Learning Outcomes (PLOs) (Table 2.1). Each Program Learning Outcome (PLO) is linked to several pedagogical approaches, including lectures, collaborative exercises, classroom dialogues, or computer-assisted activities. This feature guarantees that instructional activities directly facilitate the attainment of learning objectives.

Index	TL Methods	PLO1	PLO2	PLO3	PLOn
T01	Lecture	X			X
T02	Problem solving		X	X	
T03	Case study		X		
T04	Computer-based training				X

Table 2.1: Mapping of TL Methods & PLOs

Analysis through Performance Indicator: The system assesses Student Learning Outcomes through the performance indicator (PI) (Table 2.2) achievement level for each subject. Instructors can input and evaluate data to ascertain if students have met the learning objectives as outlined by the PI. This feature aids in monitoring student performance and assists lecturers in assessing the efficacy of instructional approaches.

Assessment of Student Learning Outcomes: A notable element of the system is its capacity to evaluate the achievement level of each student's output standards (Figure 2.4). The system consolidates data and assesses the attainment level of PLOs based on the outcomes of CLOs. This offers insight into the learning efficacy of each individual, assisting lecturers and administrators in making selections for enhancement.

Visualization of PLO Achievements: The system offers graphic charts to illustrate the attainment levels of PLOs (Figure 2.5). These charts assist administrators in efficiently

Index	Student Outcomes	Performance Indicators (PI) for outcomes
1	**Be able to apply knowledge, techniques, skills, and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to information engineering technology.**	• **PI 1.1:** Apply discrete mathematics or probability and statistics, and scientific knowledge to make solutions to address the functional requirement of information systems. • **PI 1.2:** Apply appropriate algorithms to devise solutions to the problems required. • **PI 1.3:** Implement algorithms using programming skills. • **PI 1.4:** Apply modern technical tools to model the proposed solutions.
2	**Be able to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to information engineering technology.**	• **PI 2.1:** Collect information (platform, user requests, data structures) to identify system functional requirements. • **PI 2.2:** Design an information system infrastructure architecture based on defined functional requirements.

Table 2.2: Performance Indicators (PI) of outcomes

analyzing and assessing learning objectives at the institutional level, therefore offering ways to enhance training programs more effectively.

c) Advantages LHU's output measuring system possesses numerous substantial features that effectively facilitate the evaluation and enhancement of educational quality:

Varied and extensive attributes: The system offers functionalities for mapping CLOs to PLOs, integrating teaching and evaluation methodologies, and conducting comprehensive analyses of the achievement levels for each PI, CLO, and PLO. This integration guarantees that the assessment process is conducted thoroughly and precisely, from the individual student level to the overall training program.

Facilitate comprehensive evaluation: The method emphasizes total learning outcomes while enabling a comprehensive review of each student's accomplishment levels in PI, PLO, and CLO. This facilitates the provision of comprehensive insights into individual learning efficacy, aiding educators and administrators in making data-driven enhancement decisions.

User-friendly and comprehensible interface: Well-structured visual tables and charts facilitate user comprehension of information. This is particularly beneficial for assisting lecturers and administrators in monitoring learning performance and identifying areas for enhancement.

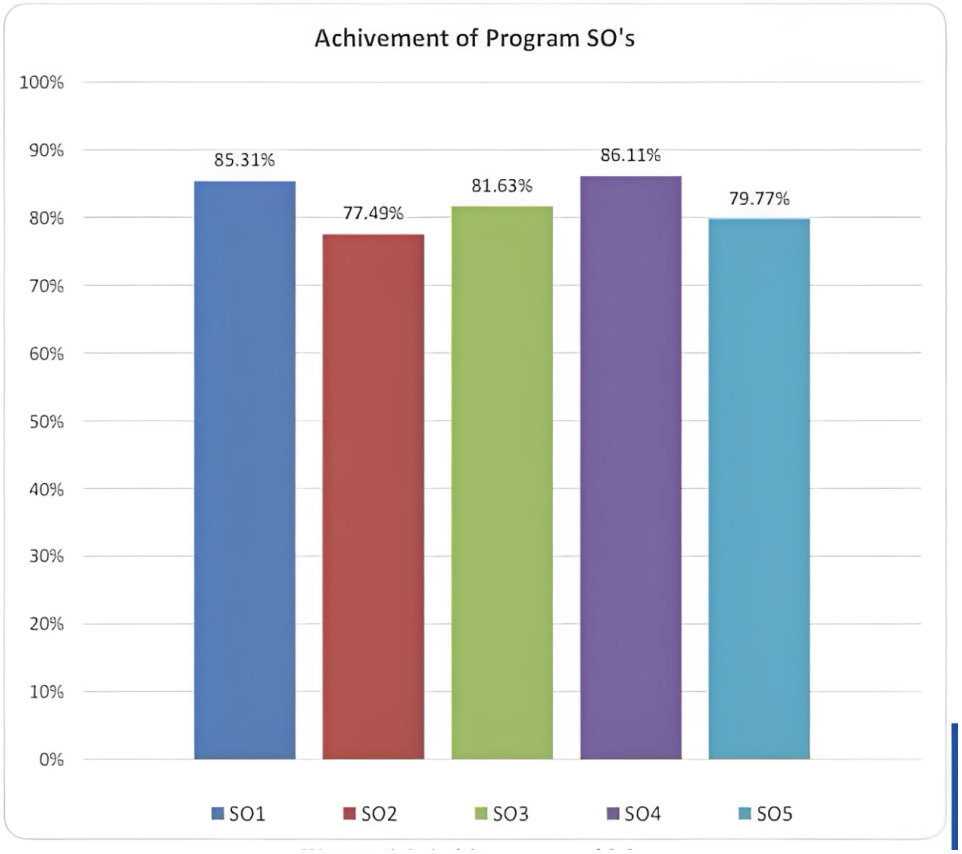


Figure 2.5: Visualization of PLO Achievements

Adhering to international norms: The system is designed according to worldwide quality accreditation standards, including ABET and AUN-QA, guaranteeing that the evaluation outcomes align with domestic criteria while also adhering to global norms.

d) Limitations Notwithstanding its numerous advantages, the LHU output standard measurement system possesses certain drawbacks that require enhancement:

The calculation approach is not applicable to all disciplines: Certain methodologies for assessing output standards may be incompatible with the features of specific disciplines. This may result in assessment outcomes that do not accurately represent students' genuine capabilities, hence diminishing the system's accuracy and reliability.

Complex procedure, resulting in challenges for instructors: The evaluation procedures, particularly the alignment of CLOs and PLOs or the input of PI data, can be intricate and perplexing, particularly for instructors unfamiliar with the system. This may diminish efficacy and establish obstacles to broad implementation.

The interface has an excessive number of functions: Despite the interface's straightforward design, the incorporation of excessive functionality on a single screen may overwhelm consumers. Utilizing and maneuvering through features becomes challenging, particularly for novice users.

Performance is not optimized: The system may experience performance challenges while managing substantial data quantities or several concurrent users. This is particularly significant in the context of major universities with numerous departments and faculties that require simultaneous access to the system.

2.3 Significance of the Research for Building EVALLOS

The purpose of this research is to conduct a comparative analysis of two learning management systems (LMS) – TDTU and LHU – to evaluate their potential contributions to the development of the EVALLOS system. This study focuses on examining and comparing the features, functionalities, and advantages of these systems, particularly in terms of their capacity to assess and manage Program Learning Outcomes (PLOs), Course Learning Outcomes (CLOs), and related performance indicators. By analyzing their methodologies and tools, this research aims to provide valuable insights into how these LMS platforms support student academic growth and achievement, thereby informing the design and enhancement of the EVALLOS system to better serve educational institutions.

2.3.1 Research Questions

1. What are the key features and functionalities of TDTU and LHU systems in supporting the management and assessment of learning outcomes?

2. How do the evaluation methods and tools of TDTU and LHU systems facilitate the management of Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs)?

3. What are the advantages and limitations of TDTU and LHU systems in contributing to the development and enhancement of the EVALLOS platform?

2.3.2 Principal Findings

The principal findings of this research indicate that TDTU and LHU systems provide robust features and functionalities that significantly support the management and assessment of learning outcomes. However, they differ in terms of their methodologies, tools, and user experience. The table 2.3 below summarizes the key differences:

These findings highlight the complementary strengths of TDTU and LHU systems. TDTU excels in academic process management and regulatory oversight, whereas LHU's system focuses on detailed outcome measurement and visualization. Insights from this comparative analysis will guide the development of EVALLOS, allowing it to integrate the best practices from both systems. By addressing limitations like outdated interfaces and complex procedures, EVALLOS can better support the effective management of learning outcomes and enhance overall educational quality.

2.3.3 Summary

The comparison of TDTU and LHU systems highlights their complementary strengths. TDTU excels in academic management with features like student violation tracking and CLO scoring, while LHU focuses on detailed performance measurement, offering advanced visualization tools and comprehensive PLO assessment. Despite limitations such as outdated interfaces and complexity, insights from both systems provide valuable guidance for developing EVALLOS to enhance learning outcome management and educational quality.

TDTU System	LHU System
Focuses on efficient academic management with features such as student infraction tracking, answer structure input for exams, and faculty assignment for CLO scoring.	Emphasizes detailed output measurement using performance indicators (PI) to assess CLO and PLO alignment, with extensive visualization tools for PLO achievements.
Provides functionalities for locking/unlocking exam groups and regulatory role-based access control to enhance data security.	Integrates teaching and learning methods with PLOs, offering comprehensive mapping tools for course syllabi.
Simplifies CLO management and ensures transparency in evaluating educational quality but offers limited visualization tools.	Offers advanced visualization features like PLO achievement charts and detailed analyses of PI for individual subjects.
User interface is outdated and may cause navigation difficulties for users.	Interface is clear but can overwhelm users due to excessive features on a single screen.

Table 2.3: Comparison of Features and Functionalities in TDTU and LHU Systems.

Chapter 3

Materials and methods

This chapter will give an overview of the project's approach, including the procedures used to assess CLOs, PLOs, and SLOs, analyse data, and make recommendations.

3.1 Techniques and Tools

a) Analysis and Design tool: Figma is a cloud-based online tool for user interface (UI) and user experience (UX) design, enabling users to create, share, and collaborate on designs in real time. Figma offers a versatile platform for interface design, prototyping, and design management, operating directly in the browser without requiring program installation. It is also expandable via plugins and design libraries, and accommodates design systems to maintain consistency in design products [17].

The architecture of the EVALLOS platform is based on reusable and modular components. The system's general layout is seen in Figure 3.1, where it is separated into a number of important tabs or parts, such as Education Programs, Courses, Classes, Exam Teams, Students, Accounts, Permissions, and a General section (Figure 3.2).

b) Version Control Git is a decentralized version control tool designed to monitor modifications in source code throughout the software development process. It allows multiple developers to work collaboratively on the same project, ensuring efficient tracking of code changes and streamlined management of different versions [18].

c) Front-end Development

JavaScript: JavaScript is a flexible programming language that facilitates the creation of interactive and dynamic functionalities on websites [19].

Redux: Redux is a library and architectural pattern that utilizes "actions" or events to handle and modify an application's state. By enforcing rules that ensure the state is updated in a consistent and predictable way, Redux serves as a centralized store for state management across the entire application [20].

React.js: React.js is an open-source JavaScript library developed by Facebook to simplify the intricate process of building interactive user interfaces [21].

Tailwind CSS: Tailwind CSS is a utility-based CSS framework that offers a collection of pre-defined classes, enabling developers to efficiently style HTML elements directly in their markup [22].

Shadcn/ui: Shadcn/ui is a library of React components designed to be both accessible and customizable, leveraging Tailwind CSS for styling [23].

d) Backend Development

Node.js is an open-source, cross-platform runtime environment for JavaScript, allowing developers to execute JavaScript code outside the browser. Built on Google Chrome's V8

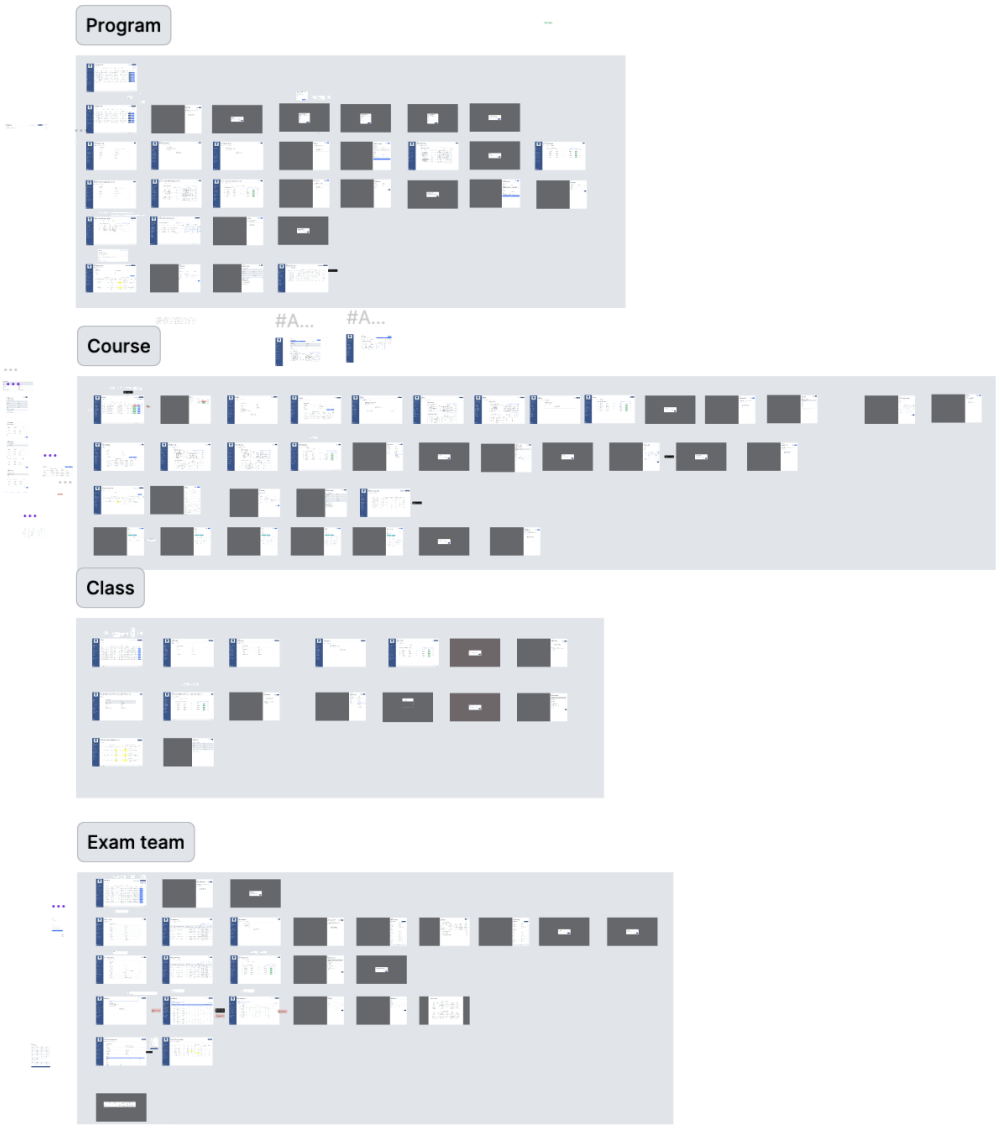


Figure 3.1: Overview figma board for UI design.

JavaScript engine, Node.js delivers high performance and efficiency [24].

Express.js is a minimal and flexible web application framework for Node.js, providing robust tools and features for building mobile and web applications [25].

e) Database

MongoDB is an open-source NoSQL database management system designed for efficiently handling large, distributed datasets. It is widely utilized for high-volume data storage, allowing organizations to rapidly store and manage extensive amounts of data [26].

3.2 Requirement analysis

Explicitly delineating and quantifying CLOs is essential for assessing the efficacy of a training program. CLOs are explicitly stated for each module, ensuring coherence and alignment with PLOs (Program Learning Outcomes) - the aims and results of the training program. The hierarchical link between CLOs and PLOs establishes a thorough assessment framework that enables institutions to discern strengths and shortcomings in their

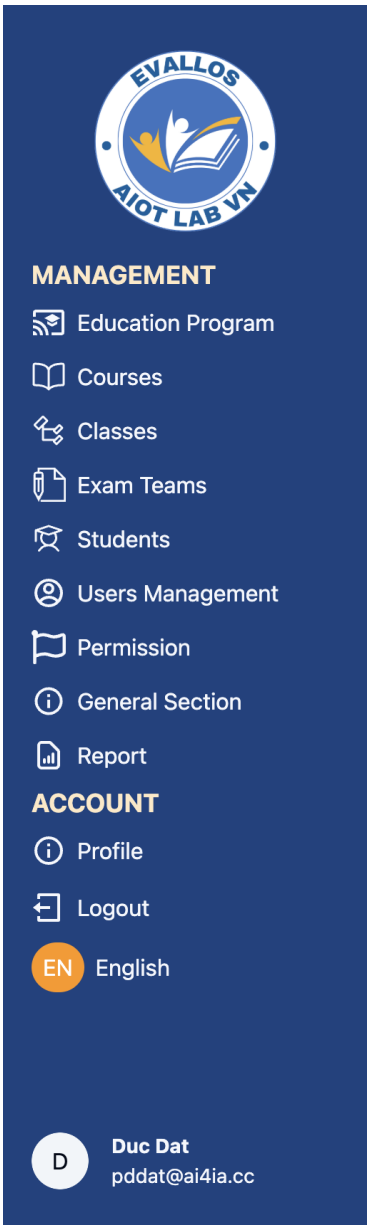


Figure 3.2: Main component of EVALLOS - Navigation Bar.

training programs, pinpoint areas for enhancement, and make data-informed decisions to elevate the overall quality of education. This systematic approach enables universities to guarantee that the assessment process is thorough, consistent with the institution's objective, and dedicated to the ongoing enhancement of student learning and accomplishment.

3.2.1 Test Structure and Answers

It is crucial to develop a comprehensive answer key and a clear test structure in order to guarantee an accurate evaluation of student performance. In order to facilitate the assessment and analysis of results, lecturers must select question types that are pertinent to the course content, ascertain the level of difficulty, and create precise answer keys. The test structure should be in alignment with the intended learning objectives and should offer a dependable assessment tool that can effectively evaluate students' knowledge and skills.

3.2.2 Statistical analysis of student test outcomes

In order to evaluate the effectiveness of CLOs, it is imperative to conduct a statistical analysis of student test scores. This function will enable the computation of statistical indicators, including average scores and score distributions, which will provide comprehensive information regarding students' overall performance and identify areas for improvement. Universities can enhance student achievement by assessing the efficacy of teaching methods, identifying learning deficits, and implementing the appropriate interventions through data analysis.

3.2.3 Conclusions and suggestions for enhancement

The evaluation of CLOs not only offers a perspective on the extent to which course objectives have been satisfactorily completed, but also serves as a foundation for the computation of PLO-related indicators.

Educational institutions can develop a more profound comprehension of the extent to which students achieve PLOs by assessing aggregated data from CLOs. The statistical analysis of PLO performance can be a potent instrument for the development of future program enhancements.

The results of CLO assessments can suggest whether students are performing exceptionally well or experiencing difficulty with the desired PLOs. This data can be employed to pinpoint areas of the training program that require revision, reinforcement, or modification in order to more effectively facilitate the attainment of PLOs.

The system will facilitate the computation of CLOs for each exam group, module, and PLO in the training program. Subsequently, instructors may obtain comprehensive reports that encompass data analysis and recommendations for enhancement. These reports not only contribute to the enhancement of the training program's content, but also guarantee that the program is consistently enhanced over time, with the objective of enhancing the efficacy of student assessment in relation to the training program's output standards.

This iterative process of assessment, analysis, and development contributes to the ongoing enhancement of the educational experience, thereby enhancing the quality of learning and the level of achievement of the desired PLO output standards.

3.3 System Design

The EVALLOS System Design (Figure 3.3) illustrates how various components interact to manage, analyze, and visualize educational data. On the Client side, a web interface built with React and Redux (supported by Tailwind CSS and Shadcn/UI) allows users often instructors or administrators to upload Excel/CSV files containing student scores and other pertinent information. These files are then transferred via HTTPS using a REST + JSON approach to a Server running Node.js and Express.

Within the server, business logic is organized into routes and controllers, which communicate with a MongoDB database over TCP/IP to persist data such as education programs, courses, classes, CLO/PLO definitions, and assessment scores. For data analysis and automated reporting, the server invokes a self-hosted Llama3 AI model. In parallel, the server also supplies datasets to a D3.js-based visualization module, which presents results in interactive charts and graphs. By decoupling each layer—client, server, database,

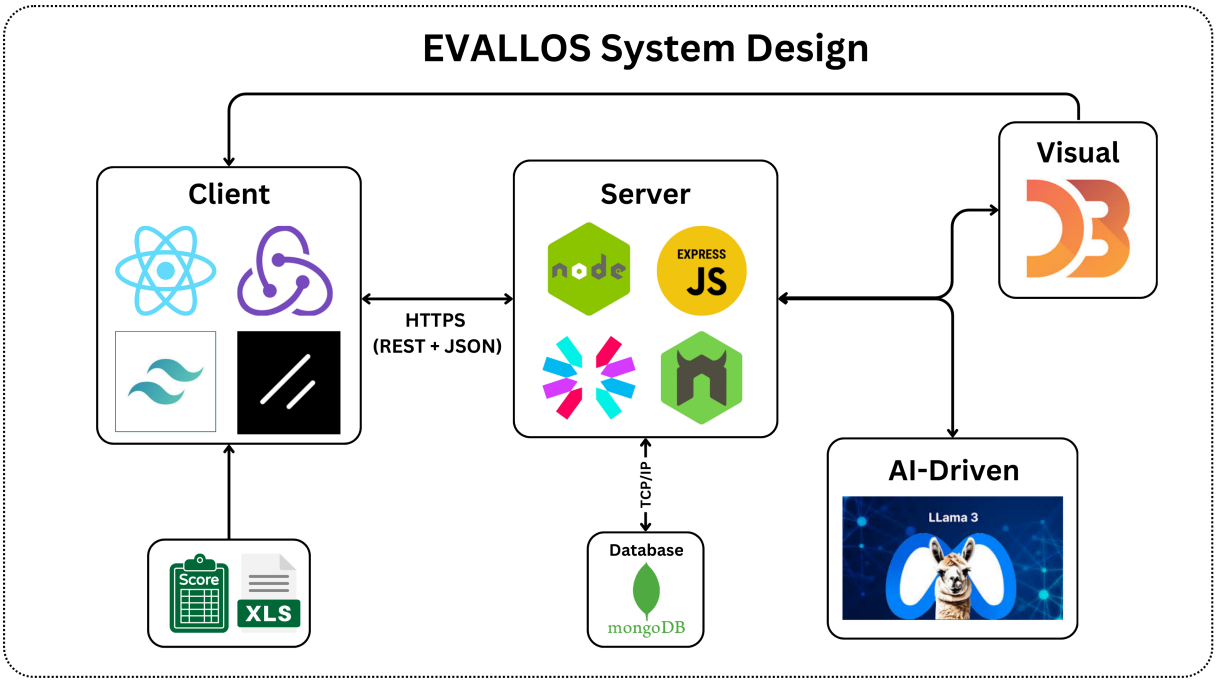


Figure 3.3: System design of EVALLOS Platform

AI, and visualization—the architecture achieves both scalability and flexibility, supporting everything from large-scale data imports to advanced analytics and AI-driven insights in a single cohesive platform.

Target Users The analysis is intended to be utilized by various stakeholders, including the Board of Directorss (BODs), Department Chairs, the Testing and Quality Assurance Centers (QACs), Training Department, and the instructors responsible for specific courses.

Stakeholder Descriptions: The relationship between the analysis findings and recommendations and stakeholders in Figure 3.4 is reciprocal; the analysis yields valuable information that aids stakeholders in making data-driven decisions and implementing suitable actions to assess and enhance both course learning outcomes (CLOs) and programs learning outcomes (PLOs). Figure 3.4 depicts the interaction between stakeholders and system functions.

Board of Director: The analytical results and suggestions assist the Board of Directors in establishing long-term strategic objectives. By assessing the curriculum's effectiveness in meeting CLOs and its alignment with PLOs, the Board may make informed judgments about resource allocation, curriculum enhancement, and overall educational strategy. This study assists the Board in identifying deficiencies for enhancement and prioritizing suitable efforts to ensure the curriculum's quality aligns with the organization's strategic objectives.

Department Chairs: Analysis is essential in curriculum formulation and modification. By evaluating the degree of attainment of CLOs and their alignment with PLOs, Chairs can discern the strengths and flaws within the course material. Utilizing the analytical data, they can determine course organization, modify teaching materials, and enhance instructional methods to ensure that the training program satisfies the CLO criteria and achieves the PLO objectives.

Testing and Quality Assurance Centers: QACs employs analytical results to systematically monitor and enhance educational quality. Evaluating student performance via CLOs and gauging the extent of PLO completion offers QAC a definitive understanding

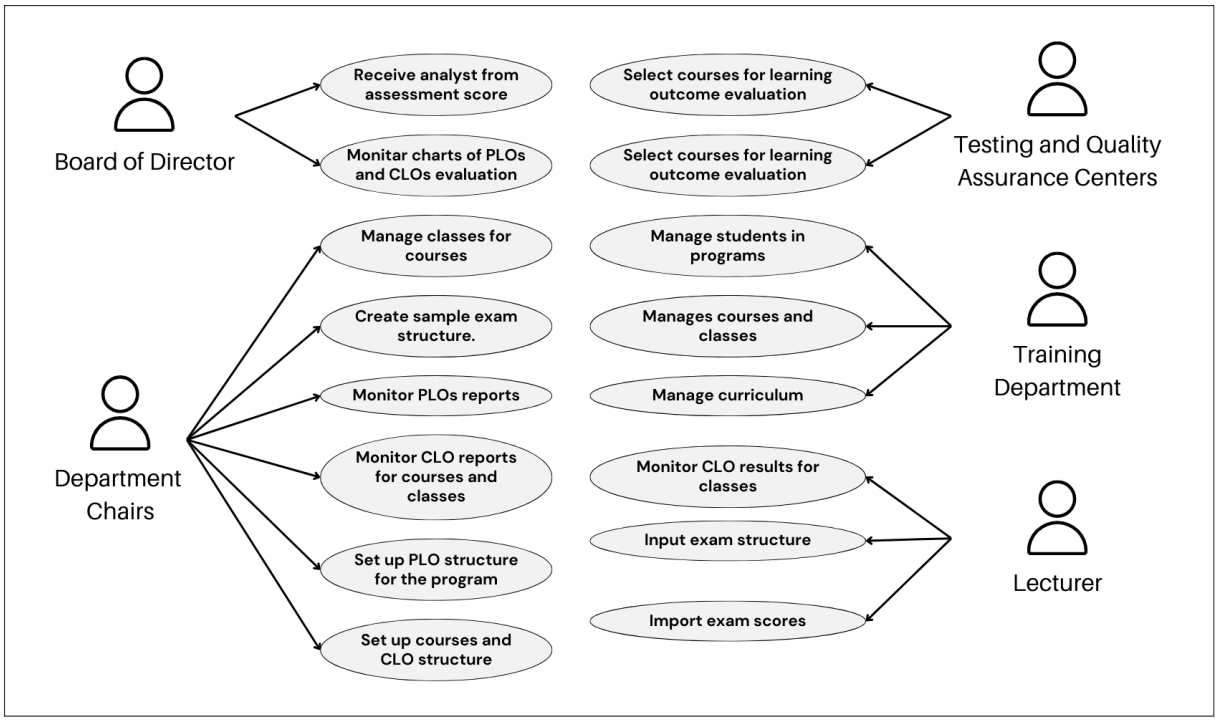


Figure 3.4: Use Case Diagram

of teaching quality, evaluation methodologies, and the pertinence of the training program. Based on this data, QAC can execute enhancement strategies to maintain the elevation of educational standards at both the course and training program tiers.

Training Department: The Training Department is responsible for coordinating and managing training programs informed by the analysis of CLOs and PLOs. The Department oversees the alignment of courses with the program's overarching learning outcomes, guaranteeing the relevance and currency of training content. The Training Department arranges faculty development events, enhances teaching methodologies, and assists students in achieving learning objectives.

The instructors: Educators utilize the findings from the investigation to modify instructional techniques and enhance educational efficacy. By analyzing student performance on CLOs and its correlation to PLOs, instructors can discern the deficiencies that students face. Subsequently, they modify their lectures, pedagogical approaches, and create suitable learning support activities, guaranteeing that students not only attain their Course Learning Outcomes (CLOs) but also progress towards their Program Learning Outcomes (PLOs).

Required Inputs: Examine the data requirements for score distribution, which encompass the number of students enrolled and the individual scores of each student. The score distribution data serves as a foundation for a comprehensive evaluation of student performance across modules and for the determination of the level of achievement of CLOs and PLOs in the training program.

Grade Distribution: Examine the data requirements for score distribution, which encompass the number of students enrolled and the individual scores of each student. This information will be crucial in evaluating student performance and determining the efficacy of each module in attaining CLOs.

The score distribution data enables a comprehensive evaluation of student performance across modules, thereby establishing a foundation for evaluating the level of achievement of CLOs. This analysis assists in the identification of high-achieving students, students at

risk, and performance patterns across various modules. This can subsequently result in the development of suitable interventions and the enhancement of programs. Furthermore, the data substantiates the calculation and evaluation of the achievement of PLOs throughout the entire program.

Objectives for PLO and CLO Achievement: It is imperative to establish explicit achievement objectives for both PLOs (Program Learning Outcomes) and CLOs (Course Learning Outcomes). These objectives will function as benchmarks for evaluate student performance, enabling a thorough evaluation of the program's alignment with the intended learning outcomes.

The identification of achievement objectives serves as a benchmark for evaluating pupil performance and evaluating the program's efficacy. Educational institutions can guarantee that students are adequately prepared to achieve the intended learning outcomes and make informed decisions in program design and assessment strategies by establishing clear expectations. Additionally, this evaluation serves as the foundation for the training program's overall PLO score.

Excel Files for the System: The management and organization of data in the system necessitates the utilization of numerous Excel files during the analysis process. These files are employed to input and retain pertinent information, including student rosters, test scores, grade distributions, and other pertinent data.

Excel files offer a structured and easily accessible format for organizing the data necessary for analysis. They ensure that information is organized and prepared for CLO assessment, PLO score calculation, and the compilation of in-depth analytical reports by supporting efficient data entry, manipulation, and analysis. The quality of training is also improved by implementing specific enhancements based on this data each school year.

3.4 Database design

3.4.1 Overview

The database system is constructed using MongoDB, a versatile and robust NoSQL database, to efficiently manage data pertaining to training programs, courses, classes, exam groups, and students. MongoDB has a document-oriented approach, wherein data is structured as collections and documents, rather than tables and relationships as found in relational databases (Figure 3.5).

3.4.2 Main Components (Collections)

EducationProgram: This collection stores information about training programs in the school, including: Training program name, Program code, Management faculty, Training duration, Degree type, Number of credits to complete, Program output standards (PLO).

Course: This collection manages information about the courses in the training program, with main information such as: Course code and course name, Number of credits of the course, Detailed description of course content, Course output standards (CLO).

Class: This collection stores information about classes, including: Class code and associated course code, Schedule, instructor, room, Number of students participating, Results achieved by CLOs from this class.

ExamTeam: This collection stores information about exam groups in the class, including: Exam type (midterm, final), Instructor in charge, School year, semester in which

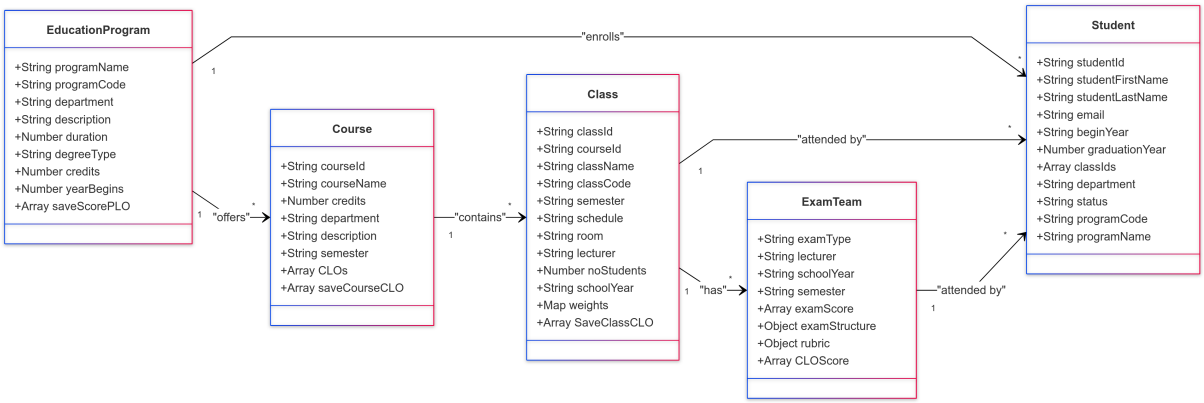


Figure 3.5: Class Diagram for EVALLOS System

the exam is held, Exam structure and grading criteria (rubric), Exam results and CLO achievement levels from this exam group.

ExamTeam This collection stores information about exam groups in the class, including: Exam type (midterm, final), Instructor in charge, School year, semester in which the exam is held, Exam structure and grading criteria (rubric), Exam results and CLO achievement levels from this exam group.

3.4.3 Relationships Between Components

The relationships between the components of the system reflect the logical connections that support the management and analysis of data within the database. These relationships ensure consistency, accuracy, and relevance, allowing the educational institution to evaluate and improve its programs effectively.

a) EducationProgram and Course: The relationship between an education program and its courses is characterized by a **1:N relationship**, where each program includes multiple courses. This structure ensures that each course is aligned with the intended learning outcomes (PLOs) of the program. The linkage between courses and the program provides a well-structured curriculum framework, where the courses collectively contribute to the achievement of the program's overall objectives. Additionally, this relationship enables the seamless tracking of course offerings under different programs, ensuring the consistency and quality of educational content delivered to students.

b) Course and Class: The connection between a course and its classes is defined by a **1:N relationship**, with each course capable of organizing multiple classes. Each class serves as a specific instance of the course offered during a semester. This relationship allows for effective management of various sections of the same course, each with its own schedule, instructor, and group of students. The flexibility provided by this structure enables educational institutions to cater to diverse student needs, optimize resource allocation, and maintain the integrity of course delivery.

c) Class and ExamTeam: A class and its associated exam teams have a **1:N relationship**, where a single class can host multiple exam teams. These exam teams are responsible for evaluating student performance through various assessments such as midterm exams, final exams, or project evaluations. This relationship supports a structured approach to assessing Course Learning Outcomes (CLOs), providing detailed insights into both individual and group performance. It also forms the foundation for continuous improvement in teaching methods and curriculum design by offering actionable data for analysis.

d) Class and Student: The relationship between a class and students is represented as a **N:M relationship**, indicating that a class can include many students, and each student can participate in multiple classes. This structure ensures that students are able to enroll in various classes to complete the courses required for their training programs. By facilitating comprehensive tracking of student participation across classes, this relationship enables effective monitoring of progress and performance, ensuring that students achieve their educational goals in alignment with the program's learning objectives.

e) ExamTeam and Student: The interaction between an exam team and students is described by a **N:M relationship**, where an exam team can include many students, and each student can participate in multiple exam teams. This relationship plays a crucial role in evaluating individual student performance in various assessments. The data collected through these assessments is used to evaluate specific Course Learning Outcomes (CLOs). By supporting detailed analysis of assessment results, this relationship provides valuable insights into the effectiveness of teaching methods and the overall attainment of learning objectives.

The structure of these relationships forms a robust database system capable of managing and analyzing data efficiently. It facilitates seamless integration of educational components, enabling institutions to assess student learning outcomes at both course and program levels. This systematic approach fosters continuous improvement in teaching, curriculum design, and overall educational effectiveness.

3.5 Theory Behind Calculating CLOs and PLOs Achievement

3.5.1 Bloom's Taxonomy

What Bloom's Taxonomy?

Bloom's taxonomy is a widely recognized framework for categorizing educational goals, first introduced in 1956 by a team of educators led by Benjamin Bloom (Figure 3.6). This taxonomy provides a structured way to classify learning objectives into three primary domains: cognitive (knowledge and intellectual skills), affective (emotions and attitudes), and psychomotor (physical skills and motor functions). Each domain is further organized into hierarchical levels, emphasizing the progression of skills and abilities. The taxonomy serves as a foundational tool for educators to design curricula, develop assessments, and implement effective teaching strategies to address diverse learning needs [27].

The cognitive domain, often considered the most prominent, originally consisted of six levels: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. In 2001, this domain was revised to include the following levels (Figure 3.7): Remember, Understand, Apply, Analyze, Evaluate, and Create, focusing on intellectual development and critical thinking. The affective domain outlines levels related to emotions and values, from basic awareness to complex beliefs, while the psychomotor domain, though initially less defined, addresses skill acquisition and physical coordination. Bloom's taxonomy remains a cornerstone in education, shaping instructional practices and fostering student-centered learning environments [28].

Why use Bloom's Taxonomy? Bloom's Taxonomy, in both its original and revised forms, serves as a valuable framework for educators to systematically design learning objectives, assessments, and instructional activities. By providing a clear structure for categorizing cognitive processes, the taxonomy helps instructors address various levels of

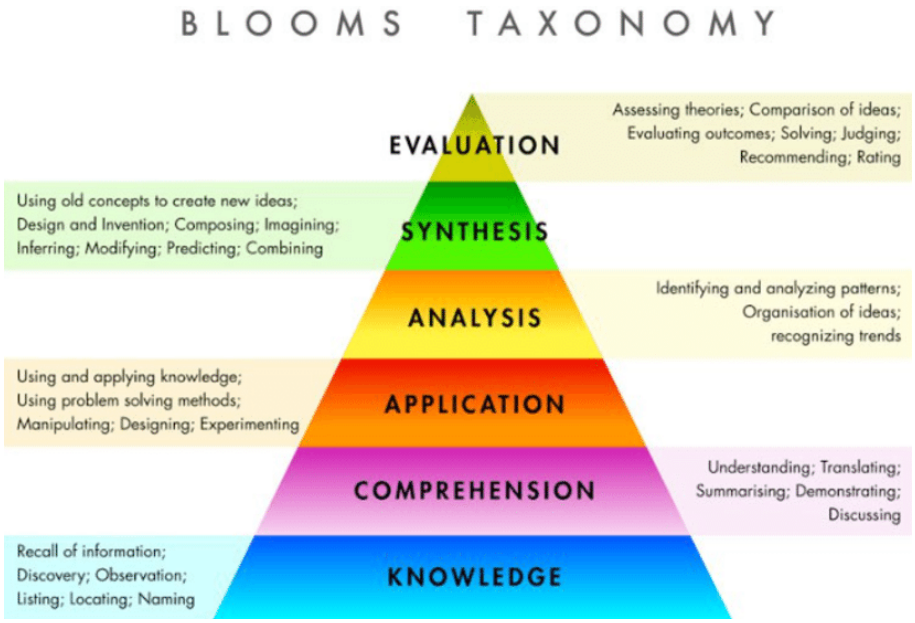


Figure 3.6: The 1956 blooms taxonomy.

complexity in learning, ensuring a comprehensive educational experience. From foundational skills like remembering and understanding to advanced abilities such as analyzing, evaluating, and creating, Bloom's Taxonomy enables educators to scaffold learning in a way that supports students' intellectual growth and critical thinking abilities.

One of the key benefits of using Bloom's Taxonomy is its ability to align teaching methods and assessments with desired learning outcomes. By incorporating activities and evaluations that target different levels of cognitive processes, educators can ensure that students are not only acquiring knowledge but also developing higher-order thinking skills. This alignment enhances student engagement, promotes active learning, and fosters deeper understanding, ultimately leading to improved academic performance and readiness to apply their knowledge in real-world contexts [29].

3.5.2 Employ Bloom's Taxonomy in the Evaluation of Program Learning Outcomes (PLOs)

Assessing Program Learning Outcomes (PLOs) is essential for evaluating the efficacy of educational programs and pinpointing areas for enhancement. Aligning Program Learning Outcomes with Bloom's Taxonomy enables institutions to guarantee that their educational objectives foster the cultivation of both fundamental and advanced cognitive talents. This systematic method enables a thorough assessment of educational results and promotes ongoing program improvement.

Bloom's Taxonomy offers a structured framework for categorizing learning objectives into six levels (Table 3.1): Remember, Understand, Apply, Analyze, Evaluate, and Create. Each level signifies a more intricate cognitive process, allowing educators to develop tests that correspond with these levels and embody the program's objectives. Moreira Gois et al. [30] underscored the significance of employing rubrics grounded in Bloom's Taxonomy for the assessment of student performance. These rubrics establish explicit criteria for evaluating learning outcomes, guaranteeing that assessments gauge not only knowledge retention but also critical thinking, problem-solving, and creativity.

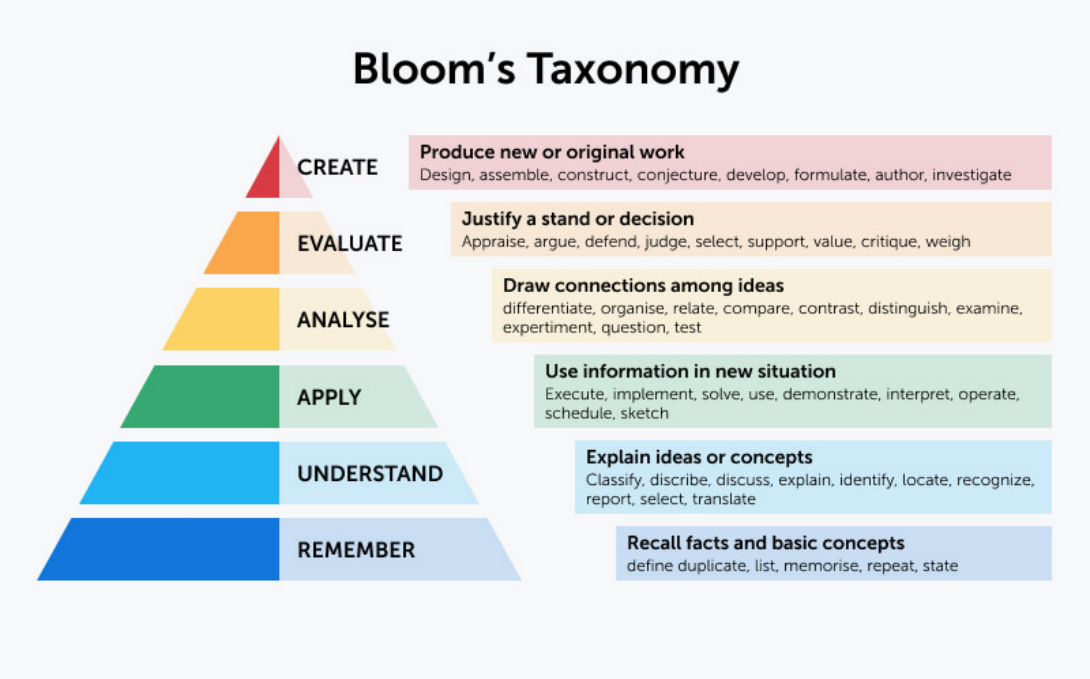


Figure 3.7: The revised blooms taxonomy.

Bloom's Taxonomy Level	**Description**
Understand and Remember	Evaluating students' capacity to comprehend and contextualize fundamental concepts within their discipline.
Apply	Assessing the application of academic knowledge by students in solving practical challenges or real-world situations.
Analyze and Evaluate	Assessing their capacity to deconstruct intricate difficulties, evaluate the efficacy of implemented solutions, and provide educated conclusions.
Create	Fostering creativity by prompting pupils to create novel strategies or solutions to tackle issues.

Table 3.1: Exemplary Evaluation of PLOs Using Bloom's Taxonomy Levels.

Rubrics developed for these assessments, such as those utilized at Concordia University, St. Paul, are essential instruments for upholding academic standards. The Curriculum & Instruction Center at Concordia created a thorough rubric that incorporates Bloom's Taxonomy for the assessment of course quality [31]. This rubric assesses courses according to general criteria, fundamental elements, and the structure of learning activities, emphasizing the development of higher-order cognitive skills like analysis, assessment, and creation. Through the implementation of these stringent requirements, Concordia guarantees uniformity in course quality and compatibility with institutional objectives [32].

Furthermore, the self-assessment methodology articulated by Moreira Gois et al. [30] underscores the capacity for students to participate in reflective learning. This method allows students to assess their competencies in issue comprehension, knowledge application,

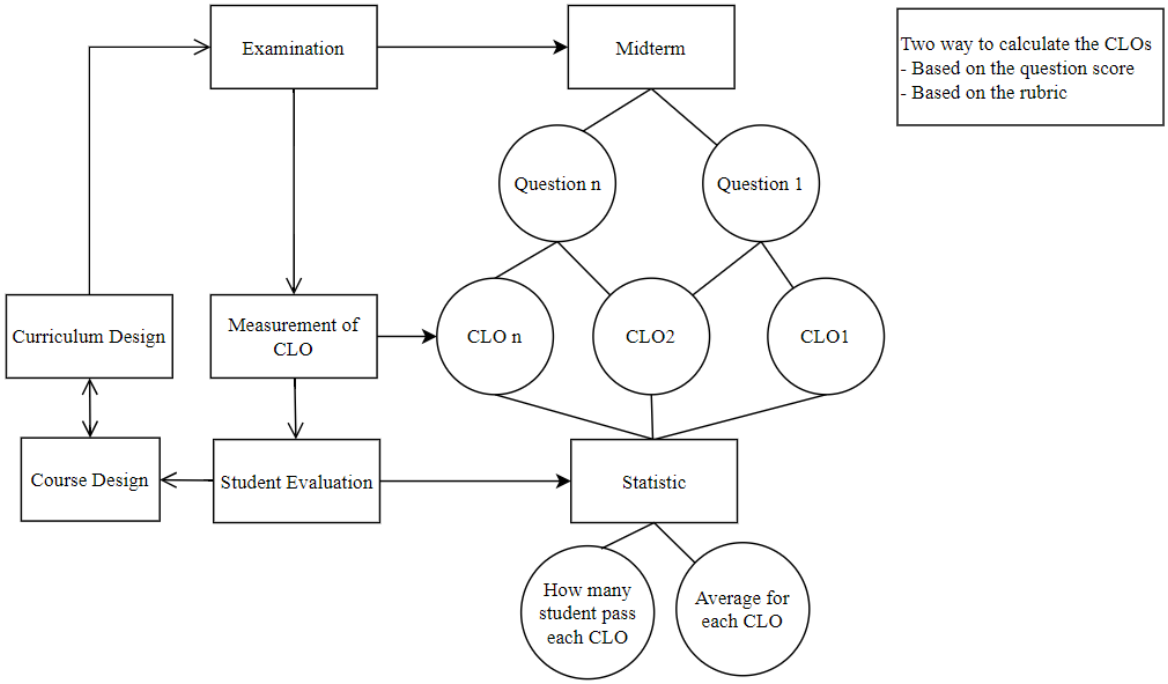


Figure 3.8: Workflow for calculating CLOs achievement by exam teams in EVALLOS.

data analysis, and solution creation. These techniques are very efficacious in promoting self-awareness and accountability in attaining PLOs, as evidenced by initiatives such as the SR program at Mackenzie Presbyterian University.

The incorporation of Bloom's Taxonomy within PLO assessments facilitates a methodical and clear strategy for evaluating program efficacy. Institutions might utilize these technologies to guarantee that their programs adhere to educational requirements while perpetually improving curriculum design and instructional methodologies. This iterative process enhances educational quality and equips students with the cognitive capabilities essential for success in professional and academic environments.

3.6 Methodology for Calculating CLOs Achievement

3.6.1 Methodology for Calculating CLOs Achievement by Exam Teams

The methodology for determining Course Learning Outcomes (CLOs) achievement in EVALLOS is designed to focus on analyzing the performance of students within specific exam teams. This approach builds on the curriculum regulations defined by International University VNU HCM (Second Law) [33], adapting established frameworks for quantitative analysis of CLOs. Furthermore, Abeywardena's study from Wawasan Open University [34] served as an inspiration for integrating matrix-based assessments to map student performance to CLOs across various assessment methods.

Note: Exam types such as midterm exams, final exams, and group presentations are included, as these assessments are directly linked to the CLOs.

The process leverages a question-to-CLO mapping matrix (Table 3.2), inspired by Abeywardena [34]. This matrix connects individual questions and rubrics to specific

CLOs	Assessment Methods	Assessment Questions
CLO1	Exam Type	Question 1 (Q1) Question 2 (Q2) Question 3 (Q3) Question 4 Rubric 1 (Q4.1) Question 4 Rubric 2 (Q4.2) Question 4 Rubric 3 (Q4.3)
CLO2	Exam Type	Question 1 (Q1) Question 4 Rubric 1 (Q4.1) Question 4 Rubric 2 (Q4.2) Question 4 Rubric 3 (Q4.3)
CLO3	Exam Type	Question 1 (Q1) Question 2 (Q2)
CLOn	...	Question n (Qn) Question x Rubric y (Qx.y)

Table 3.2: Matrix between Assessment Questions and CLOs.

CLOs. EVALLOS computationally traces student responses back to their associated CLOs, enabling the calculation of CLOs achievement percentages across exam teams. This detailed analysis supports longitudinal evaluation and refinement of learning outcomes.

3.6.1.1 CLOs Calculation Equations

The following equations are used to compute CLOs achievement:

$$\text{Average CLOs} = \frac{\sum_{i=1}^{n} \text{Number of Students Passing Question } i}{n} \tag{3.1}$$

$$\%\text{CLOs Achievement} = \frac{\text{Average CLOs} \times 100}{\text{Total Students in Exam Team}} \tag{3.2}$$

3.6.1.2 CLOs Mapping Matrix

The CLOs mapping matrix defines the relationship between assessment questions and CLOs. Table 3.2 illustrates an example:

3.6.1.3 Rubric-Based Evaluation

Student performance for rubric-based assessments is evaluated according to pre-defined performance levels. Each rubric level corresponds to a percentage range, as shown in Table 3.3.

Rubric	Score Range	Evaluation Levels
Rubric 1	0% - 100%	Level 1 (0% - 49%): Inadequate Level 2 (50% - 59%): Adequate Level 3 (60% - 79%): Good Level 4 (80% - 100%): Excellent
Rubric 2	0% - 100%	Same as Rubric 1
Rubric 3	0% - 100%	Same as Rubric 1
...	...	...

Table 3.3: Rubric Levels and Evaluation Criteria.

3.6.1.4 Student Pass Criteria

For numeric assessment questions, a student is considered to have passed if their score is 50% or higher of the maximum possible score. For rubric-based evaluations, students must achieve at least Level 2 (50% - 59%) to be deemed passing. This ensures consistency in evaluating CLOs achievement across different exam teams and assessment formats.

The outlined methodology provides a comprehensive framework for assessing CLOs achievement, enabling precise tracking and analysis of learning outcomes at the exam team level. This approach supports continuous program improvement and aligns with institutional educational goals.

3.6.2 CLOs Achievement by Classes

EVALLOS enables the calculation of CLOs achievement at the class level, incorporating various grading components such as presentations, midterm exams, and final exams. Instructors define the grading criteria, including the Pass Threshold (%), which sets the minimum required percentage to achieve a CLO, and Exam Type Weights, which determine the relative importance of each assessment type (e.g., Presentation: 30%, Midterm: 30%, Final Exam: 40%).

The CLO achievement for a class is calculated using a weighted average:

$$\text{CLO Achievement (Class)} = \sum_{i=1}^{n} \big(\text{CLO Achievement (Assessment}_i\big) \times \text{Weight}_i\big) \quad (3.3)$$

Here,

- *CLO Achievement (Assessment$_i$)* is the average achievement for the i-th assessment.
- *Weight$_i$* is its assigned weight.

This approach provides a balanced evaluation by accounting for the significance of each assessment type.

By calculating weighted averages, instructors can evaluate class-level CLOs effectively, gaining insights into student performance and identifying areas for improvement. This systematic method supports continuous enhancement of teaching practices and ensures alignment with program-level objectives.

3.6.3 CLOs Achievement by Courses

EVALLOS provides a systematic methodology to calculate CLOs achievement at the course level by aggregating the results from all classes within a course. This approach allows instructors to analyze the average performance of each CLO across all classes in a specific course, enabling data-driven improvements over time.

The calculation of course-level CLOs is based on the average achievement of each CLO from all classes associated with the course. The formula is as follows:

$$\text{CLO Achievement (Course)} = \frac{\sum_{i=1}^{n} \text{CLO Achievement (Class}_i\text{)}}{n} \tag{3.4}$$

Here:

- *CLO Achievement (Class$_i$)* represents the achievement of a specific CLO in the i-th class of the course.
- n is the total number of classes associated with the course.

This aggregated calculation provides instructors with insights into how CLOs are being achieved across multiple classes, helping to identify trends and areas for improvement.

By tracking CLO results over semesters and academic years, instructors can monitor progress and implement targeted strategies to enhance the quality of the course. This longitudinal analysis ensures continuous refinement of the course content, teaching methods, and assessment strategies, ultimately leading to better alignment with program-level learning outcomes.

3.7 Methodology for Calculating PLOs Achievement

EVALLOS provides a structured framework for evaluating Program Learning Outcomes (PLOs), integrating quantitative and qualitative data to ensure comprehensive assessment. This methodology draws inspiration from systems like QOBE [35], which link Course Learning Outcomes (CLOs) to PLOs to monitor and improve student progress under the Outcome-Based Education paradigm. By leveraging these practices, EVALLOS facilitates data-driven decision-making to enhance teaching effectiveness and curriculum design.

3.7.1 CLOs and PLOs Matrix in EVALLOS

The QOBE system [36] highlights the importance of linking CLOs to PLOs to ensure alignment with key performance indicators (KPIs) at the program level. The evaluation process incorporates data from exams, assignments, and other assessments, using this information to calculate PLO achievement rates. A study in the *International Journal of Innovation in Teaching and Learning (IJITL)* [35] demonstrated a matrix approach to mapping CLOs to PLOs, similar to the methodology adopted by EVALLOS. The matrix is illustrated in Figure 3.9.

CLO	PLO	CLO Weight * credit	Assessment Methods					Marks obtained in CLO
			Midterm Marks	Test Marks	Problem-based learning assignment	Final marks	Exam	
CLO1	PLO1	0.25 x 3 = 0.75	16/20= 0.8	3/5= 0.6				19/25= 0.76
CLO2	PLO4	0.34 x 3 =1.02		4/5= 0.8	4/5=0.8	20/24= 0.83		28/34= 0.82
CLO3	PLO3	0.41 x 3 =1.23			4/5=0.8	30/36= 0.83		34/41=0.83
Total		3	Weighted Average					81%

Figure 3.9: CLOs and PLOs matrix in EVALLOS.

This matrix captures the contribution of each CLO to its respective PLO and outlines the assessment methods used. It enables institutions to track student performance and ensure effective teaching practices.

3.7.2 Formula for Calculating PLOs Achievement in EVALLOS

In EVALLOS, PLOs are calculated by aggregating data from CLO achievements across different courses. This process incorporates numerical scores and qualitative evaluations via rubrics, providing a holistic view of student performance. As CLOs are mapped to PLOs, the system evaluates higher-order cognitive development based on Bloom's Taxonomy [37].

The following formulas are used to calculate PLOs achievement:

$$\text{AveragePLOs} = \frac{\sum_{i=1}^{n} \text{No. of Students Passing CLOs}_i}{n} \tag{3.5}$$

$$\%\text{PLOs Achievement} = \frac{\text{AveragePLOs} \times 100}{\text{Total Students in Program}} \tag{3.6}$$

These formulas calculate the percentage of students who successfully meet CLO-linked requirements, providing actionable insights into program-level learning outcomes.

3.7.3 PLOs and CLOs Matrix in EVALLOS

A key component of EVALLOS is the mapping of CLOs to PLOs, enabling institutions to track how courses contribute to overall program goals. Table 3.4 demonstrates this relationship.

	PLO1	PLO2	PLO3	...	PLOn
CLO1	X				
CLO2		X	X		X
...					X
CLOn	X	X		X	

Table 3.4: Matrix between CLOs and PLOs.

This matrix provides a clear overview of how individual CLOs contribute to achieving PLOs. By analyzing this alignment, institutions can identify strengths and areas for improvement, ensuring that program objectives are consistently met.

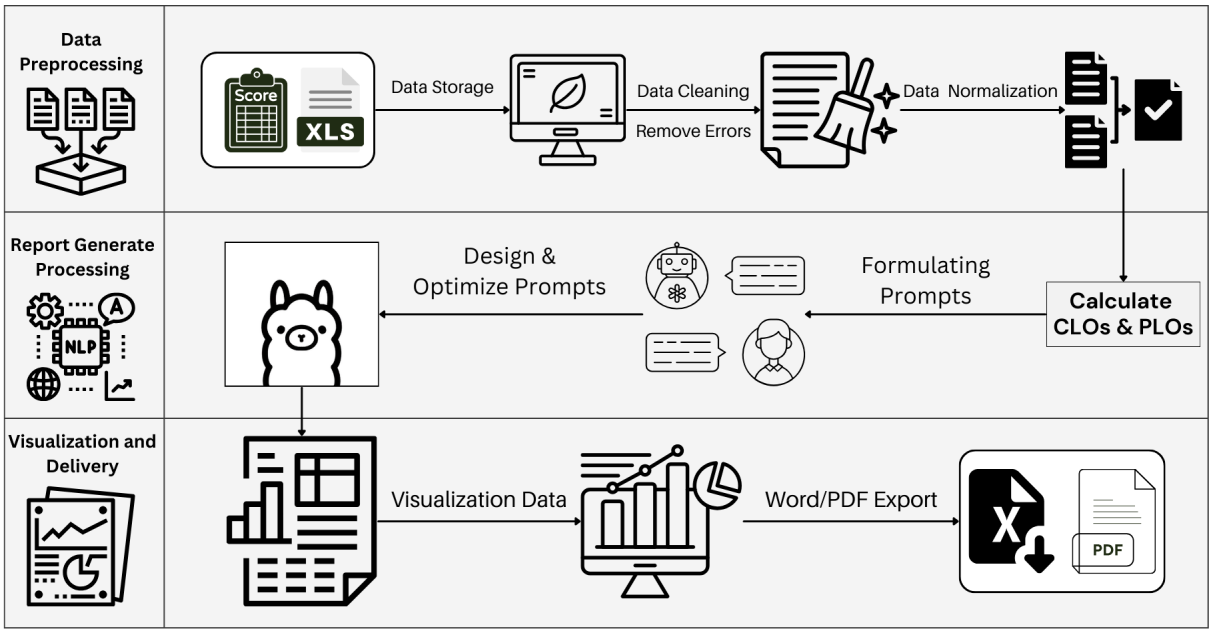


Figure 3.10: AI-Driven Workflow for Generating PLO and CLO Reports

3.7.4 Continuous Improvement Through PLO Analysis

EVALLOS tracks PLO achievements across semesters and academic years, enabling institutions to analyze trends and implement targeted improvements. By identifying patterns in CLO and PLO performance, instructors and others actors can refine teaching strategies, enhance curriculum design, and align assessments with desired outcomes. This iterative process ensures continuous quality improvement and maintains alignment with institutional goals.

3.8 AI-Driven Workflow for Generating PLO and CLO Reports

The AI-driven PLO and CLO Reporting Process automates and enhances the evaluation of Program Learning Outcomes (PLO) and Course Learning Outcomes (CLO). This procedure incorporates sophisticated technologies including the MongoDB database management system, data processing, and large language models (LLM) to guarantee precise, efficient, and informative reporting.

Data is extracted from the EVALLOS system, purified, and standardized prior to utilization. Subsequently, prompts are constructed to direct the AI model (such as Llama3) in producing reports that fulfill the assessment criteria. The final report is meticulously structured, incorporating charts, tables, and enhancement recommendations, facilitating user accessibility and utility.

This technique automates report generation and assists lecturers and administrators in making data-driven decisions, refining program design, and elevating educational quality.

3.8.1 Data Preparation and Retrieval

Data Collection and Storage: Lecturers input grade data into the system via the management interface, encompassing midterm and final test scores, assignment scores,

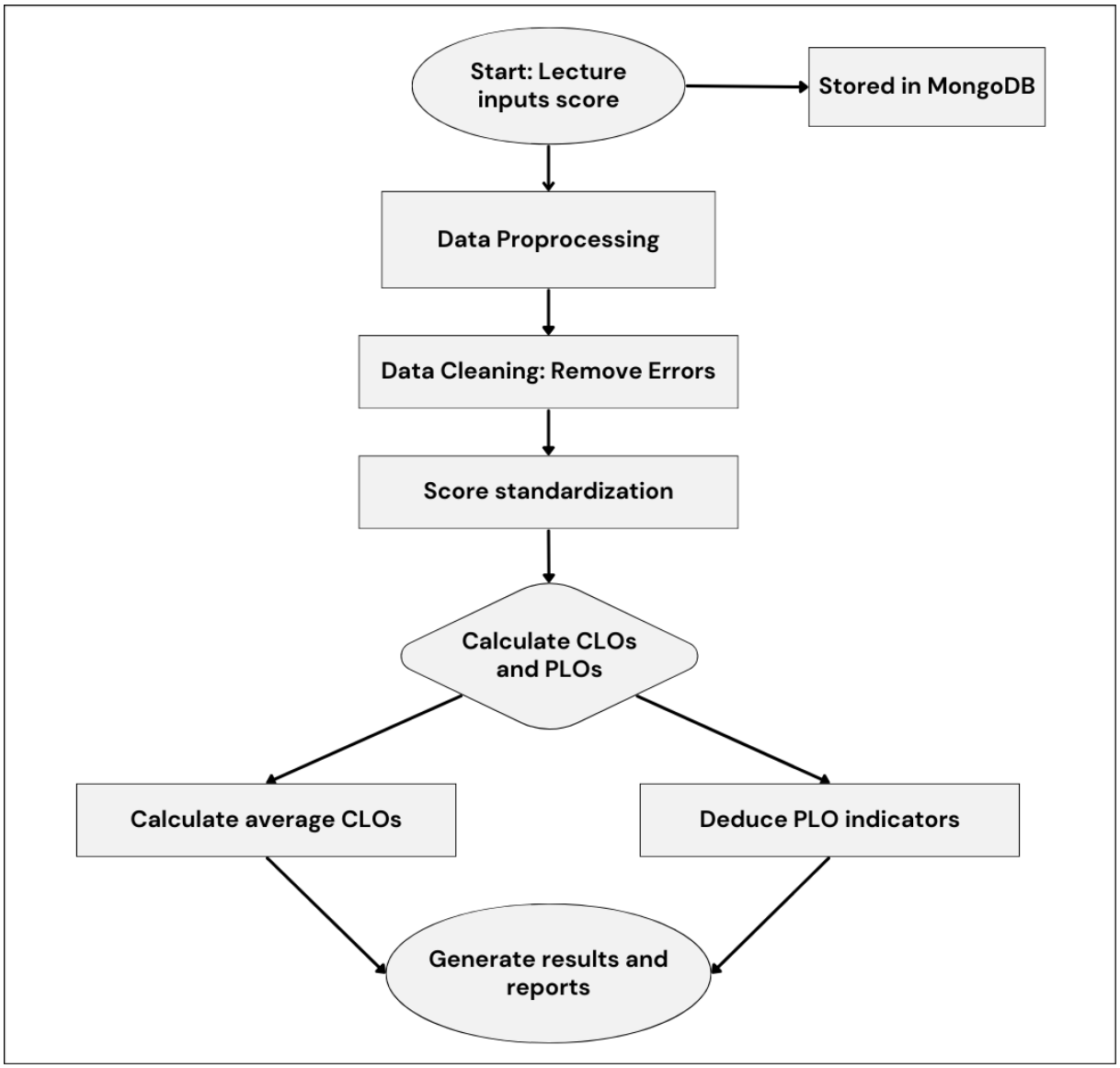


Figure 3.11: Step by step for data preparation and retrieval

presentations, and comprehensive comments from lecturers. All of this information is kept in the MongoDB database, a contemporary NoSQL platform that facilitates the effective management and processing of extensive data. MongoDB facilitates flexible querying and processing of unstructured data, effectively organizing information regarding students' learning processes. Due to its document-oriented storage methodology, MongoDB can effectively manage intricate items like grade structures and lecturer feedback, hence streamlining subsequent data processing and analysis (Figure 3.10).

Data Preprocessing: To guarantee quality and consistency, the gathered data undergoes a comprehensive pre-processing procedure. Initially, Data Cleaning is conducted to eliminate absent or erroneous values, including points that surpass permissible limits or asynchronous data, which may compromise the analysis outcomes. The data is subsequently normalized by the application of format synchronization techniques. This entails standardizing all scores to a uniform % scale, hence ensuring uniformity in processing algorithms and facilitating integration into following computation phases. This step is essential for preparing the data for precise analysis and review.

Calculating CLOs and PLOs: Upon completion of cleaning and standardization,

the system will process the data to compute the indicators for CLOs (Course Learning Outcomes) and PLOs (Program Learning Outcomes). The procedure commences with the classification and mapping phase, wherein results from tests, assignments, and presentations are associated with the relevant CLOs via a mapping matrix. This matrix enables the system to ascertain the correlation between each score type and certain CLOs, hence ensuring precision and thoroughness in data processing. The algorithm subsequently computes the average score for each CLO in the course by utilizing established formulas. The outcomes of this phase will be utilized to deduce the program's PLO indicators, offering a summary of student performance and the efficacy of the training program.

3.8.2 Formulate and Modify Prompts

Preliminary Prompt Formulation: The preliminary quick design approach seeks to explicitly delineate the precise specifications for the report. This phase involves generating educational evaluation questions that concentrate on Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs). It is essential to ascertain the preferred format of the report, encompassing content organization, visual charts, data tables, and comprehensive analysis. The initial prompt is to direct the large language model (LLM) to produce a report that aligns with the analytical objectives and fulfills the user's specifications.

Modifying and Enhancing the Prompt: Upon receiving the model's output, the system will evaluate the report's quality to identify inconsistencies or unsuitable elements. Following this examination, the prompt will be modified to enhance the report's content and organization. A/B testing methodologies are employed during the optimization process to evaluate several iterations of the prompt. The model will receive these versions to assess output performance. The optimal version of the prompt will be chosen based on parameters including accuracy, content completeness, and alignment with the requirements, hence ensuring the highest quality of the created report.

3.8.3 Generate Reports using LLM (Self-Host Llama3 Model)

LLM Model Deployment: The system employs Llama3, a large language model (LLM), hosted on a dedicated server to guarantee optimal security and oversight. Llama3 was selected for its superior natural language processing accuracy, capable of fulfilling intricate demands such as creating PLOs and CLOs assessment reports. To guarantee the model's efficacy, the hardware and software configurations were tuned, encompassing the fine-tuning of parameters like batch size and learning rate. These optimizations greatly enhance the model's efficacy in producing precise and automatic results.

The Llama3 hosting server is equipped with robust hardware to manage substantial workloads. The NVIDIA Corporation GA100 GPU [A100 SXM4 80GB] offers exceptional computational performance, while the AMD EPYC 7742 CPU with 64 cores guarantees effective multi-threading. 64GB of RAM facilitates extensive data processing while minimizing latency. The Ubuntu 22.04.5 LTS operating system was selected for its stability and security, accompanied with PyTorch library version 2.4.1+cu121 to enhance hardware compatibility and facilitate advanced model functionalities. This design guarantees great performance while preserving security and control throughout the data processing procedure.

Transmit Prompt and Obtain Output: Prompts that are meticulously crafted and optimized are transmitted to the Llama3 model through an interactive interface or

API, guaranteeing a seamless and adaptable integration. The model is guided to generate a report that is specifically tailored to the user's requirements by each prompt being meticulously customized. A comprehensive report is automatically generated by Llama3 after the data processing pipeline is executed upon receipt of the request. This report comprises intuitive visualizations, specific data tables, in-depth analysis, and professionally formatted content, all of which are predicated on the data that has been supplied. This procedure bolsters the capacity to facilitate data-driven decision-making while also guaranteeing accuracy.

3.8.4 Report Format and Completion (PDF and Word Files for Export)

Report Format: The report formatting process commences with the transformation of text produced by the Llama3 model into professional document formats, including Word and PDF. Tools like python-docx and PDFKit provide automated, rapid, and precise format conversion, adhering to elevated display criteria. Simultaneously, charts and tables are directly derived from the source data with the D3.js framework. This library facilitates the development of interactive charts and visual representations, augmenting the capacity to communicate information and rendering the report more comprehensible and vibrant.

Completion and Quality Assurance: Post-formatting, the report undergoes meticulous verification to confirm its accuracy and adherence to the prescribed formatting standards. The system employs a substantial language model (LLM) like Llama3 to autonomously verify the content for grammatical, typographical, and logical inaccuracies. The model may analyze context to identify flaws or inconsistencies in the text. The technology enables users to submit immediate feedback via the management interface, facilitating the identification of necessary enhancements. Following the comments and the results of the evaluation, the report has been finalized, guaranteeing that the document is of superior quality and satisfies the stakeholders' needs.

3.8.5 Advanced Data Visualization

Generate Automated Charts Utilizing D3.js and Artificial Intelligence: The solution use D3.js, a robust library for generating data visualizations, in conjunction with AI to autonomously analyze and extract significant insights from score data and teacher input. Initially, AI is utilized to process and analyze data, identifying significant patterns, anomalies, and trends. Subsequent to processing, the data is standardized into data points prepared for visualization. D3.js is subsequently employed to generate dynamic visualizations, including bar charts, pie charts, and scatter plots. These charts not only display data graphically but also facilitate user engagement through hovering or clicking to examine details, so offering a more natural and streamlined analytical experience.

Assisting Boards of Directors in Acquiring Insights into Training Programs: The integration of D3.js and AI facilitates robust visualizations, enabling leaders to comprehend indicators such as the status of CLOs and PLOs, score trends across semesters, and the efficacy of instructional techniques. These charts offer a thorough and extensive perspective, enabling executives to make informed decisions to enhance the quality of training programs.

3.8.6 Automated Recommendation Generation

Integrated Method: A large language model (LLM) processes the scores and feedback data from teachers, delivering comprehensive analysis of patterns and concerns within each course. LLM possesses the capability to comprehend and evaluate intricate data, offering lucid insights into learning efficacy, student success rates, and opportunities for enhancement. The analysis enables the system to autonomously produce targeted recommendations, such as modifying instructional strategies to enhance student comprehension, including suitable educational resources, or prioritizing essential topics in instruction. Furthermore, LLM identifies essential modifications in the exam structure or course content to enhance the pass rate.

Instructor Assistance: The system-generated recommendations are explicitly included in the report, offering instructors a valuable resource for implementing necessary enhancements. Utilizing LLM guarantees a rapid and precise analytical process, delivering insights grounded in actual data. This facilitates instructors in making adjustments to enhance course quality and more effectively addresses students' learning needs. Consequently, training efficiency is enhanced, resulting in the creation of more comprehensive and high-quality educational programs.

3.8.7 Results From AI Report Generation Process

The EVALLOS system employs artificial intelligence to autonomously produce comprehensive reports, assisting educators and administrators in assessing the efficacy of student learning across various levels. The reports are enhanced and attractively displayed, concentrating on two primary categories:

Program Learning Outcomes Report: Offers a summary of the standard level of PLOs within the training program. This report presents indicators regarding the percentage of students achieving standards for each Program Learning Outcome (PLO), trend analysis between semesters, and identified areas for enhancement. This assists program leaders in making strategic decisions to enhance training quality at the program level.

Course Learning Outcomes Report: Detailed by subject, class, and exam team. CLO reports furnish comprehensive data on student learning outcomes in each course, encompassing pass rates by CLO, score data analysis, and instructional efficacy. This report aids educators in comprehending the efficacy of pedagogical approaches and facilitates prompt modifications to enhance the curriculum.

These reports offer both clear and intuitive data and function as effective instruments for enhancing training programs. Utilizing AI, the reports are formatted professionally (Word, PDF) and include explanatory charts and tables, facilitating stakeholders' comprehension and informed decision-making.

Chapter 4

Results

4.1 Implementation and Evaluation for Course Learning Outcomes

4.1.1 Exam Teams CLO Scores

4.1.1.1 Exam Teams Management Interface

The EVALLOS platform enables the administration of examination groups, permitting teachers to categorize assessments by kind (e.g., midterm, final, group presentation). Designated lecturers can employ the system's functionalities to evaluate and alter the examination framework (Figure 4.1).

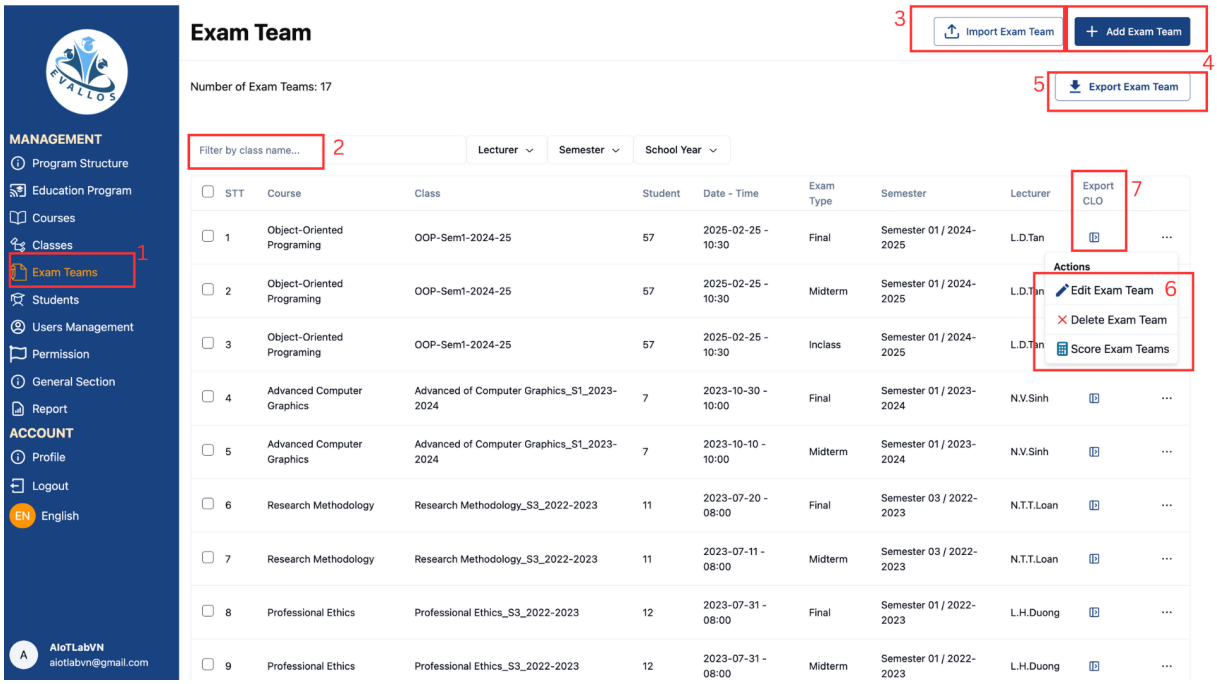


Figure 4.1: Exam Teams Table Management

Steps to Manage Exam Teams

- Step 1: Choose the "Exam Teams" tab from the management menu to access the examination groups (point 1).

- Step 2: Utilize the search bar to refine exam teams by class designation (point 2).
- Step 3: Upload several examination teams using an Excel file by selecting "Import Exam Team" (point 3).
- Step 4: Establish a new examination team by selecting "Add Exam Team" (point 4).
- Step 5: Export the list of examination teams by selecting "Export CLO" column (point 5).
- Step 6: Execute actions such as changing, deleting, or scoring exam teams via the options provided in the actions menu (point 6).
- Step 7: Produce CLO assessment reports by choosing the relevant option (point 7).

4.1.1.2 Mapping and Rubrics

A comprehensive Question-CLO Matrix (Table 4.1) is created to depict the correlation between specific questions and the Course Learning Outcomes (CLOs) they aim to evaluate. This matrix ensures that all required learning outcomes are adequately assessed.

Question/CLO	**CLO1**	**CLO2**	**CLO3**
MCQ Q1a	X	X	X
MCQ Q1b	X	X	
MCQ Q1c		X	X
MCQ Q1d			X
MCQ Q1e	X		X
MCQ Q1f	X	X	
MCQ Q2a	X	X	X
MCQ Q2b		X	
MCQ Q2c	X		X
MCQ Q2d			
MCQ Q3a	X		X
MCQ Q3b	X	X	
MCQ Q3c			X
MCQ Q3f	X		X
WQ1 criteria1	X	X	X
WQ1 criteria2		X	
WQ1 criteria3	X		X

Table 4.1: Matrix of Question CLOs.

4.1.1.3 Score Tracking and Inputs

Score tracking is facilitated using an examination group score table that allows professors to input and monitor student results systematically (Figure 4.2).

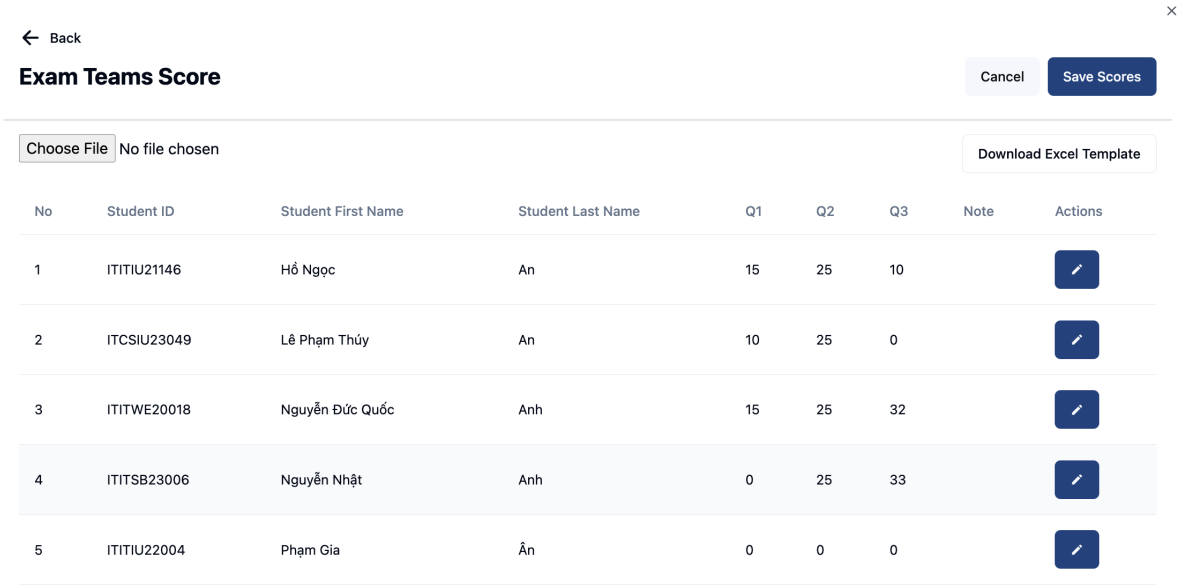


Figure 4.2: Score table of the exam group.

4.1.1.4 Configuring Exam Teams CLO Scores

The Exam Teams CLO Scores interface (Figure 4.3) offers lecturers a range of configurable options to facilitate precise evaluation of student performance. Lecturers can define the Pass Threshold (%), establishing the minimum percentage required for a student to achieve a CLO. They can also select appropriate rubrics to ensure performance is evaluated consistently and fairly. Additionally, the system allows setting Expected Pass Scores for each CLO (Figure 4.4), aligning the evaluation process with institutional objectives and ensuring that assessments meet the desired educational standards. These settings provide flexibility and accuracy in tailoring assessments to the specific needs of each course and exam team.

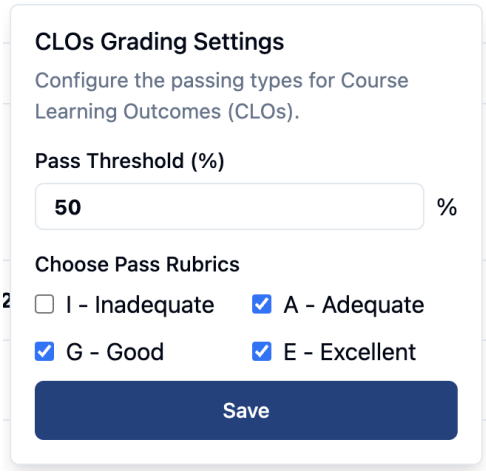


Figure 4.3: CLOs Grading Settings

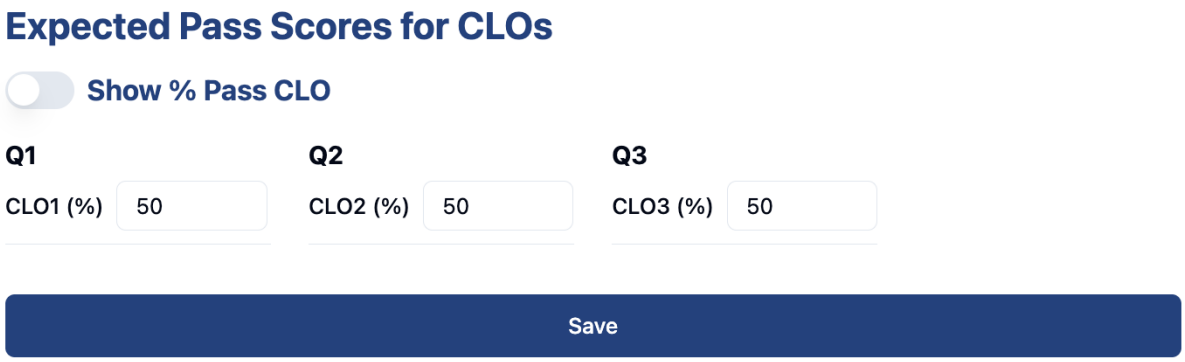
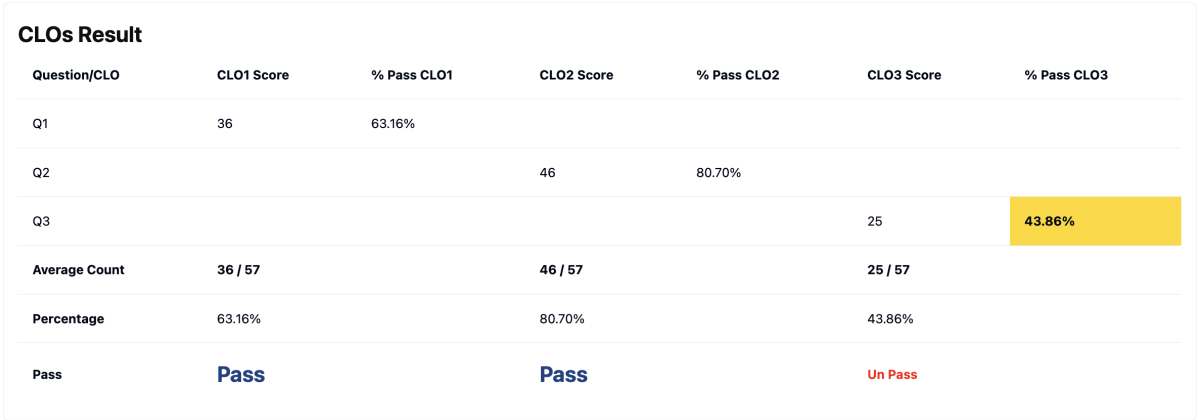


Figure 4.4: Expected Pass Scores for CLOs

4.1.1.5 Saving and Accessing CLO Reports

After configuring the necessary settings, the system calculates the CLO scores by mapping each exam question to its corresponding CLO. Questions that do not meet the Expected Pass Score are automatically highlighted in yellow, enabling lecturers to quickly identify underperforming areas (Figure 4.5). The system also determines the pass or fail status for each CLO, providing a detailed breakdown of the number of students passing each outcome. Lecturers can save the results and download comprehensive CLO reports in Excel format for further analysis. Additionally, real-time CLO scores are accessible directly on the website, offering instant visualization and enabling lecturers to monitor and evaluate performance effectively. This dual functionality ensures streamlined assessment and supports data-driven improvements in course outcomes.



CLOs Result

Question/CLO	CLO1 Score	% Pass CLO1	CLO2 Score	% Pass CLO2	CLO3 Score	% Pass CLO3
Q1	36	63.16%				
Q2			46	80.70%		
Q3					25	43.86%
Average Count	36 / 57		46 / 57		25 / 57	
Percentage	63.16%		80.70%		43.86%	
Pass	Pass		Pass		Un Pass	

Figure 4.5: CLOs in ExamTeams Result

4.1.2 Class CLO Scores

4.1.2.1 Class Management Interface

The Class CLO results are presented in the management interface, providing lecturers with a streamlined workflow to manage, evaluate, and review Course Learning Outcomes (CLOs) for individual classes. This section outlines the steps for generating CLO reports and showcases how the system assists in evaluating student performance.

Steps for Managing Class and Generating CLO Reports (Figure 4.6)

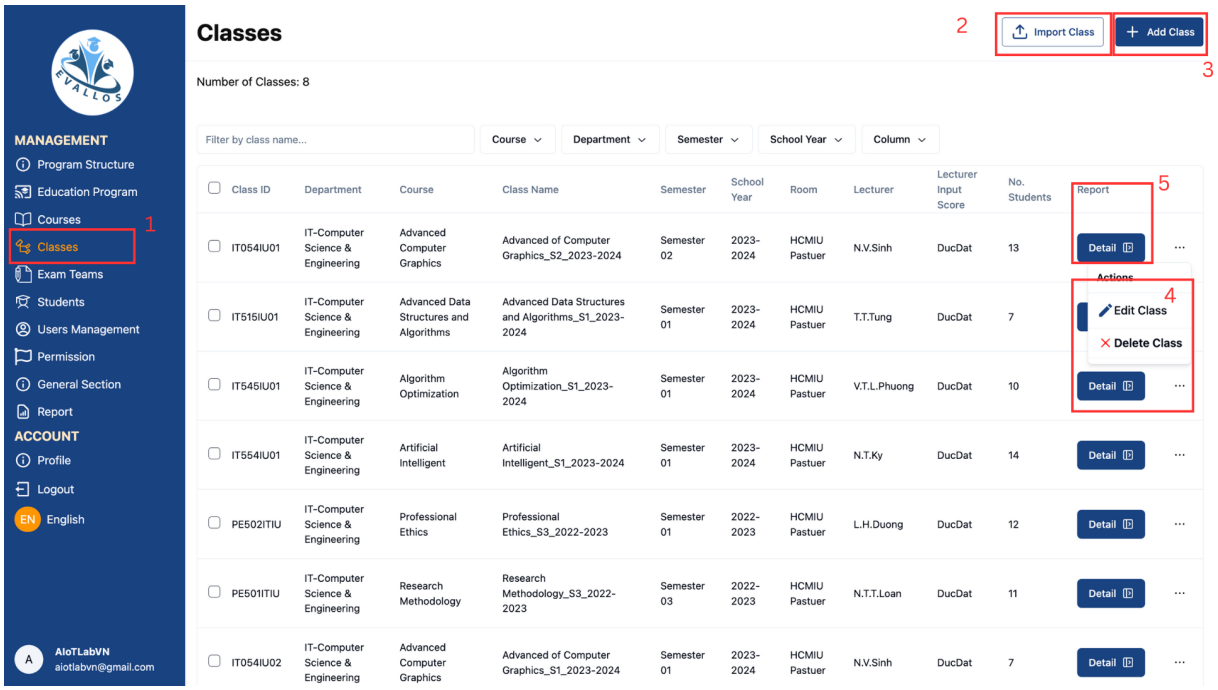


Figure 4.6: Class Table Management

- Step 1: Navigate to the "Class" tab from the management menu to access the class management interface (point 1).
- Step 2: Upload multiple classes at once by using the "Import Exam Team" option. This action allows users to upload data through an Excel file (point 2).
- Step 3: Create a new class by selecting "Add Class" from the interface. This feature allows lecturers to set up a new class and link it to the relevant course and program (point 3).
- Step 4: Utilize the actions menu to perform various tasks, such as editing, deleting, or importing students into a class (point 4). This ensures that all class data is accurate and up-to-date.
- Step 5: Select the relevant option to produce CLO assessment reports for a specific class (point 5). These reports provide detailed insights into the attainment of learning outcomes.

4.1.2.2 CLO Settings and Output

Within the class management interface, lecturers configure essential parameters to evaluate Course Learning Outcomes (CLOs) accurately. These settings (Figure 4.7) include defining the Pass Threshold (%), which establishes the minimum percentage required for students to achieve a CLO, and assigning Exam Type Weights to various assessment types such as midterm exams, final exams, and presentations. These weights reflect the relative importance of each assessment in evaluating CLO achievement.

Once the parameters are set, the system calculates the CLO achievement for the class (Figure 4.8, displaying results with pass or fail indicators. This feature enables lecturers to determine whether the class has successfully met the defined learning outcomes. Additionally, detailed results for each exam type and the overall pass rate for the class are

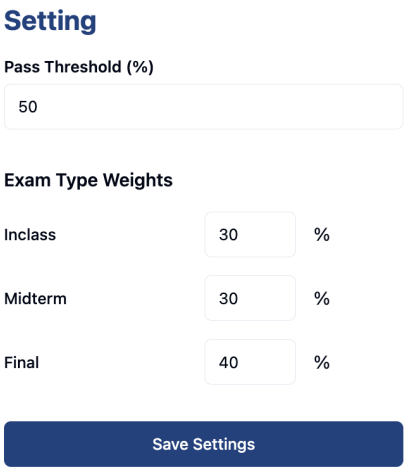


Figure 4.7: CLOs Class Settings

highlighted, offering a comprehensive overview of student performance. After reviewing the results, lecturers have the option to save the scores within the system and download a comprehensive report in Excel format for further analysis and reporting purposes.

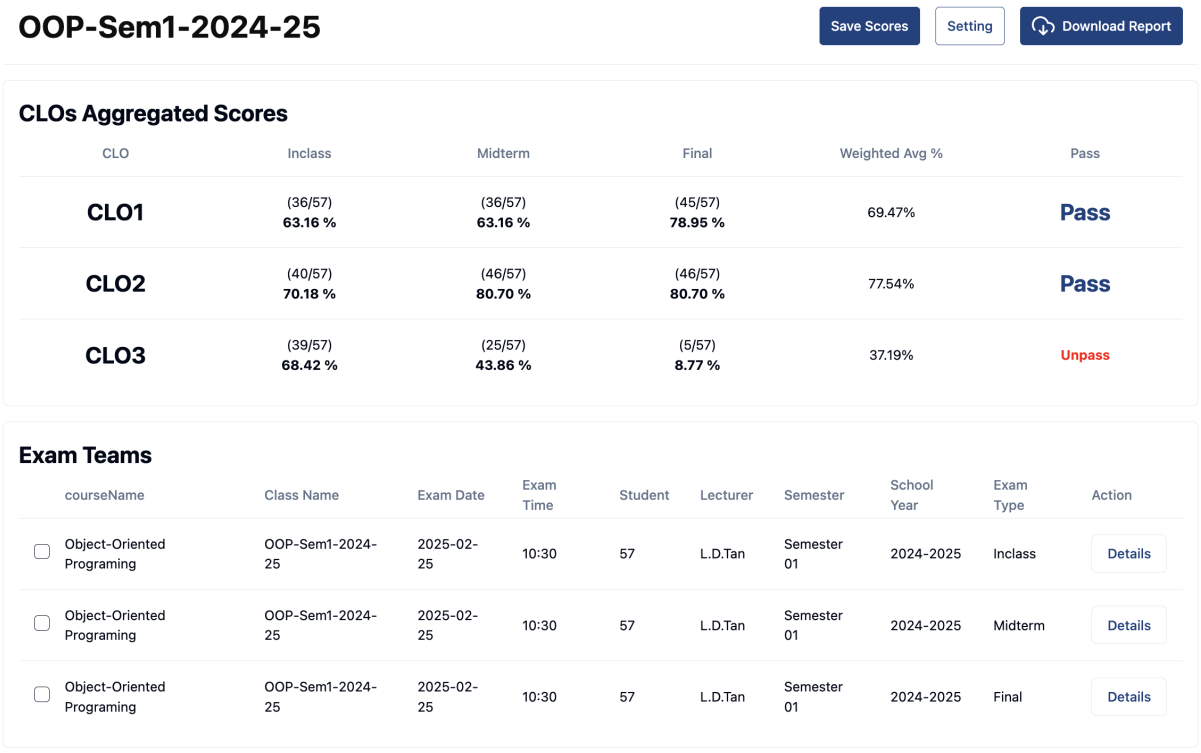


Figure 4.8: CLOs in Class Result

4.1.3 Courses CLO Scores

4.1.3.1 Courses Management Interface

The Courses CLO Scores section in the EVALLOS platform provides lecturers with a streamlined interface for managing and exporting aggregated Course Learning Outcome (CLO) scores. The interface offers a familiar and user-friendly experience for accessing

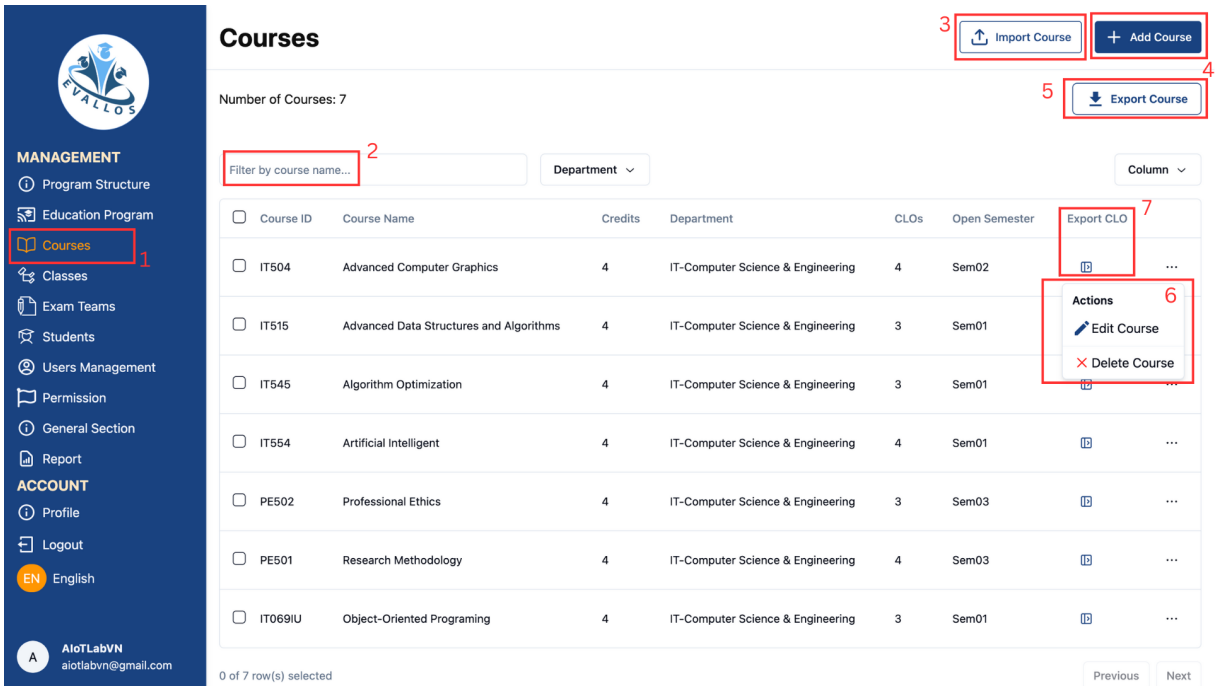


Figure 4.9: Courses Management Interface

and analyzing course-level CLO data.

Steps for Managing Courses and Generating CLO Reports (Figure 4.9)

- Step 1: Choose the "Courses" tab from the management menu to access the courses (point 1).
- Step 2: Utilize the search bar to refine course designation (point 2).
- Step 3: Upload several courses using an Excel file by selecting "Import Course" (point 3).
- Step 4: Establish a new course by selecting "Add Course" (point 4).
- Step 5: Export the list of courses by selecting "Export CLO" column (point 5).
- Step 6: Execute actions such as changing, deleting via the options provided in the actions menu (point 6).
- Step 7: Produce CLO assessment reports by choosing the relevant option (point 7).

4.1.3.2 CLO Aggregated Scores and Insights

Upon exporting the CLO scores, users receive a comprehensive table (Figure 4.10) that summarizes the aggregated results for each CLO within the course. The table includes detailed descriptions of each CLO and its associated objectives, the percentage of students achieving each CLO across different semesters and academic years, and the calculated average score for each CLO based on historical data. This aggregated information allows lecturers and administrators to identify trends in CLO performance, observe fluctuations over time, and pinpoint areas requiring improvement. These insights are vital for recognizing disparities and refining course structures and teaching strategies to enhance overall learning outcomes.

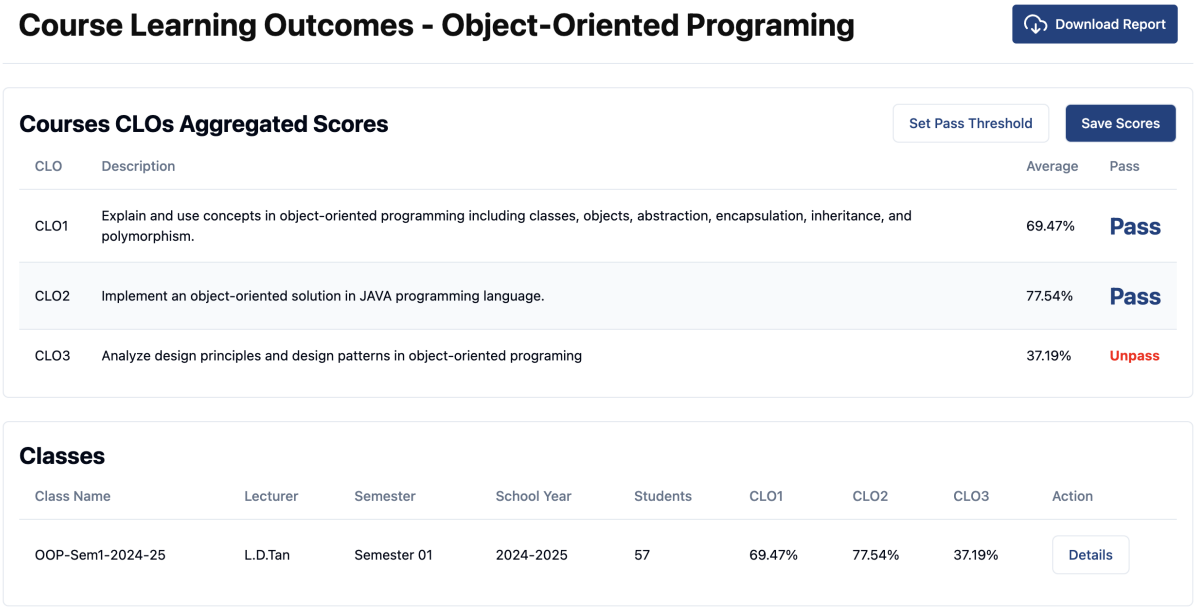


Figure 4.10: Courses CLOs Aggregated Scores

4.1.3.3 Actionable Insights and Reporting

The Courses CLO Scores feature empowers users to monitor the progress and effectiveness of CLOs over time. By analyzing the aggregated data, lecturers can identify patterns and adapt their instructional methods to address observed gaps. The ability to download detailed reports in Excel format allows for further analysis and facilitates comprehensive reporting to stakeholders.

This functionality supports continuous course improvement, enabling lecturers to make data-driven decisions and ensuring alignment with program-level learning objectives. By tracking performance trends, the EVALLOS system provides a robust framework for enhancing the quality and effectiveness of courses over successive semesters.

4.2 Program Management and CLO-PLO Mapping for Program Learning Outcomes Assessment

The EVALLOS platform provides a robust interface for managing training programs and mapping Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs). This functionality allows departmental staff to oversee and refine the curriculum structure while ensuring alignment with institutional learning objectives.

4.2.1 Program Management Interface

The program management interface enables faculty members and program coordinators to manage the training program effectively. Users can add new courses to the training program via an intuitive interface (Figure 4.11). This functionality is essential for keeping the program curriculum up to date and ensuring that all required courses contribute to achieving the Program Learning Outcomes (PLOs).

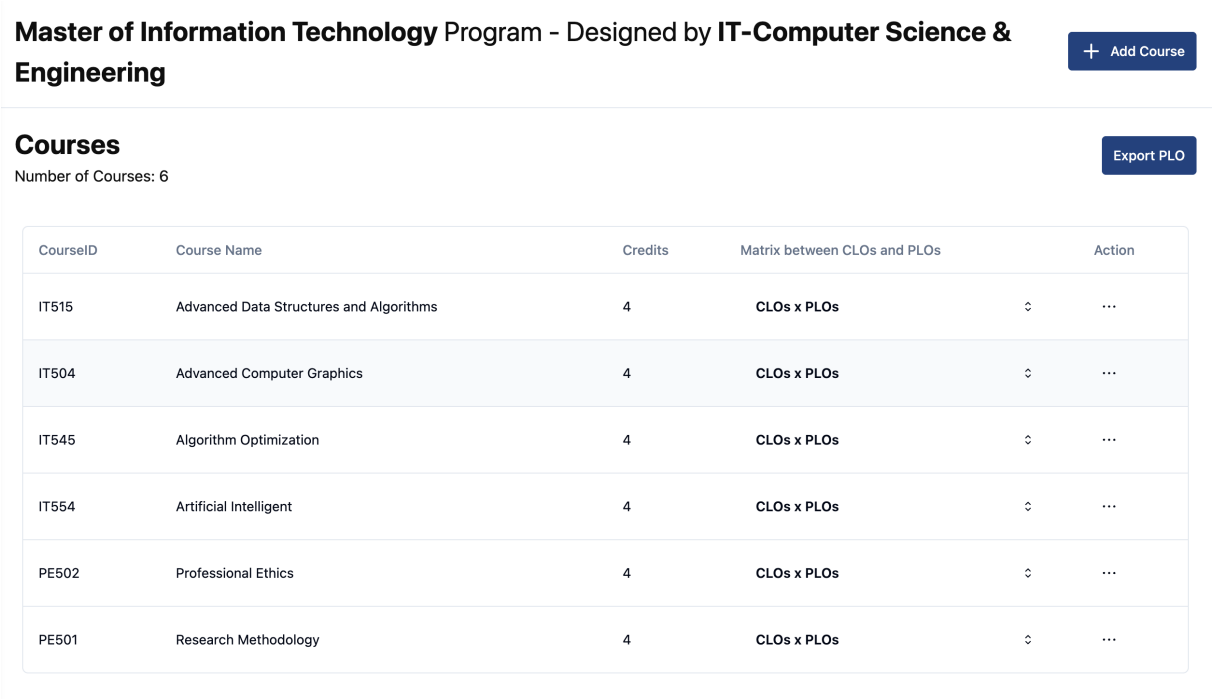


Figure 4.11: Program Management Interface

4.2.2 CLO-PLO Mapping for Each Course

For each course in the training program, the platform offers a detailed mapping table linking the course's CLOs to the PLOs of the program (Figure 4.12). This mapping ensures that every CLO contributes to the overarching program outcomes, allowing for a structured evaluation of how individual courses align with institutional goals.

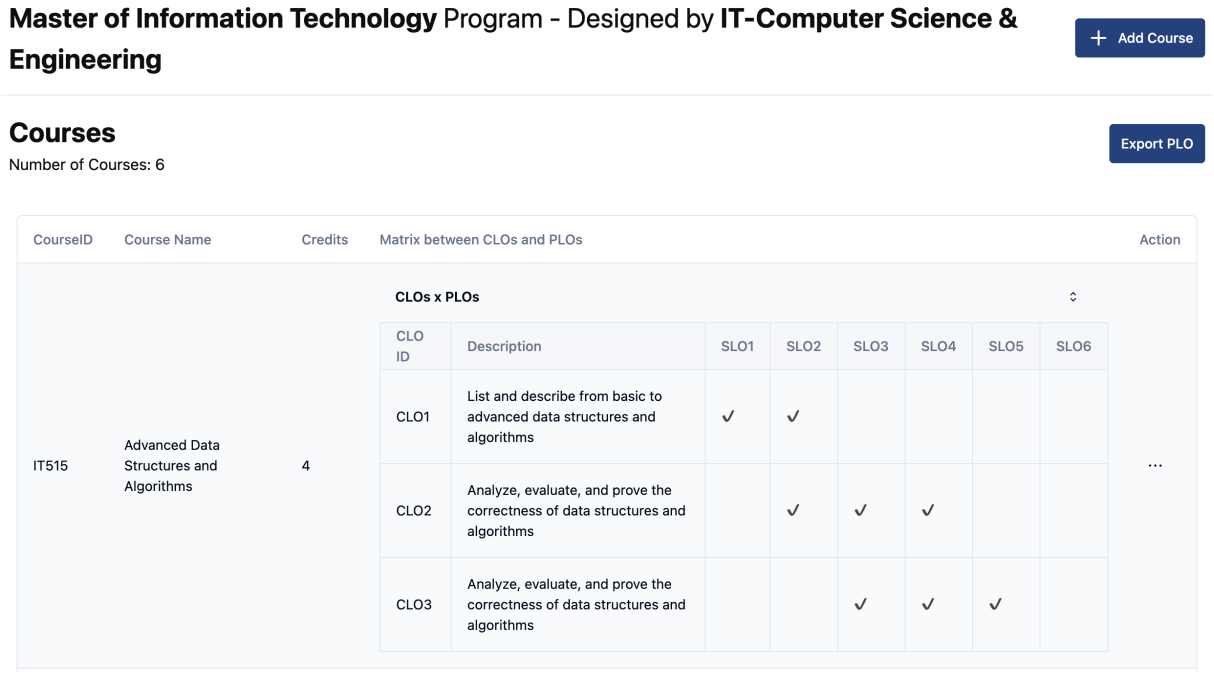


Figure 4.12: CLO-PLO Mapping for Courses

4.2.3 PLO Assessment Results

The platform aggregates PLO achievement results based on the performance of CLOs across all courses in the program. The PLO assessment table provides a clear summary of the achievement levels for each PLO, represented as percentages (Figure 4.13). This table is generated by calculating the average scores of the CLOs mapped to each PLO, taking into account historical data from various semesters and academic years.

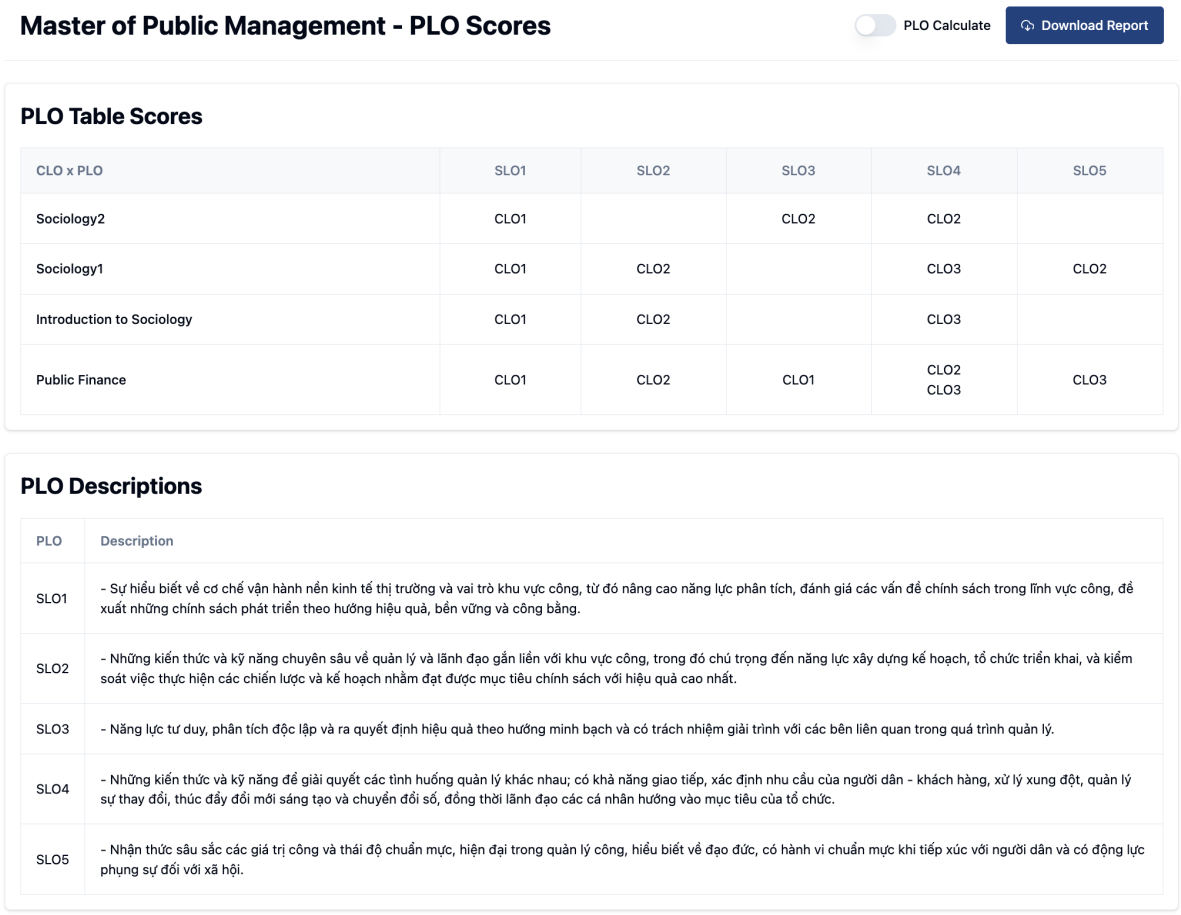


Figure 4.13: PLO Assessment Results Interface

4.3 System Administration and Management Modules

4.3.1 Permission and User Management

The Permission and User Management module in the EVALLOS platform streamlines the administration of user roles, access levels, and permissions, ensuring secure and organized usage of the system while upholding data integrity. With Role-Based Access Control (RBAC), roles such as administrator, lecturer, or departmental staff can be assigned specific access rights tailored to their responsibilities. Administrators can efficiently manage user accounts by adding, editing, or deactivating accounts as needed, guaranteeing that only authorized individuals access the platform. Granular permission assignment allows for tailored access to specific modules, such as CLOs, PLOs, or training program management. Additionally, the system includes audit logs to monitor user activities, ensuring

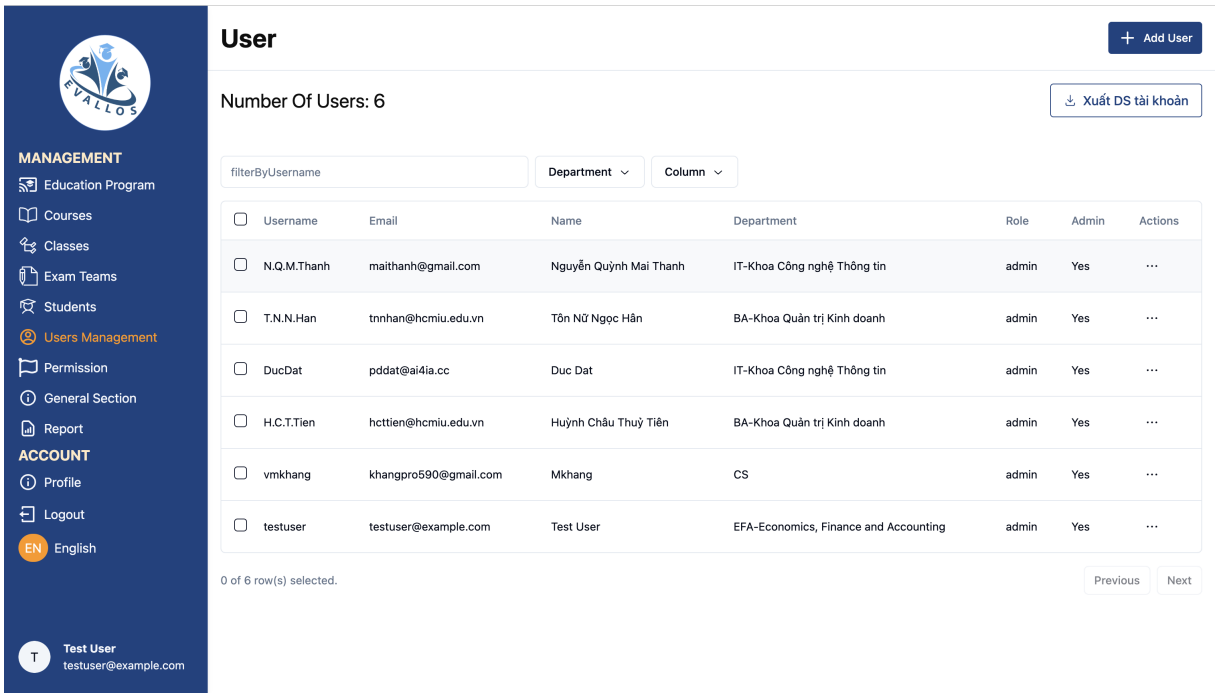


Figure 4.14: User Management Interface

transparency and accountability. The intuitive user management interface (Figure 4.14) provides administrators with tools for overseeing all user accounts, including bulk imports via Excel files and role assignment. Furthermore, a detailed roles and permissions interface (Figure 4.15) enables precise customization of access levels, ensuring flexibility and security in system usage.

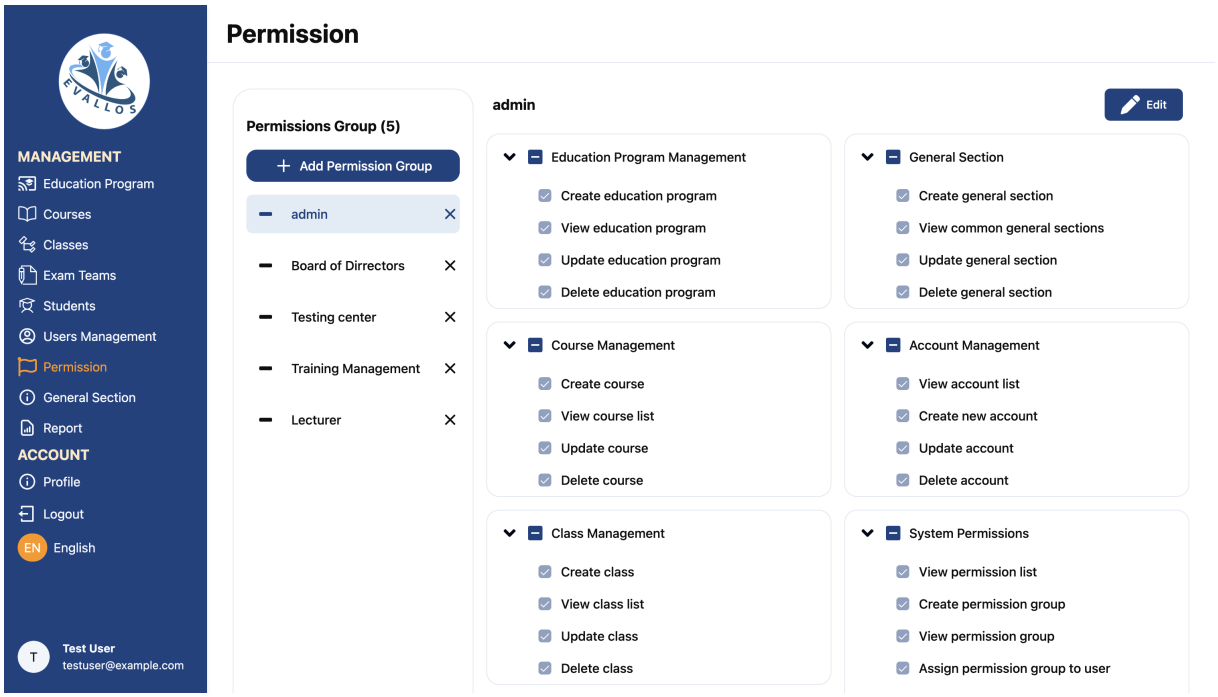


Figure 4.15: Roles and Permissions Interface

4.3.2 Student Management

The Student Management module in the EVALLOS platform provides a centralized and efficient system for managing detailed student information, including their enrollment in specific training programs, associated classes, and academic performance. This module enables administrators and instructors to maintain accurate and up-to-date student records, ensuring seamless integration with class and exam data. Key features include managing student enrollment, updating their association with programs and classes, and tracking performance metrics such as scores, attendance, and participation. The student management interface (Figure 4.16) offers intuitive tools for sorting and filtering students by program, class, or academic performance, enabling educators to make informed decisions to enhance student outcomes.

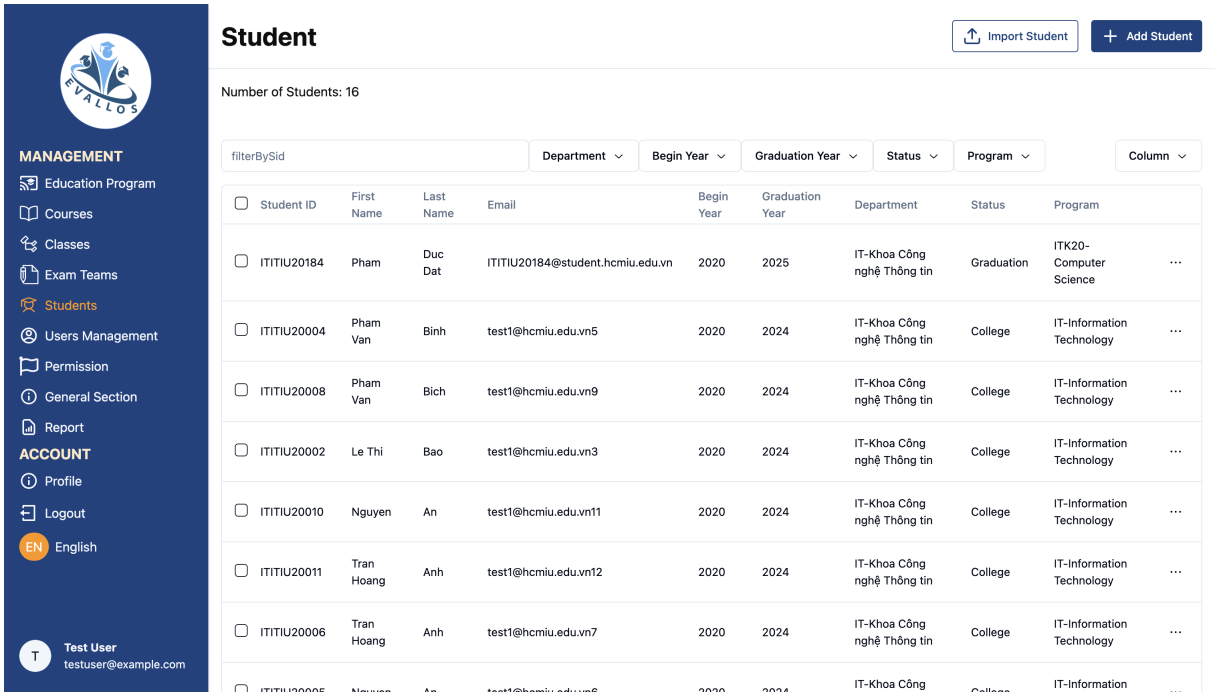


Figure 4.16: Student Management Interface

4.4 Implementation for Generating Course Learning Outcomes (CLO) Reports

The EVALLOS platform optimizes the generation of comprehensive Course Learning Outcomes (CLOs) reports, offering teachers critical insights into course efficacy. Upon selecting criteria like as pass thresholds and assessment weights, the system computes the course's CLO accomplishments. By selecting the "Download Report" button, educators obtain a professionally formatted Word document that includes a thorough analysis.

The report features a summary table that presents average CLO scores over several semesters (Figure 4.2), providing a longitudinal view of performance. Furthermore, it includes a line chart (Figure 4.19) that illustrates trends in CLO scores, enabling educators to readily discern patterns or areas need enhancement. The report finishes with introspective questions that encourage teachers to evaluate their findings, assess previous interventions, and devise plans for enhancing future student performance. This organized and engaging methodology integrates quantitative data with qualitative analysis,

Table 4.2: The summary table presents average CLO scores over semesters.

Part 1: Course Learning Outcomes (CLOs) Aggregated Scores

CLO	Description	Average (%)	Pass Status
CLO1	Understand the background of mathematics for computer graphic, image processing, computer vision, etc.,	93.75%	Pass
CLO2	Understand how to process 3D objects and 3D transformation in different space.	83.33%	Pass
CLO3	Analyze, design and develop 3D objects process digital images and geometric modeling for real application	81.25%	Pass
CLO4	Positive, work and study hard, follow requirements and apply professional ethics in practice	85.42%	Pass

Part 2: Classes Information

Class Name	Lecturer	Semester	School Year	Students	CLO1 (%)	CLO2 (%)	CLO3 (%)	CLO4 (%)
Advanced of Computer Graphics_S2_2023-2024	N.V.Sinh	Semester 02	2023-2024	13	87.50%	66.67%	62.50%	70.83%
Advanced of Computer Graphics_S1_2023-2024	N.V.Sinh	Semester 01	2023-2024	7	100.00%	100.00%	100.00%	100.00%

promoting a cycle of ongoing enhancement in course delivery and results.

Figure 4.17 shows the CLO score trends of an example course over several semesters, displayed as a bar chart with individual bars for each CLO (CLO1, CLO2, and CLO3). Examining these side-by-side bars highlights variations in student performance across semesters, thereby helping instructors pinpoint which CLOs may require urgent attention or targeted interventions. By comparing semester-to-semester changes, lecturers can also evaluate the effectiveness of any instructional strategies or curriculum updates they have introduced. Consequently, this bar-chart view allows for more data-driven planning and helps refine teaching methods and resource allocation, ultimately promoting continual improvement in student learning outcomes.

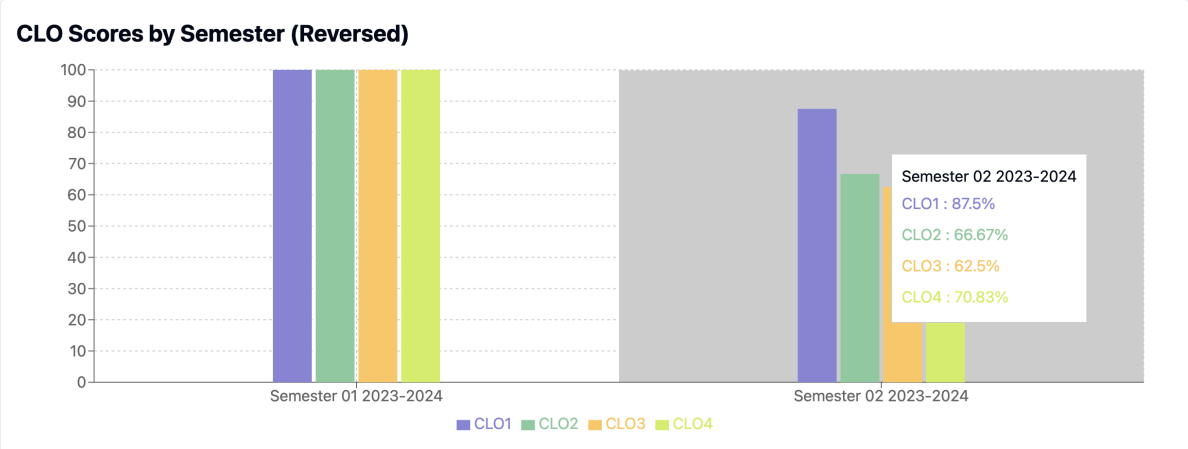


Figure 4.17: Bar Chart of CLO Scores Across Semesters

Figure 4.18 presents a sample of aggregated CLO (Course Learning Outcomes) results for a specific class. Each CLO—labeled CLO1, CLO2, and CLO3—is divided into multiple assessment components, such as final exams, midterm exams, and an overall weighted

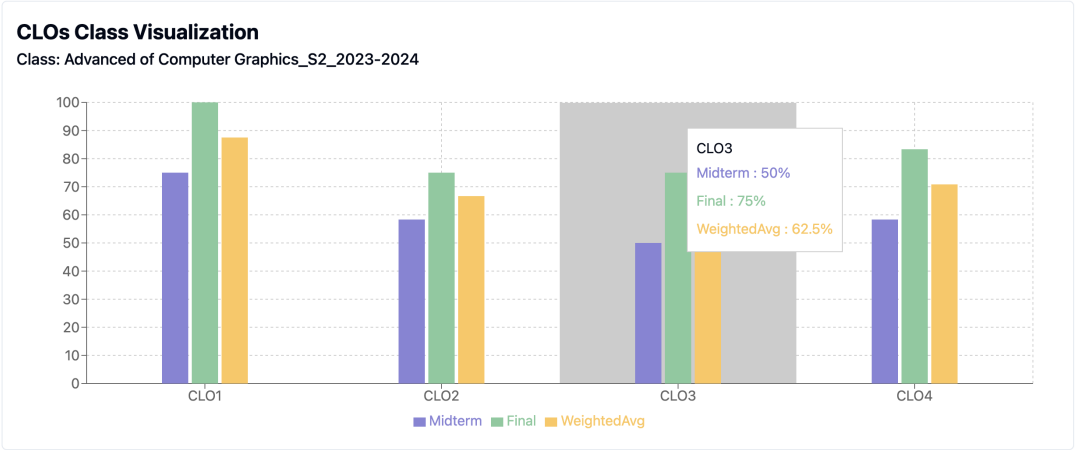


Figure 4.18: Bar Chart of Class CLO Scores Across Semesters
Each CLO (CLO1, CLO2, CLO3) is broken down by various assessment components (e.g., Final, Midterm) as well as the overall weighted average.

average. By placing these components side by side, the chart offers a clear comparison of students' performance across different assessments. This visualization helps instructors quickly identify which CLOs excel and which may require additional attention or targeted instructional strategies.

This chart (Figure 4.19) illustrates a sample exam team from the aforementioned class, showing the number of students who passed each question (blue bars) alongside the corresponding pass percentage (yellow line). The horizontal axis contains question labels (e.g., MCQ-Q1a, WQ1-criteria2), each representing part of the test, while the vertical axes depict the total pass count on the left and the pass percentage on the right. By comparing these two metrics, instructors can easily identify which questions students found more challenging or excelled at, thereby facilitating more targeted analysis and guiding potential refinements in teaching strategies or assessment design for future courses.

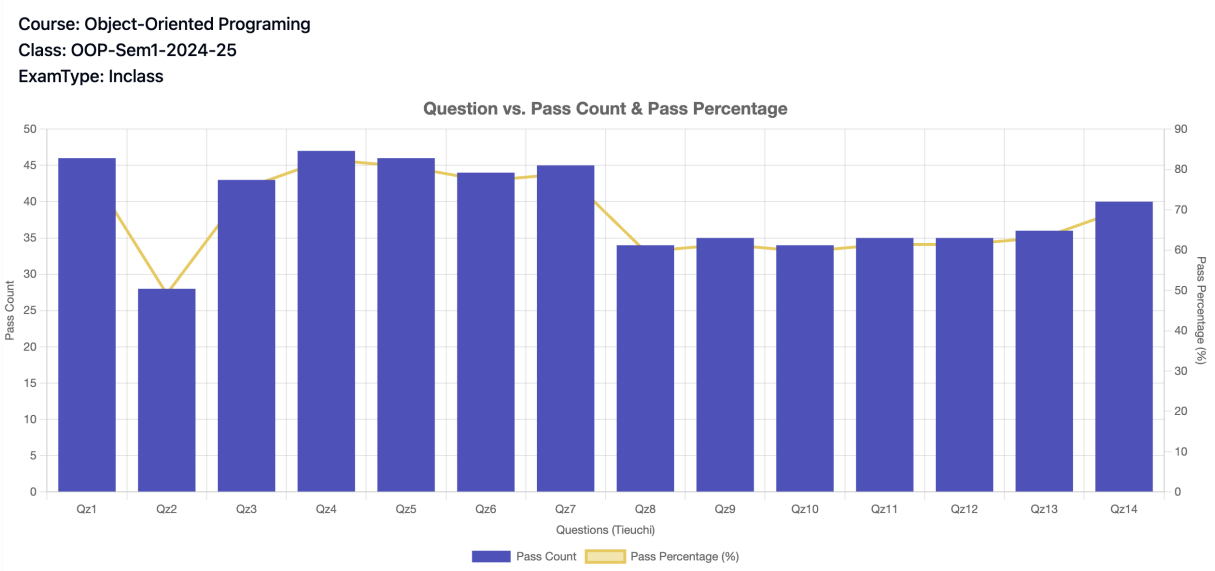


Figure 4.19: Chart of ExamTeam CLOs Scores

The output report produced by EVALLO (Figure 4.20) emphasizes noteworthy discoveries and provides actionable insights for ongoing enhancement. The analysis indi-

cates a positive trajectory in CLO scores across semesters, with significant improvements in student performance and comprehension of the course material, particularly between Semester 01 and Semester 03. These advancements were made possible by targeted interventions, such as personalized feedback, enriched case studies, and active engagement strategies, which were instrumental in improving student outcomes. In the future, the primary objective will be to enhance the practical applications of public budgeting concepts, incorporate the perspectives of industry professionals, and cultivate interactive learning environments in order to maintain and expand upon the progress that has been made thus far.

Question 1: What did you learn from the finding results through different semesters?

The findings from the aggregated CLO scores and classes information across different semesters reveal a noticeable difference in student performance between Semester 01 and Semester 02.
In Semester 01, the class "Advanced of Computer Graphics_S1_2023-2024" taught by Lecturer N.V.Sinh had a smaller number of students (7) compared to Semester 02. However, all CLO scores in Semester 01 were outstanding with 100% achievement, indicating a high level of understanding and proficiency in the topics covered. This suggests that the teaching methods and course materials in Semester 01 were effective in helping students grasp the concepts and skills related to computer graphics. On the other hand, in Semester 02, the class "Advanced of Computer Graphics_S2_2023-2024" also taught by Lecturer N.V.Sinh had a larger number of students (13). However, the CLO scores in Semester 02 were lower across all categories compared to Semester 01. The average scores for CLO1, CLO2, CLO3, and CLO4 were 87.50%, 66.67%, 62.50%, and 70.83% respectively. This indicates a decrease in overall performance and understanding in Semester 02. The lower scores in Semester 02 could be attributed to various factors such as the number of students, teaching methods, individual student engagement, or the complexity of the course material. It is important for educators to analyze these factors and make necessary adjustments to improve student learning outcomes in future semesters. Overall, the data highlights the importance of monitoring student performance across different semesters and continuously evaluating and improving teaching strategies to ensure the best possible learning outcomes for students. By identifying areas of strength and weakness, educators can tailor their approach to better support student learning and success.

Question 2: What did you do to improve the student learning performance and scores of this course?

Improvements made to enhance student learning performance and scores in the course:
1. Implemented targeted interventions for students in the Advanced of Computer Graphics_S2_2023-2024 class who had lower CLO scores compared to the average. This included additional study materials, one-on-one tutoring sessions, and extra practice assignments to reinforce understanding in areas of weakness.
2. Conducted regular progress assessments and feedback sessions to monitor student performance closely and provide timely guidance and support for improvement. This allowed for early identification of struggling students and intervention strategies to be implemented promptly.
3. Offered supplementary resources and materials for students to deepen their understanding of complex concepts related to 3D objects processing, digital images, and geometric modeling. The availability of these resources helped students grasp challenging topics more effectively.
4. Encouraged active participation and engagement in class discussions, group projects, and practical assignments to enhance hands-on learning experiences. This interactive approach fostered a deeper understanding of the course materials and encouraged collaborative learning among students.
5. Organized review sessions and study groups to facilitate peer-to-peer learning and knowledge sharing. This collaborative environment allowed students to benefit from each other's insights and perspectives, leading to improved comprehension and retention of course content.

Question 3: What will you do to improve the student learning performance in future?

Planned Improvements:
1. Implement targeted interventions for the students in the "Advanced of Computer Graphics_S2_2023-2024" class who scored lower in CLO2 and CLO
3. This could include additional practice exercises, one-on-one sessions with the lecturer, or supplementary materials to improve their understanding of 3D objects processing and digital images analysis.
2. Encourage peer-to-peer learning and group study sessions to foster a collaborative learning environment that can help improve overall performance in all CLOs for both classes. This can also help students in the "Advanced of Computer Graphics_S2_2023-2024" class who may benefit from peer support and explanations.
3. Provide regular feedback and progress updates to students, highlighting areas of improvement and celebrating successes. This can motivate students to continue working hard and improve their performance in all CLOs.
4. Offer additional resources and support for the students in the "Advanced of Computer Graphics_S2_2023-2024" class to enhance their understanding of 3D transformation and geometric modeling. This could include workshops, tutorials, or online resources to supplement their learning and address any gaps in knowledge.
5. Encourage a growth mindset among students, emphasizing the importance of continuous learning and improvement. This can help students develop a positive attitude towards challenges and setbacks, leading to increased motivation and better performance in all CLOs.

Figure 4.20: The EVALLOS output report highlights key findings and provides actionable ideas for continual improvement.

Chapter 5

Evaluation

5.1 Discussion

The establishment of a CLO and PLO management system signifies a strategic enhancement in synchronizing curriculum, instruction, and evaluation to attain learning outcomes. The system utilizes automated mapping, real-time tracking, and comprehensive reporting to facilitate data-driven enhancements and increase educational quality. Its capacity to discern deficiencies and offer implementable ideas promotes ongoing enhancement in pedagogical methods. This effort guarantees accountability, adherence to standards, and a learner-centric educational methodology.

5.2 Key Strength

Closed Linkage Between the CLO and the PLO: The system ensures that each course directly contributes to the overall educational objectives of the training program by establishing a close connection between Course Learning Outcomes (CLO) and Program Learning Outcomes (PLO). This not only guarantees consistency but also simplifies the process of monitoring and evaluating the efficacy of each course in facilitating the attainment of program learning outcomes for administrators.

Assessment Process Automated: Automation tools are delivered by the system for the purposes of data collection, score calculation, and report generation. Every process is optimized to reduce errors and save time, from the input of scores to the generation of detailed reports. This enables administrators and instructors to concentrate on the enhancement and analysis of the quality of instruction.

User-Friendly and Intuitive Interface: The management interface is intended to be user-friendly, enabling users to effortlessly access and manage information regarding CLOs, PLOs, and other pertinent data. The level of output standards by semester and school year is readily monitored by lecturers and staff due to the clear display of tables and charts.

Capacity to Generate Comprehensive Reports: The system facilitates the export of comprehensive reports that contain the standard results of each CLO and PLO, as well as the percentage of students who have met the standards and the areas that require refinement. This not only facilitates precise evaluations but also furnishes valuable information for the development of suitable improvement strategies, thereby enhancing the efficacy of training.

Assistance with Data-Driven Decision-Making: The system enables lecturers and administrators to effortlessly identify deficiencies in the training program and imple-

ment the requisite modifications as a result of its robust data analysis capabilities. This guarantees that the program not only satisfies the standard requirements but also evolves to accommodate the demands of society and students.

5.3 Comparison with Other Assessment Systems

Table 5.1 compares such learning outcomes evaluation systems to explain their updating.

Key feature	**EVALLOS**	TDTU	LHU
Comprehensive CLO-PLO Mapping	**Yes**	Limited	Yes
Advanced PLO Visualization Tools	**Yes**	No	Yes
UI/UX Design	**Modern and User-Friendly**	Outdated	Overloaded
Automated Report Generation	**Yes (AI-driven)**	No	No
Rubric-Based Evaluations	**Yes**	Yes	Limited

Table 5.1: Feature Comparison: EVALLOS, Ton Duc Thang University Platform (TDTU) and Lac Hong University Systems (LHU).

5.4 Evaluation of the System: Human Approach and Comparative Analysis

The assessment of the EVALLOS system emphasizes human evaluations to verify its efficacy in producing actionable findings. Insights into its practical value and conformity with educational requirements are derived from feedback obtained through real-world usage and expert reviews.

5.4.1 Human Evaluation

The EVALLOS system has been implemented at Nguyen Tat Thanh University (NTTU) and evaluated in the Faculty of Information Technology and the Faculty of Business Administration of the International University. The evaluation process garnered numerous commendations from educational quality assurance specialists and involved instructors. The system is recognized for its user-friendly interface, ease of use, and simultaneous provision of high accuracy in calculating Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs). Furthermore, EVALLOS provides numerous practical advantages to educators, including the capacity to facilitate thorough examination and evaluation of student learning outcomes. Experts in education quality assurance have commended the system's capacity to fulfill accreditation standards, thereby assisting educational institutions in enhancing training quality effectively. The EVALLOS system, with its significant advantages, is regarded as an effective instrument for enhancing academic quality and facilitating the assessment of student output standards.

5.4.2 Comparison of Models (Open Source vs. Closed Source)

Model	Accuracy	Coherence	Speed	Cost Effectiveness	Customizability
Llama3	High	High	Fast	High	High
GPT-4	Very High	Very High	Moderate	Moderate	Moderate
Qwen	Moderate	High	Fast	High	Moderate

Table 5.2: Comparison of different models based on key performance metrics.

Llama3 is the superior model for conducting CLO and PLO evaluations, distinguished by its remarkable adaptability, cost-effectiveness, and strong performance. Llama3 offers excellent accuracy, rapid response times, and significant customizability, making it ideal for academic institutions seeking to optimize learning outcome assessments while ensuring cost-effectiveness. Its capacity to adjust to many assessment contexts guarantees consistency and dependability in producing comprehensive and actionable findings.

Although GPT-4 provides exceptional accuracy and coherence in generating advanced reports, its elevated prices and restricted customizability render it less viable for institutions facing budget limitations or requiring special adaptations. Likewise, Qwen offers a cost-efficient and effective alternative with well-rounded capabilities. Nonetheless, its moderate accuracy and absence of significant customization features render it inadequate for situations necessitating exact modifications or sophisticated assessments.

By using Llama3, institutions acquire a robust instrument for the management and analysis of learning outcomes, emphasizing scalability and pragmatism. Its equilibrium of performance, cost-effectiveness, and adaptability guarantees that it not only satisfies but surpasses the requirements of educational quality assurance protocols, rendering it the optimal selection for attaining sustained academic success.

5.5 Summary

The evaluation of the EVALLOS system emphasizes its effectiveness in managing Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs). Through human evaluation, the system has been successfully implemented at International University, Nguyen Tat Thanh University, validated by accreditation experts, and received positive feedback from lecturers for its practicality and user-friendly design. Automated evaluation using advanced tools and metrics ensures the quality and consistency of generated reports. When compared to systems from TDTU and Lac Hong University, EVALLOS stands out with superior functionality, intuitive interfaces, and adaptability to institutional needs. Additionally, comparisons of AI models, including Llama3, GPT-4, and Qwen, highlight EVALLOS's strengths in producing accurate and context-aware reporting aligned with educational goals. This evaluation confirms EVALLOS as a robust tool for educational outcome assessment, fostering continuous improvement in teaching and learning quality.

Chapter 6

Conclusion & Future works

6.1 Conclusion

The creation and execution of the EVALLOS system signify a substantial advancement in the administration and assessment of Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) in educational institutions. EVALLOS systematically addresses issues in evaluating student performance and connecting outcomes with institutional goals, ensuring a transparent and data-driven approach to educational quality assurance.

The extensive framework incorporates sophisticated procedures for CLO and PLO assessment, utilizing cutting-edge instruments such as Bloom's Taxonomy, intricate mapping matrices, and data visualization strategies. These methods enable precise assessment of learning outcomes and offer actionable insights for improved curriculum design and instructional strategies, hence boosting teaching quality and student learning experiences.

The novel application of AI-driven reporting, employing models such as Llama3, has markedly optimized the generation of comprehensive and precise reports. This feature assists educators and administrators by automating intricate evaluations, allowing them to concentrate on strategic enhancements. EVALLOS's capacity to modify, assess, and download reports at several levels—exam teams, classes, courses, and programs—highlights its versatility in meeting unique institutional requirements.

The system's comprehensive user and permission management, coupled with its integration of student performance monitoring, guarantees safe and efficient functionality while preserving an overarching perspective of program performance. The alignment of CLOs with PLOs via transparent mapping procedures allows institutions to consistently evaluate and enhance their programs, promoting a culture of excellence and accountability.

EVALLOS offers a scalable, intuitive, and effective system for managing outcome-based education. It enables educational institutions to fulfill accreditation criteria, enhance instructional efficacy, and attain enduring improvements in educational quality. This work establishes a robust basis for future improvements and wider implementation in many educational contexts.

6.2 Future works

In the future, EVALLOS will focus on optimizing system performance to enhance processing speed, integration capabilities, and scalability for handling larger datasets and complex analyses. Additionally, the system will be expanded to include functionality

for evaluating individual Student Learning Outcomes (SLOs), enabling detailed tracking of each student's progress and providing personalized insights for improvement. EVALLOS will also partner with more universities to implement and refine the platform across diverse educational contexts, contributing to standardized best practices in learning outcome assessment. Through these advancements, EVALLOS aims to elevate the quality of higher education, improving curriculum design, teaching effectiveness, and student success, ultimately supporting institutions in achieving educational excellence.

Bibliography

[1] "Learning outcomes - center for teaching excellence — university of south carolina," 2024.

[2] A. Software, "The importance of learning outcomes in higher ed teaching," *Akari Software*, October 2023.

[3] C. for Teaching Innovation, "Measuring student learning," 2024.

[4] "Promulgating regulations on university level training," 2021. Accessed: 2021-03-18.

[5] "Regulations on training program standards; development, evaluation and promulgation of training programs for levels of higher education," 2021. Accessed: 2021-06-21.

[6] M. Giang, "10 years of higher education quality assurance in vietnam," *Tuoi Tre*, November 2023.

[7] H. Kristianto, S. Prasetyo, R. Susanti, and M. Adithia, "Design of student and course learning outcomes measurement," *JPI (Jurnal Pendidikan Indonesia)*, vol. 10, March 2021.

[8] "Fibaa accreditation and learning outcomes assurance," 2024.

[9] "Aun-qa guidelines for quality assurance in higher education," 2024.

[10] "Aun-qa programme assessment framework," 2024.

[11] "Abet accreditation overview," 2024.

[12] "Global engagement," 2024.

[13] J. Biggs and C. Tang, *Teaching for Quality Learning at University: What the Student Does*. McGraw-Hill Education, 4th ed., 2011.

[14] L. K. Luu and L. Phan, "The process of evaluating students based on university program learning outcomes," *Vietnam Journal of Education*, vol. 4, no. 4, pp. 93–99, 2020. Received: 05 October 2020; Accepted: 15 November 2020; Published: 30 December 2020.

[15] N. T. T. Tra, "Building rubrics for evaluating students' learning outcomes in pedagogy subjects at university level in competency-based approach," *Vietnam Journal of Educational Sciences*, 2022.

[16] "Regulations - statutes — undergraduate studies." `https://undergrad.tdtu.edu.vn/en/academics/regulations-statutes`, 2024. Accessed: 2024-06-18.

[17] I. Figma, "Figma: The collaborative interface design tool," 2023. Accessed: 2024-06-17.

[18] S. Chacon and B. Straub, *Pro Git*. Apress, 2nd ed., 2014. Accessed: 2024-06-17.

[19] D. Flanagan, *JavaScript: The Definitive Guide*. O'Reilly Media, 7th ed., 2020. Accessed: 2024-06-17.

[20] D. Abramov and A. Clark, *Redux Essentials: A Predictable State Container for JavaScript Apps*. 2016. Accessed: 2024-06-17.

[21] I. Facebook, "React – a javascript library for building user interfaces," 2023. Accessed: 2024-06-17.

[22] I. Tailwind Labs, "Tailwind css documentation," 2023. Accessed: 2024-06-17.

[23] Shadcn, "shadcn/ui documentation," 2023. Accessed: 2024-06-17.

[24] O. Foundation, "Node.js documentation," 2023. Accessed: 2024-06-17.

[25] E. Foundation, "Express.js documentation," 2023. Accessed: 2024-06-17.

[26] I. MongoDB, "Mongodb documentation," 2023. Accessed: 2024-06-17.

[27] B. S. Bloom, M. D. Engelhart, E. J. Furst, W. H. Hill, and D. R. Krathwohl, *Taxonomy of Educational Objectives: The Classification of Educational Goals*. David McKay Company, Inc., 1956.

[28] L. W. Anderson and D. R. Krathwohl, *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives*. Addison Wesley Longman, 2001.

[29] B. University, "Outcomes assessment essentials: Articulate goals, objectives, and outcomes," 2011.

[30] M. Moreira Gois, M. Eliseo, R. Mascarenhas, I. Carlos Alcântara de Oliveira, and F. Silva Lopes, "Evaluation rubric based on bloom taxonomy for assessment of students learning through educational resources," in *EDULEARN23 Proceedings*, 15th International Conference on Education and New Learning Technologies, pp. 7765–7774, IATED, 3-5 July, 2023 2023.

[31] "Course evaluation rubric - instruction and course design - libguides at concordia university - st. paul." `https://library.csp.edu/instruction-and-course/rubric`. Accessed: 2024-06-17.

[32] "Academic Integrity - Instruction and Course Design - LibGuides at Concordia University - St. Paul." `https://library.csp.edu/instruction-and-course`, 2024. Accessed: 2024-06-18.

[33] "Decision on promulgating the regulation on tertiary education training according to the credit system at the university of science ho chi minh city belonging to vietnam national university ho chi minh city," 2021.

[34] I. Abeywardena, "Mastery of course learning outcomes in odl: A case study of the pearson ecollege learning outcome manager," *Open Praxis*, vol. 5, pp. 239–248, 2013/09/01.

[35] S. Bhatti, M. Memon, and A. Meghji, "Scrutinizing outcome assessment of outcome-based education using q-obe in engineering education," *International Journal of Innovation in Teaching and Learning (IJITL)*, vol. 9, pp. 55–74, 2023.

[36] L. K. Bansal, P. K. Mishra, and S. Sachdeva, "Creation of an obe model po attainment tool," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, vol. 12, no. 10, pp. 4427–4431, 2021.

[37] N. E. Adams, "Bloom's taxonomy of cognitive learning objectives," *J Med Libr Assoc.*, vol. 103, no. 3, pp. 152–153, 2015.

Appendix

Publications

This application has demonstrated its performance and scientific rigor through acceptance for presentation at conferences and journal. Specifically, this topic has been approved for posting at:

International Conference

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh, Tan Duy Le*, Kha Tu Huynh*, "A technical platform supporting the assessment of the level ofachievement of course learning outcomes, contributing to academic program quality assurance.", The Fourth International Conference on Material, Machines, and Methods for Sustainable Development (MMMS 2024), Accepted (October, 2024).

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh*, Ngoc Tram Huynh Thi, Tien Phat Le, Thien Huong Nguyen Trang, Nhan Pham Le Thanh, "EVALLOS: An Effective Solution for CLO and SLO Assessment, Supporting Enhanced Teaching Quality.", The 2024 Conference on Applications of Technology, Automation, and Civil Engineering (ATAC 2024), Accepted (November, 2024).

International Journal

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh, Mai Oanh Nguyen Ngoc, Tan Duy Le*, Kha Tu Huynh*, "Automated Reporting and Data-Driven Insights in EVALLOS: Enhancing CLO and PLO Assessment for Improved Educational Quality.", The Journal of Data Science and Artificial Intelligence (JDSAI), ISSN 2831-4794., Accepted (March 2025).

Domestic Journal

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh, Tan Duy Le*, Kha Tu Huynh*, "EVALLOS: An Effective Solution for CLO and SLO Assessment, Supporting Enhanced Teaching Quality.", Vietnam Journal of Education, Under Review.

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh, Mai Oanh Nguyen Ngoc, Tan Duy Le*, Kha Tu Huynh*, "A Comprehensive Platform for Enhancing the Achievement of Program Learning Outcomes and Advancing Academic Quality Assurance.", Journal of Science and Technology – Nguyen Tat Thanh University, Accepted (March, 2025).

• **Duc Dat Pham**, Mai Thanh Nguyen Quynh, Mai Oanh Nguyen Ngoc, Tan Duy Le*, Kha Tu Huynh*, "A Personalized Evaluation System for Course and Program Learn-

ing Outcomes in Higher Education.", Journal of Science and Technology – Nguyen Tat Thanh University, Accepted (March, 2025).

Achievement

• The EVALLOS platform is currently in the technology transfer phase with Nguyen Tat Thanh University, aiming for broader implementation to support academic program quality assurance.

• The EVALLOS platform is currently in the trial phase at the School of Computer Science and Engineering at International University, assessing its effectiveness in enhancing teaching quality and managing learning outcomes.