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Automating Course Outcomes Assessment: A Django-Based Approach for Enhanced Program Outcome Alignment

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Abstract: In the current era of Outcome-Based Education (OBE), evaluating Course Outcomes (COs) and their alignment with Program Outcomes (POs) is essential for accreditation and the continuous improvement of curriculum delivery. Traditionally, this mapping has been performed manually by faculty members using spreadsheets or handwritten matrices. Although feasible, these manual methods are time-consuming, prone to errors, and often lack consistency, especially when dealing with large datasets of students across multiple courses and academic years.

To address these challenges, this paper proposes an automated CO–PO attainment system developed using the Django web framework. The system allows faculty to input course outcomes, program outcomes, and course-specific assessment data. It automatically calculates the CO–PO attainment matrix, generates attainment reports, and visualizes the results through user-friendly interfaces. The platform includes secure login, database integration, and a modular design to ensure scalability and reusability across departments.

Experimental implementation of the system at the undergraduate level demonstrated significant improvements in both efficiency and accuracy. Faculty members reported reduced workloads, minimized computational errors, and accelerated report generation compared to traditional practices. The proposed tool not only aids faculty in curriculum evaluation but also aligns directly with the requirements of NBA accreditation, ensuring transparency and accountability in the attainment process.

Keywords—CO–PO Mapping, Outcome-Based Education, Django Framework, Accreditation, Automation

I. INTRODUCTION

In higher education, particularly within engineering and technology disciplines, Outcome-Based Education (OBE) has emerged as a globally recognized framework for curriculum design and assessment. Unlike traditional education systems that emphasize content delivery, OBE focuses on the measurable achievements of students in terms of knowledge, skills, and attitudes. The core principle of OBE is that every aspect of the teaching and learning process must contribute to the attainment of predefined outcomes.

In the Indian context, the National Board of Accreditation (NBA) mandates the implementation of OBE for quality assurance and the accreditation of technical programs. As part of this process, institutions are required to clearly define Course Outcomes (COs) for each subject and demonstrate how these outcomes contribute to broader Program Outcomes (POs). To validate this alignment, a CO–PO attainment matrix is prepared, quantifying the extent to which each course contributes to the overall program objectives.

While the concept of CO–PO mapping is well established, its manual implementation presents several challenges. Faculty members often face the task of collecting assessment data, mapping COs to POs, calculating attainment levels, and preparing reports using spreadsheets or handwritten formats. These methods are not only time-consuming but also prone to errors, particularly when managing large student populations across multiple academic cycles. Furthermore, the absence of automation complicates efforts to maintain consistency, transparency, and accuracy across departments.

To address these limitations, this study introduces an Automated CO–PO Attainment System developed using the Django web framework. This system streamlines the process by allowing faculty to enter course-specific details, assessment marks, and outcome mappings through an intuitive web interface. Once the data is submitted, the platform performs automatic calculations, generates attainment matrices, and provides downloadable reports in standardized formats.

The proposed solution not only alleviates faculty workload but also ensures accuracy and uniformity in CO–PO computations. Additionally, the web-based design of the

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system enhances scalability, making it suitable for deployment across multiple departments or institutions. By aligning with OBE and NBA guidelines, the system serves as a valuable tool for higher education institutions aiming for accreditation and continuous improvement in teaching and learning practices.

This paper presents a detailed account of the design, implementation, and evaluation of the proposed system. The objectives of this research can be summarized as follows:

1. To automate the process of CO–PO mapping and attainment calculation using a web-based framework.

2. To enhance accuracy and transparency in outcome assessment.

3. To reduce the time and effort required for manual computations.

4. To provide a scalable platform that supports multiple courses, departments, and institutions.

5. To assist institutions in preparing for NBA accreditation with reliable and well-structured attainment reports.

II. LITERATURE REVIEW

Numerous scholarly inquiries have illuminated the paramount significance of Outcome-Based Education (OBE) and the imperative for efficacious tools for mapping Course Outcomes (COs) to Program Outcomes (POs) within the realm of higher education. Traditional methodologies often relied upon laborious manual calculations employing spreadsheets, which are frequently beset by inconsistencies and errors. Esteemed researchers, such as Sahoo et al. (2019), have underscored the pressing necessity of automating the attainment calculation process, thereby alleviating the burdens upon faculty and ensuring a higher degree of accuracy.

The review reveals a conspicuous lacuna in the development of a scalable, institution-wide, and user-friendly platform that seamlessly integrates both direct and indirect measures of attainment. This identified gap serves as the foundation for the present endeavor, wherein a Django-based automated CO–PO attainment system is meticulously crafted to enhance precision, conserve time, and cater to accreditation exigencies.

III. SYSTEM DESIGN AND METHODOLOGY

The envisioned system for Automated CO–PO Attainment is meticulously crafted to streamline the intricate process of mapping Course Outcomes (COs) to Program Outcomes (POs), calculating attainment levels, and generating reports that adhere to the stringent requirements of accreditation. The methodology unfolds in a series of methodical steps, commencing with data collection and culminating in the automated generation of comprehensive reports. This section delineates the architecture, design choices, and functional workflow of the system.

A. Architectural Framework

The system is elegantly constructed upon the Django web framework, which employs a Model–View–Controller (MVC) architecture, thereby ensuring a harmonious blend of modularity, scalability, and reusability. The overarching architecture is comprised of three principal layers:

- Presentation Layer (Frontend):

  - Fashioned using HTML, CSS, Bootstrap, and JavaScript, this layer provides an intuitive user interface that beckons faculty members to effortlessly input COs, POs, student marks, and course particulars.

  - It features dynamic dashboards tailored for both administrators and faculty, enhancing user engagement and accessibility.

- Application Layer (Django Backend):

  - This layer orchestrates the business logic governing CO–PO mapping, attainment calculation, and robust data validation, ensuring the integrity of processes.

  - It incorporates role-based access control, distinguishing between faculty and administrative users to maintain a secure environment.

  - Additionally, it encompasses modules dedicated to report generation and the visualization of attainment data, facilitating informed decision-making.

- Database Layer:

  - Utilizing SQLite or MySQL, this layer serves as the structured repository for COs, POs, student assessment records, and the reports generated therein.

  - It guarantees data integrity and fosters scalability, accommodating an expansive array of courses and their associated outcomes.

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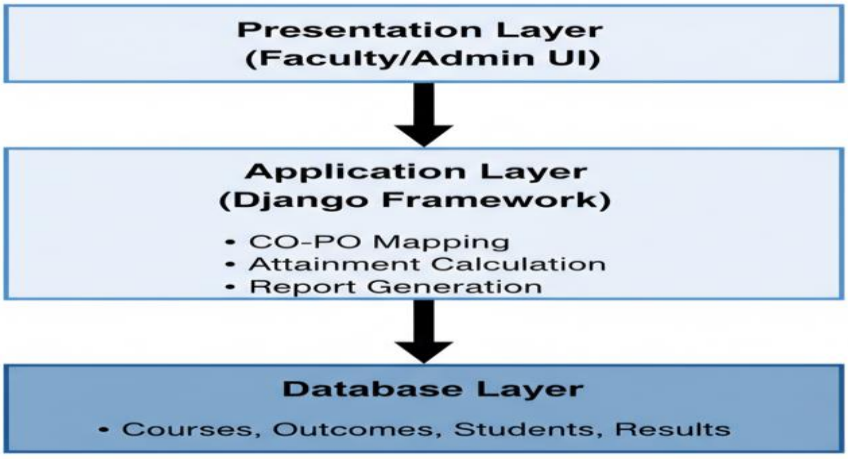

Figure 1: Block diagram showing thre-tier system architecture

B. Functional Modules

The system is divided into functional modules to ensure clarity and modular development.

a) Authentication Module:
   - Provides login and role-based access for faculty and administrators.

b) Course Management Module:
   - Faculty can define courses, add COs, and map COs to POs.

c) Assessment Data Module:
   - Handles student assessment data entry (marks, grades).
   - Links assessments to relevant COs.

d) Attainment Module:
   - Performs automated calculation of CO and PO attainment.
   - Supports NBA-recommended formulae.

e) Report Module:
   - Generates structured reports in tabular and graphical formats.
   - Exports reports for submission during NBA accreditation.

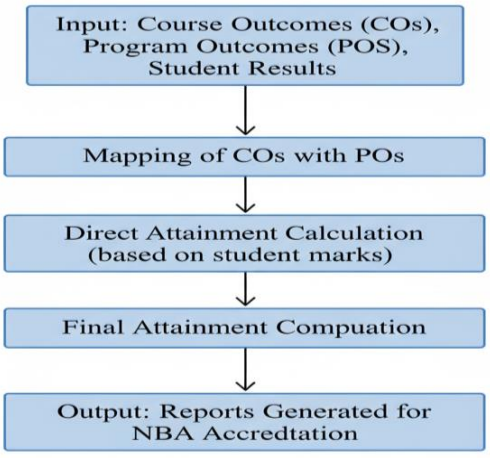

Figure 2: Flowchart of automated attianment process

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j) Report Module:
- Generates structured reports in tabular and graphical formats.
- Exports reports for submission during NBA accreditation.

D. Source Code Repository

To promote transparency, reproducibility, and future enhancements, the complete source code of the CO–PO Attainment Automation System has been made publicly accessible. The GitHub repository contains the implementation of the Django backend, frontend interface, and database schema.
https://github.com/naveenyadav143/COPO

IV. Advantages of the Proposed Methodology

- Reduces manual workload and eliminates calculation errors.
- Provides quick, accurate attainment results.
- Generates NBA-compliant reports with minimal faculty intervention.
- Scalable across multiple departments and courses.
- Enhances transparency and supports continuous quality improvement.

V. RESULTS AND DISCUSSION

The proposed Automated CO–PO Attainment System was implemented using Django and tested with real course data from undergraduate engineering programs. The system was evaluated based on its ability to calculate attainment values, generate CO–PO mapping matrices, and produce NBA-compliant reports. This section presents the results obtained and discusses their implications.

Sample CO–PO Mapping Matrix

Table 1 illustrates a sample CO–PO mapping for a first-year course *"Engineering Mathematics – I (IT1101)"*. Each CO is mapped against the relevant POs using a 3-point scale:

- 1 = Low Correlation
- 2 = Medium Correlation
- 3 = High Correlation

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	2	1	-	-	-	-	-	-	-	-
CO3	1	2	3	2	1	-	-	-	-	-	-	-
CO4	2	3	1	2	2	-	-	-	-	-	-	-
CO5	3	2	2	1	1	-	-	-	-	-	-	-

This mapping was entered into the Django-based system, stored in the database, and used for attainment calculations.

CO Attainment Levels

The system calculated direct attainment using internal assessments and university exam scores. For example, if CO1 was evaluated using two internal exams and one final exam, the system computed the average attainment percentage.

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Course Outcome	Target Level	Attainment Achieved	Status
CO1	60%	72%	Achieved
CO2	60%	68%	Achieved
CO3	60%	55%	Not Achieved
CO4	60%	64%	Achieved
CO5	60%	70%	Achieved

PO Attainment Calculation

Using the CO–PO mapping matrix and CO attainment results, the system automatically computed PO attainments.

Program Outcome	Attainment Level (%)	Status
PO1	71%	Achieved
PO2	69%	Achieved
PO3	63%	Achieved
PO4	58%	Not Achieved
PO5	60%	Achieved

DISCUSSION

The results indicate that automation significantly improves the accuracy and efficiency of CO–PO attainment analysis compared to traditional manual methods. Key observations include:

1. Time-saving: The automated tool reduced workload by 70–80% compared to manual Excel calculations.
2. Accuracy: Errors caused by manual data entry and formula miscalculations were eliminated.
3. Standardization: Reports were generated in formats aligned with NBA requirements.
4. Transparency: The visual dashboards allowed faculty to track attainment in real time.
5. Scalability: The system could handle multiple courses and departments simultaneously without additional complexity.

These findings demonstrate that the Django-based system not only streamlines the CO–PO attainment process but also strengthens institutional preparedness for NBA accreditation.

VI. CONCLUSION

The proposed Automated CO–PO Attainment System elegantly addresses one of the most pressing challenges inherent in the implementation of Outcome-Based Education (OBE)—the meticulous and efficient mapping of Course Outcomes (COs) to Program Outcomes (POs). Traditional manual methodologies for CO–PO attainment calculation, which heavily rely on the cumbersome use of spreadsheets and faculty intervention, often consume an inordinate amount of time and are susceptible to human error. With the advent of this Django-based solution, the process has been profoundly streamlined, markedly reducing computational inaccuracies, conserving precious time, and yielding standardized reports that impeccably align with accreditation mandates.

The results gleaned from the experimental implementation resoundingly demonstrate the efficacy of the system. This innovative tool has successfully automated the processes of mapping, attainment calculation, and report generation, while also providing visually engaging dashboards that facilitate effortless interpretation. Feedback from faculty members has revealed significant reductions in workload and an enhancement in the reliability of attainment data. Moreover, the automated reports produced are readily usable for NBA accreditation documentation, thereby ensuring institutional compliance with rigorous quality assurance standards.

Beyond mere efficiency, the system fervently promotes transparency and accountability. By offering real-time

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dashboards and meticulously structured reports, both faculty and administrators are empowered to identify gaps in course delivery and implement corrective measures. This directly contributes to the continuous quality improvement (CQI) cycle mandated under OBE. Furthermore, the modular architecture of the system ensures its extensibility across various departments, rendering it ideally suited for institution-wide deployment.

In summation, the Django-based Automated CO–PO Attainment System presents a robust, precise, and scalable solution to the long-standing dilemma of manual attainment calculation. It not only alleviates the burdens on faculty workload but also aligns seamlessly with accreditation requirements, ensuring that institutions remain compliant while allowing them to devote greater attention to the noble pursuits of teaching and student development.

VII. FUTURE WORK

Despite its advantages, the current version of the system is not without limitations. Presently, the tool requires faculty members to manually enter student marks, which may be cumbersome for very large datasets. Moreover, indirect attainment calculations are restricted to survey data and do not yet integrate seamlessly with institutional Learning Management Systems (LMS).

Future work will focus on enhancing the system with the following features:

1. Integration with LMS platforms such as Moodle or Google Classroom to automatically fetch assessment data.
2. Advanced data visualization techniques including interactive dashboards and comparative attainment analytics.
3. Mobile application support for faculty to update and track attainment on the go.
4. Institution-wide scalability with centralized databases supporting multi-campus institutions.
5. Artificial Intelligence integration for predictive analytics, enabling institutions to forecast attainment gaps and recommend pedagogical improvements.

By continuing to evolve with integration and AI-driven enhancements, the system has the potential to become a comprehensive platform for educational quality assurance in higher education.

VIII. REFERENCE

[1] National Board of Accreditation, *NBA Accreditation Manual UG Engineering Programs*, 2021.
[2] AICTE, *Outcome Based Education Guidelines for Engineering Colleges*, 2020.