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South Asian Journal of Management Research
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Volume 15, Issue No. 3 **July, 2025**

C O N T E N T S

Smart Analytics Platform for Generating Indirect Attainment Reports in Outcome-Based Education Using Automated Insight Engine

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Abstract

The current research proposes a comprehensive and automated web-based framework for streamlining the implementation of Outcome-Based Education (OBE) with a specific emphasis and focus on the indirect assessment of learning outcomes. Recognizing the limitations of manual feedback processing and fragmented evaluation practices, the proposed and developed system addresses these challenges by integrating key technological components for enabling efficient data collection, processing, visualization, and reporting. At the core of the system architecture is the automated acquisition of student feedback through Google Forms, which is employed to capture learners' perceptions regarding the attainment of Course Outcomes (COs) and their alignment with Program Outcomes (POs). The responses collected through Google Forms are further stored in Excel format which are parsed and analyzed within a structured backend powered by a MySQL database. The results of the indirect assessments are automatically processed which are exported into well-organized PDF reports thereby facilitating transparent and standardized documentation. Real-time data visualization is achieved through seamless integration with Microsoft Power BI, offering dynamic dashboards to enable faculty and administrators monitor course-wise and program-level attainment metrics effectively. The system is architected to support role-based access control, distinguishing between student and faculty functionalities. Students are provided with intuitive interfaces for submitting feedback and assessments, while faculty members are empowered with comprehensive administrative controls for managing academic entities such as programs, courses, COs, POs, and feedback links. Additional modules support the parsing of Excel sheets, data persistence, and the generation of analytic reports. A well-defined relational database schema underpinning the system is designed and implemented for ensuring consistency, scalability, and integrity of educational data. Further, for facilitating remote access and mobile compatibility, the system leverages ngrok, a secure tunneling solution exposing the local web application to the internet through publicly accessible URLs. This feature inevitably contributes to the significant enhancement of the flexibility and accessibility of the platform for stakeholders operating in distributed environments. The proposed framework aligns extremely well with contemporary educational quality assurance practices and accreditation requirements, offering a scalable, data-driven approach to OBE implementation. It further enables institutions to close the feedback loop through continuous quality improvement (CQI) by transforming raw feedback into actionable insights, ultimately contributing to the enhancement of curriculum design, instructional practices, and learner outcomes. The current research contributes significantly to the field of educational technology by presenting a replicable, extensible model for indirect attainment analysis in OBE, thereby supporting institutional efforts to deliver learner-centered, industry-relevant education.

Keywords: Course Outcome, Curriculum Mapping, Indirect Assessment, Outcome-Based Education, Programme Outcome, Power BI, Student Feedback

Introduction

Outcome-Based Education (OBE) is crucial in higher education as it shifts the focus from traditional teaching methods to what students are expected to achieve by the end of their learning experience. It emphasizes clear goals, measurable outcomes, and continuous improvement, ensuring that graduates possess the skills, knowledge, and attitudes required by industry and society. By aligning curriculum, teaching, and assessment with defined outcomes, OBE enhances accountability, fosters lifelong learning, and better prepares students for real-world challenges, making higher education more relevant, transparent, and impactful.

Flaws in Traditional Teaching Methods

Traditional education primarily focused on what the teacher taught rather than what the student learned. It was often lecture-driven, content-heavy, and time-based, with little emphasis on individual learning pace, skills

application, or outcome measurement. Assessment mainly tested memory rather than understanding, critical thinking, or practical skills. This led to a gap between academic learning and real-world requirements, leaving many graduates underprepared for professional challenges.

How OBE Overcomes These Flaws

Outcome-Based Education addresses these issues by cantering the educational process around clearly defined learning outcomes. It emphasizes what students are able to do after instruction, promotes active and student-cantered learning, and continuously measures performance against specific goals. OBE ensures that teaching, learning, and assessment are aligned to industry and societal needs, thus making education more meaningful, flexible, and relevant. The relative comparison between traditional education and outcome-based education is outlined in Fig 1.

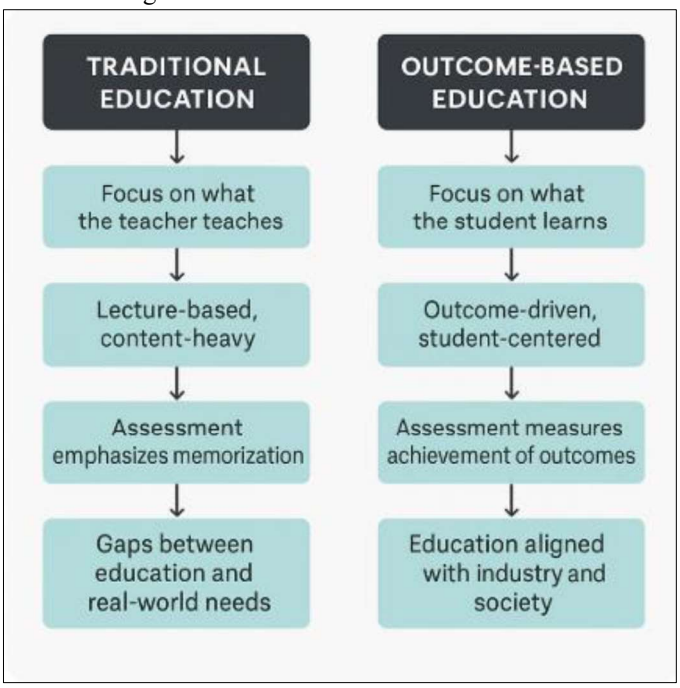


Fig. 1. Traditional Education Vs. Outcome-Based Education

Tools Used in OBE Implementation

A wide range of OBE tools have been reported, with a few prominent ones illustrated in Fig. 2.

Description of these tools is provided below:

Curriculum Mapping

Aligns course objectives with program outcomes.

Bloom's Taxonomy

Guides designing outcomes at appropriate cognitive levels (e.g., remembering, analyzing, creating).

Rubrics
Provides clear criteria for evaluating complex skills and competencies.

Direct Assessment Methods
Exams, projects, presentations, portfolios.

Indirect Assessment Methods
Surveys, feedback forms, alumni tracking.
Accreditation Frameworks
Frameworks
such as NBA (India), ABET (USA) that formalize OBE standards.

Software Tools
Outcome-based education management systems like OBEAM, Accredinator, or LMS-integrated tools (for example, Moodle with OBE plugins) help automate tracking and reporting of outcomes attainment.

Significance of Indirect Assessment Methods
Indirect assessment methods, such as feedback forms, are significant because they provide valuable insights into students' perceptions of their learning experience, teaching effectiveness, and curriculum relevance. While they do not directly measure learning outcomes, they help identify areas of improvement in instructional strategies, course design, and academic support services. Feedback forms capture subjective but essential information—like student satisfaction, engagement levels, and confidence in applying knowledge—which complements direct assessment methods and supports continuous quality enhancement in education.
The current research aims to develop an integrated web-based software solution that streamlines the process of computing indirect course attainment by automating the collection of student feedback through Google Forms, parsing and analyzing Excel responses, generating structured PDF reports, storing results in a MySQL database, and offering real-time visualizations through Power BI—ensuring a seamless and efficient mechanism for Outcome-Based Education (OBE) evaluation.

Review of Literature
The literature examined offers a detailed overview of Outcome-Based Education (OBE) within the realm of higher education, emphasizing diverse methodologies aimed at enhancing pedagogy, curriculum design, and quality assurance practices. Thakkar and Landge (2022) stress the necessity of accurately evaluating Course Outcomes (COs) and Program Outcomes (POs) through robust mapping techniques, underlining the critical role of alignment to ensure educational effectiveness. Complementing this, Okojie et al. (2022) introduce innovative strategies such as virtual learning modules, advocating for the inclusion of national curriculum standards to promote accessibility and maintain quality. Rajagopal Reddy et al. (2021) highlight the role of Continuous Quality Improvement (CQI) in fostering sustained enhancements to the teaching-learning process.
In another contribution, Jeyanthi R. (2019) emphasizes aligning educational objectives with the hierarchical structure of Bloom's Taxonomy to foster deeper cognitive engagement and knowledge application among learners. Rani (2020) proposes a balanced transition toward OBE, recommending the retention of effective elements from conventional systems while gradually integrating outcome-focused strategies across curriculum, assessments, and instructional methods. Rajak et al. (2019) provide a broader strategic perspective on achieving Program Educational Objectives and POs, supported by performance metrics and comparative analysis.

Marey et al. (2018) advocate for rubric-based evaluation frameworks to measure both course and program-level learning outcomes, offering data-driven insights to inform teaching practices. Similarly, Kavitha A. et al. (2018) focus on assessment methods that align with accreditation standards, aiming to optimize instructional delivery and student engagement. Lastly, Ahankari and Jadhav (2016) explore the effectiveness of e-rubrics in evaluating COs and POs, supporting both formative and summative assessments that guide curriculum refinement.

Collectively, these scholarly works deepen the understanding of OBE implementation, offering significant contributions in the areas of assessment methodology, curriculum alignment, instructional improvement, and academic quality assurance in higher education.

Conceptual Model Design
Conceptual Model Flow
The curriculum defines Course Outcomes (COs), which are mapped to Program Outcomes (POs). Student feedback enables indirect assessment, while assessment data analyzed via Power BI provides insights for continuous improvement of the curriculum and OBE implementation as outlined in Fig. 3.

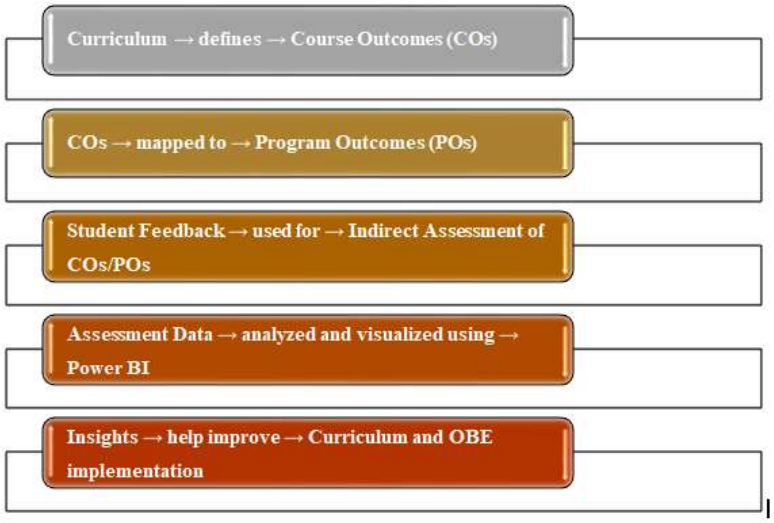


Fig.3. Conceptual Model Flow

Model Implementation

Module Dependency Diagram for Landing Page

The Module Dependency Diagram depicted in Fig, 4. for landing page illustrates the navigation flow and access control of a web-based Outcome-Based Education (OBE) system, beginning with index.php as the landing page. Users who are not logged in can access public modules like mcq.html for taking tests and home4.html for exit surveys. Upon login (session active), users gain access to administrative functionalities, including inserting links (insert_mcq_link.php, insert_link.php), managing academic entities (manage_programs.php, manage_courses.php, manage_po.php), viewing or deleting mappings (display_all_links.html, delete_all_links.php), and handling data files and indirect assessment (parse_excel_files.php, export_indirect1.php, indirect_database.php). The session can be terminated via logout.php. This diagram clearly separates user and admin functionalities, ensuring role-based access and structured navigation.

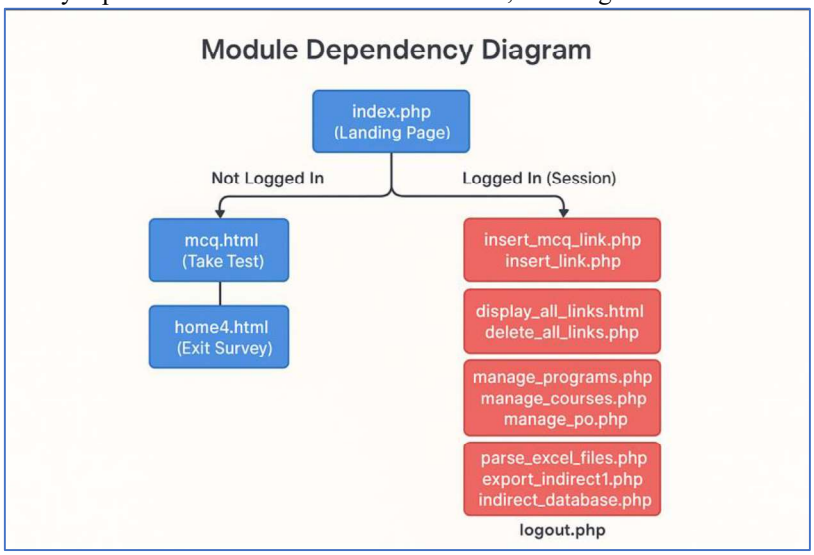


Fig. 4. Module Dependency Diagram for Landing Page

Module Dependency Diagram for Exit Survey and Generating Report

Fig.5 outlines the client-server interaction for home4.html, which serves as the front-end page handling exit survey logic using JavaScript. The JavaScript layer captures DOM events and uses Fetch APIs to request data from three backend scripts—fetch_programsp, fetch_courses1, and fetch_electives.php—which return program, course, and elective data respectively from the corresponding database tables. Once the user selects their inputs and clicks 'Proceed' the collected data is used to redirect the user to exitsurvey.php for further action, completing the data-driven survey flow. Fig 6. demonstrates the module dependency diagram for generating report.

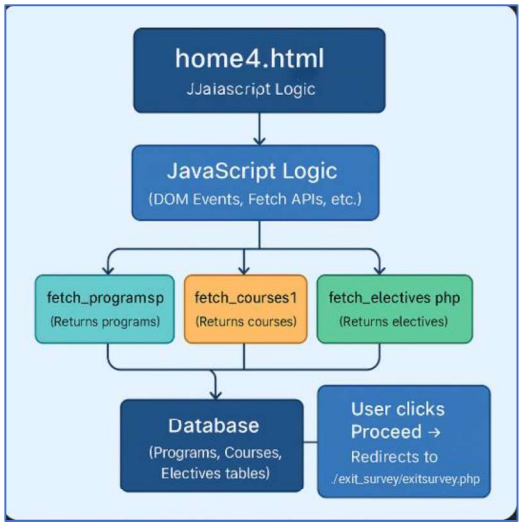


Fig. 5. Module Dependency Diagram for Exit Survey

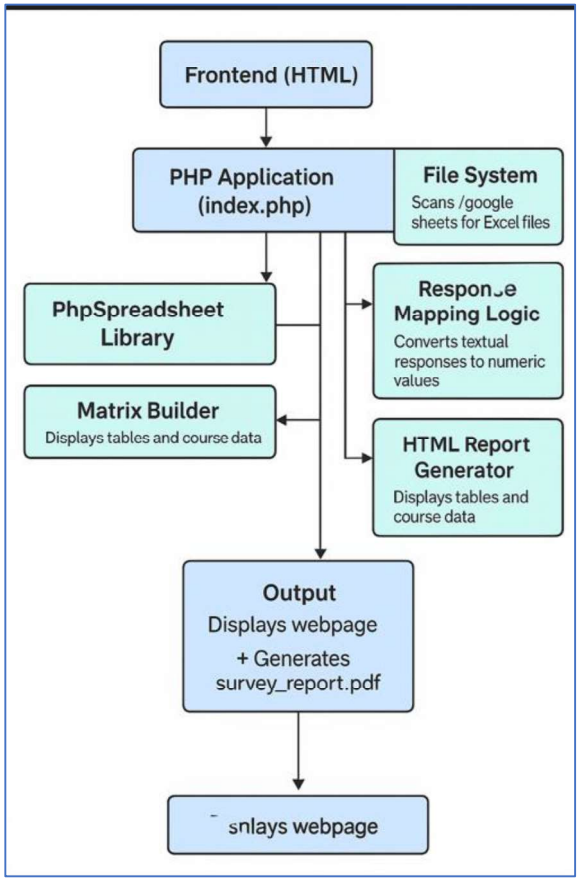


Fig. 6. Module Dependency Diagram for Generating Report

Structure of Database

The database 'exit_survey_mca' shown in Fig. 7. is structured with six tables that collectively support the mapping and assessment of course and program outcomes based on student feedback. The course_master and co_master tables likely store details about courses and their associated course outcomes (COs), while the po_master and program_master tables manage program-level outcomes (POs) and overall program details. The link_master table likely handles the mapping or relationship between COs and POs. The indirect_attainment table captures and stores indirect assessment data, such as student exit survey results, which are used to evaluate attainment levels based on perceptions rather than direct evidence. Together, this schema supports an Outcome-Based Education (OBE) framework with both direct and indirect assessment components.

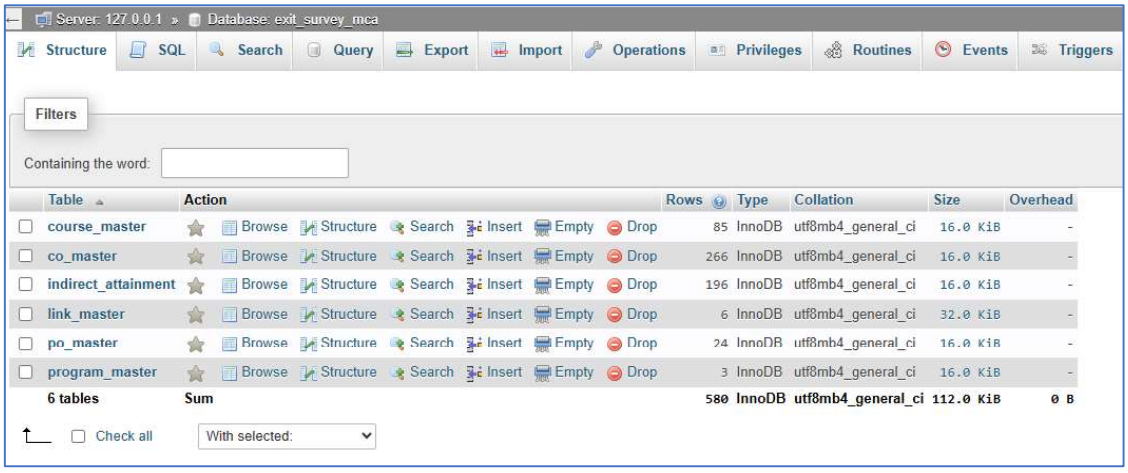
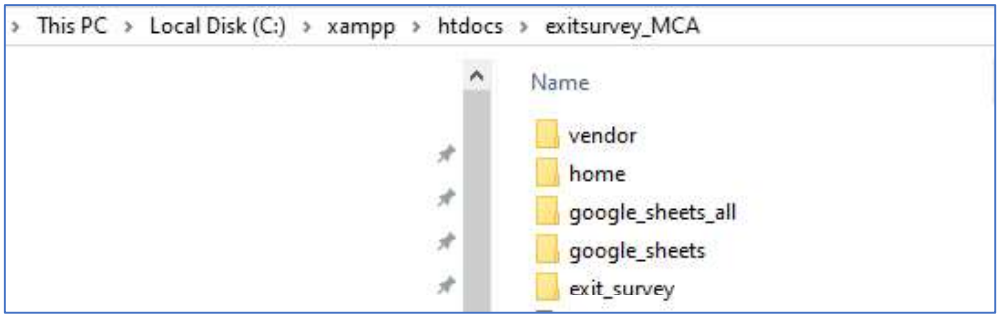


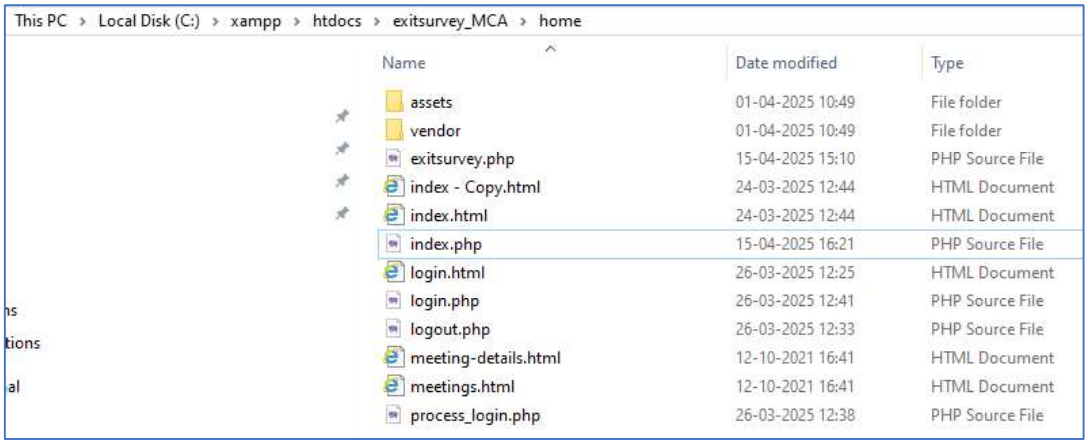
Fig. 7. Structure of Database for Exit Survey

Software System Folder Structure

A Software System Folder Structure organizing the files and directories of a software to project in a systematic way, ensuring clarity, maintainability, and efficient collaboration among developers is depicted in Fig 8(a)-8(c). It typically separates source code, configuration files, documentation, and build artifacts into distinct, well-defined folders.



Content of 'home' Folder



Google_sheets Folder of Web Application

Contains google sheets containing exit survey data.

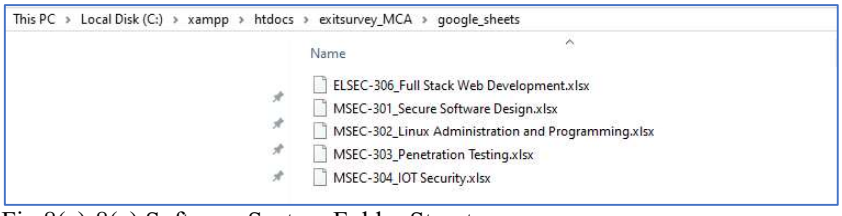


Fig 8(a)-8(c) Software System Folder Structure

Experimental Results

Setting up Execution Environment

Software Requirements for Client-Side Execution

- Operating System (Client Machine)
  Windows 7/8/10/11 (64-bit preferred)
  Admin rights to install and run services
- XAMPP Package Installation

Installation of the full XAMPP stack

- Apache (Web Server)
- MySQL/MariaDB (Database Server)
- PHP (Scripting Engine)
- phpMyAdmin (Database Management GUI)

System Roles and Permissions

The system distinguishes between two primary user roles, each with specific responsibilities and access privileges. The Student role is designed for learners who engage with the platform by providing valuable feedback through structured forms, such as exit surveys and course evaluations. This feedback contributes to indirect assessment and overall program improvement. On the other hand, the Faculty role encompasses administrative and analytical functions. Faculty members are authorized to manage academic entities such as courses, programs, and electives, configure and oversee surveys, and analyze direct and indirect attainment reports. They play a crucial role in monitoring outcome-based education metrics, ensuring that course outcomes (COs) and program outcomes (POs) are aligned and met effectively. The role-based access control ensures secure, purposeful interaction with the system tailored to each user's responsibilities.

System Access Permissions

Faculty Role – Full Administrative Access
Faculty users have extensive privileges to manage academic structures and analyze feedback data. The following menu options are available to them:

Manage Menu

- Programmes – Add, update, or delete academic programs
- Courses – Manage courses within each program
- Programme Outcomes (POs) – Define and edit outcome goals for programs
- Course Outcomes (COs) – Link course-level objectives to POs

Insert Google Form Links Menu

- MCQ Test – Upload links for direct assessment tests
- Exit Survey – Upload links to collect student feedback

Link Management Menu

- View All Links – View all currently inserted form links
- Clear All Links – Delete any outdated or unused links

Data Management and Reporting Menu

- Parse Excel Files – Read and extract data from survey sheets
- Persist Data – Save processed data into the database
- View Power BI Report – Access dynamic dashboards for attainment analysis

Student Role – Limited Functional Access

Student users have access only to essential feedback and assessment features. Their available menu items include:

- Home – Navigate to the main landing page
- MCQ Test – Participate in multiple-choice assessments
- Exit Survey – Submit feedback through the exit survey form
- Login – Authenticate and access student-specific features

Browser Access
Client accesses the application through browser employing the following URL:
http://localhost/exitsurvey_MCA/home
The home page of the web application is displayed as shown in Fig. 9.

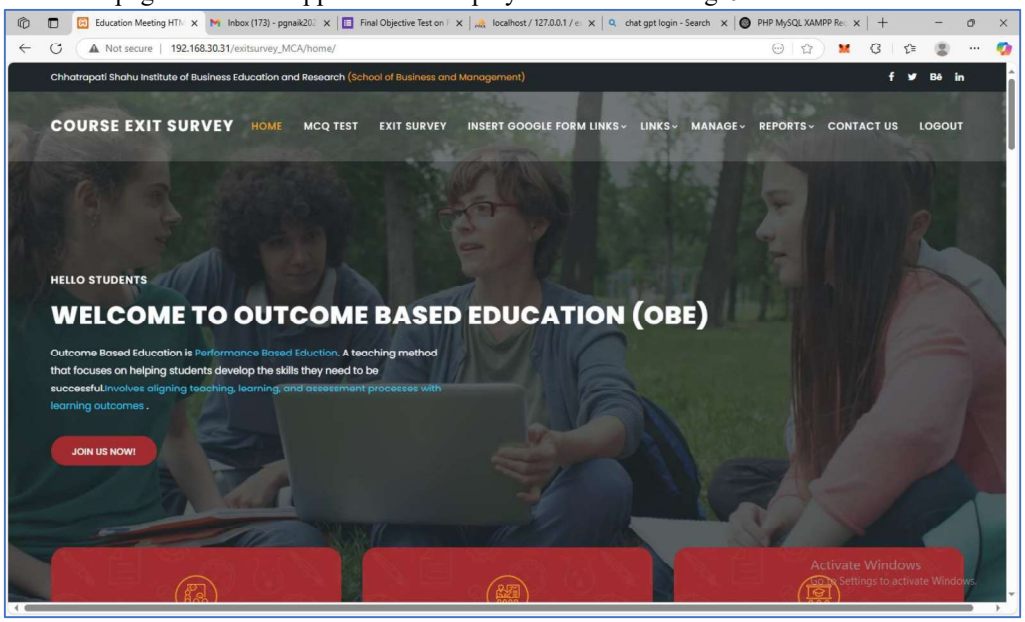


Fig. 9. Landing Page of Web Application for User in Faculty Role

Menu Structure for a User in Student Role
The home page of the system is displayed as shown in Fig. 10.

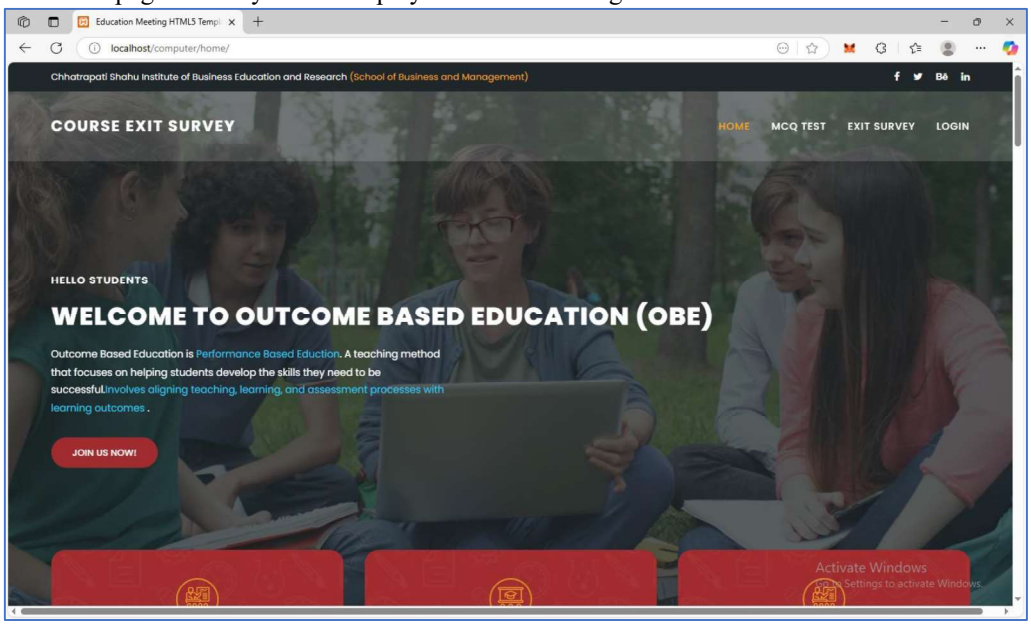


Fig. 10. Landing Page of Web Application for User in Student Role

For the student user, the following menu items are displayed:

- Home
- MCQ Test
- Exit Survey and
- Login

The student will only be able to provide the feedback using ‘Exit Survey’ menu option
The faculties will be able to authenticate with the system using the authentication information shared with them.
On selecting the ‘Login’ menu option the following authentication page is displayed as shown in Fig. 11.

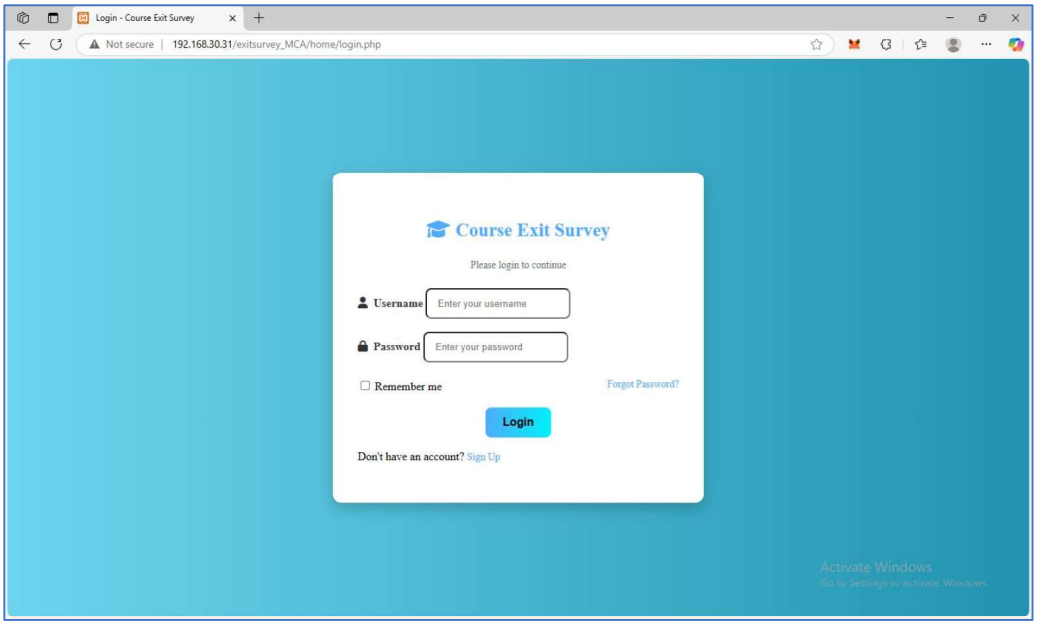


Fig. 11. Authentication Screen

On entering the valid login information, home screen for the user in Faculty role is displayed as outlined in Fig. 12.

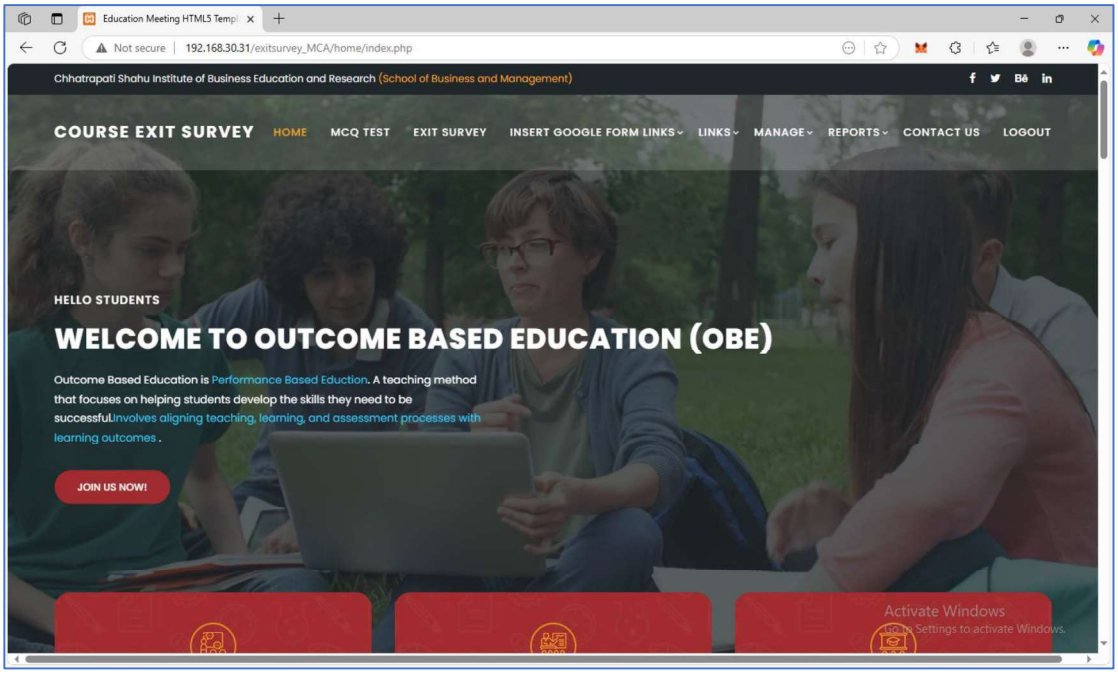
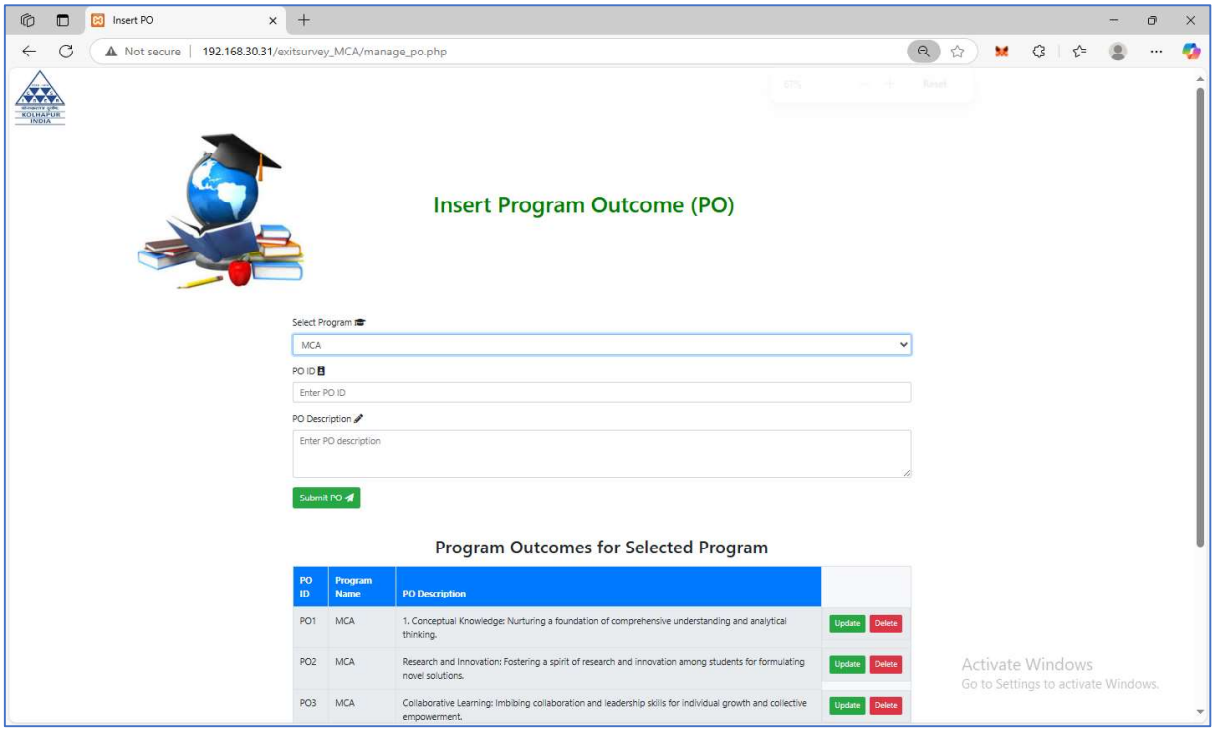
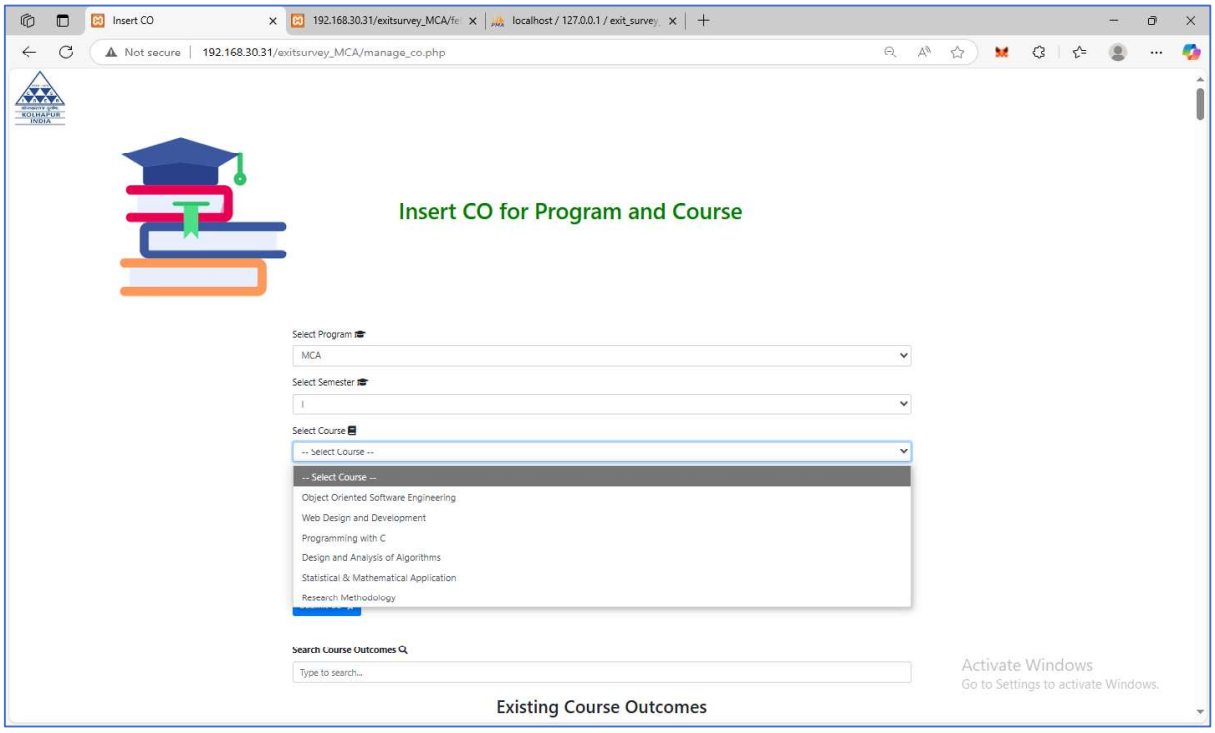


Fig. 12. Home Screen for the User in Faculty Role

Fig 13(a) – 13(c) outline the PO management, CO management and link management screens employed by the user in Faculty role.


Insert PO
Not secure | 192.168.30.31/exitsurvey_MCA/manage_po.php
Insert Program Outcome (PO)
Select Program
MCA
PO ID
Enter PO ID
PO Description
Enter PO description
Submit PO
Program Outcomes for Selected Program
PO ID
Program Name
PO Description
PO1
MCA
1. Conceptual Knowledge: Nurturing a foundation of comprehensive understanding and analytical thinking.
Update
Delete
PO2
MCA
Research and Innovation: Fostering a spirit of research and innovation among students for formulating novel solutions.
Update
Delete
PO3
MCA
Collaborative Learning: Imbibing collaboration and leadership skills for individual growth and collective empowerment.
Update
Delete
Activate Windows
Go to Settings to activate Windows.


Insert CO
Not secure | 192.168.30.31/exitsurvey_MCA/manage_co.php
Insert CO for Program and Course
Select Program
MCA
Select Semester
I
Select Course
-- Select Course --
-- Select Course --
Object Oriented Software Engineering
Web Design and Development
Programming with C
Design and Analysis of Algorithms
Statistical & Mathematical Application
Research Methodology
Search Course Outcomes
Type to search...
Existing Course Outcomes
Activate Windows
Go to Settings to activate Windows.

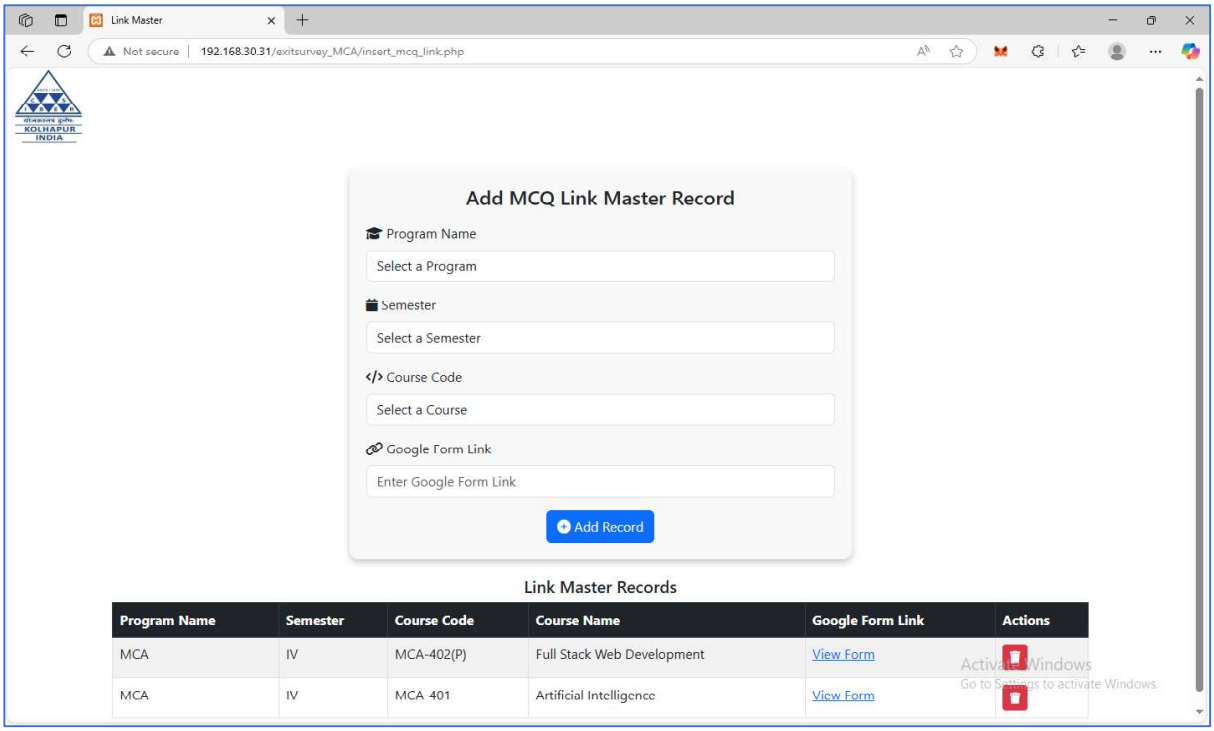


Fig. 13(a)-13(c). PO, CO and Link Management Screens

Conducting Exit Survey

Fig 14. Shows a screen to initiate conducting exit survey for the selected program and semester.

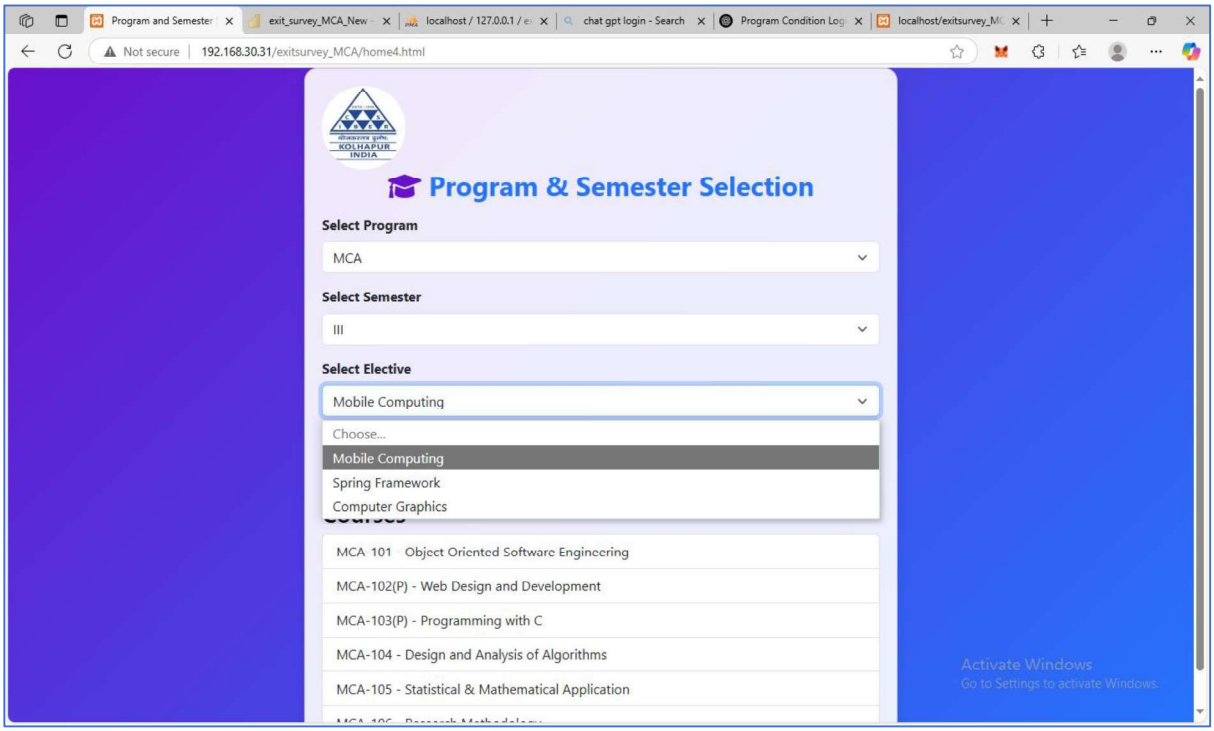
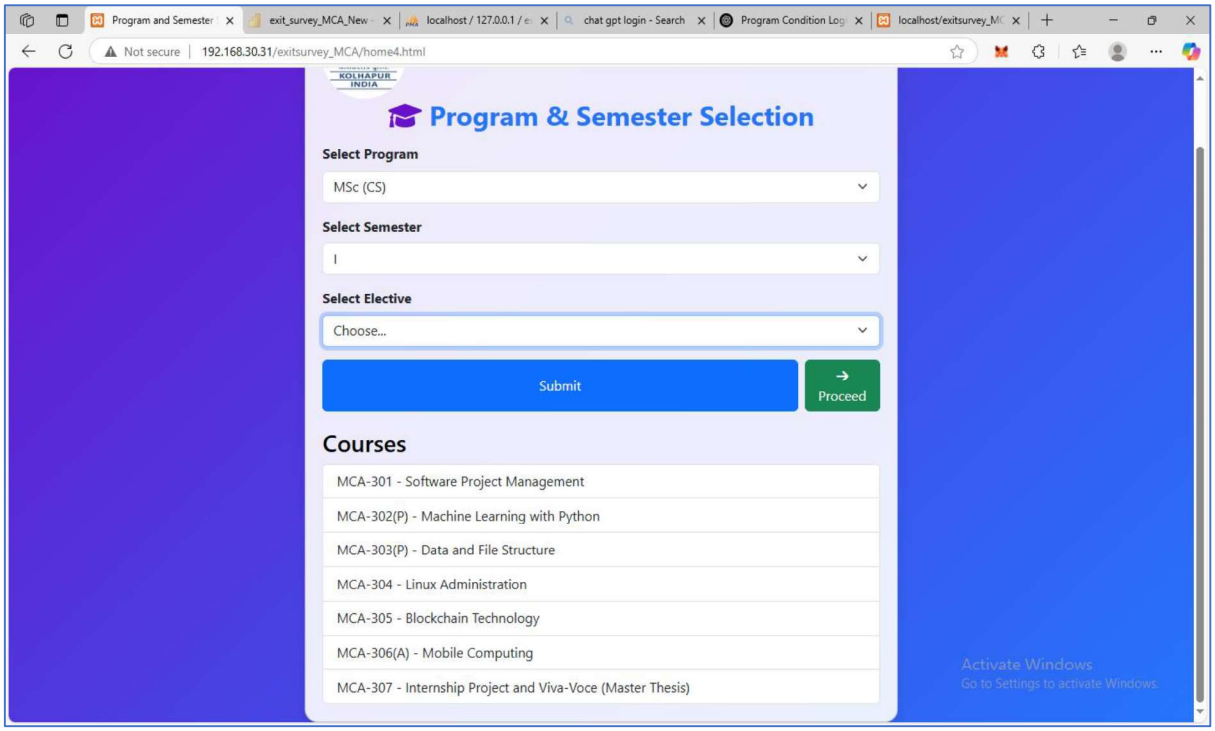


Fig. 14. Conducting Exit Survey

On clicking the 'Submit' button, all the courses of the selected program, semester and elective, if applicable are displayed as shown in Fig 15.



Click on 'Submit' button to view the courses.

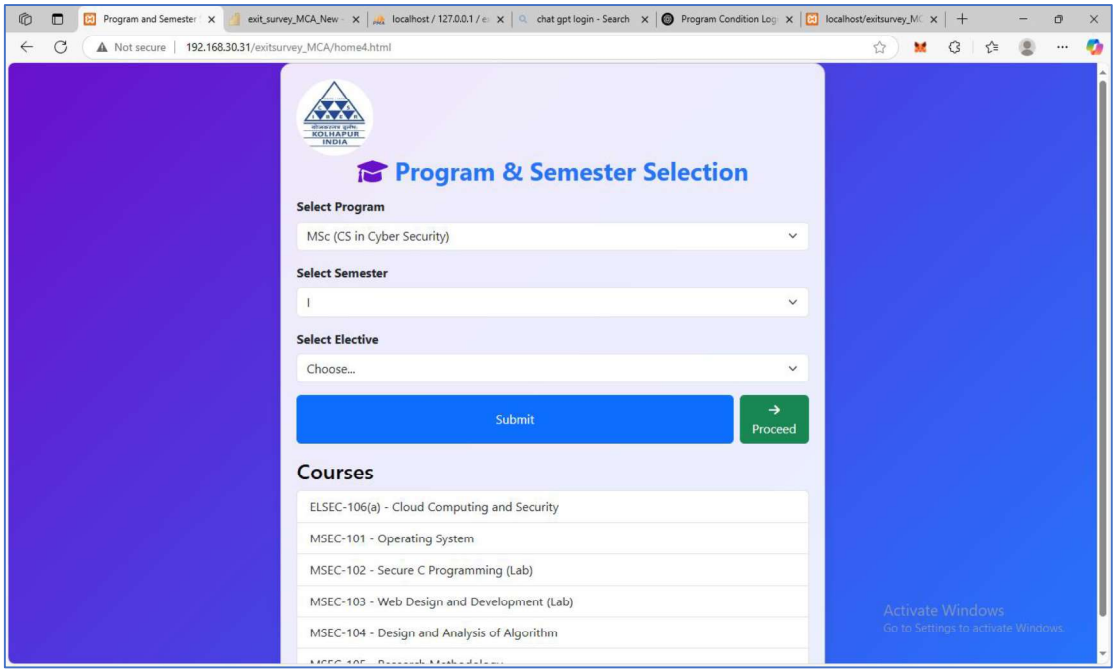


Fig 15. Course Selection Page

On clicking 'Proceed' button after confirming the courses the exit survey home page is displayed as depicted in Fig. 16. The main menu contains the course code links to the exit survey Google forms. The course names corresponding to different course codes are also displayed on the page for verification.

Fig 16. Exit Survey Home Page

Analyzing Exit Survey Data - Computing Indirect Attainment
Parsing Excel Files

Inside web root folder a subfolder with the name 'google_sheets' exists as shown in Fig. 17.

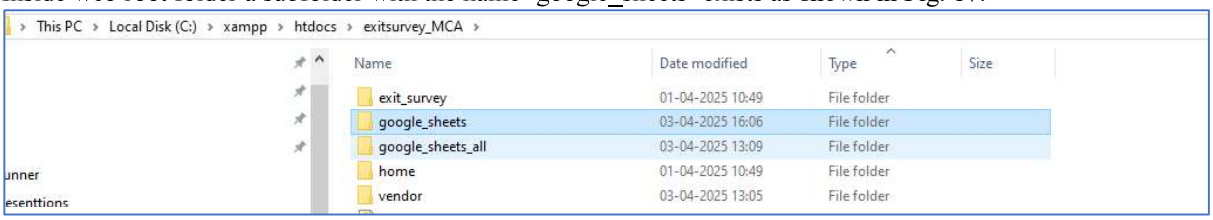


Fig. 17. Google Sheets Folder containing Exit Survey Data

The naming convention used for the Google Sheets is as shown in Fig. 18.

Course code_Course Name

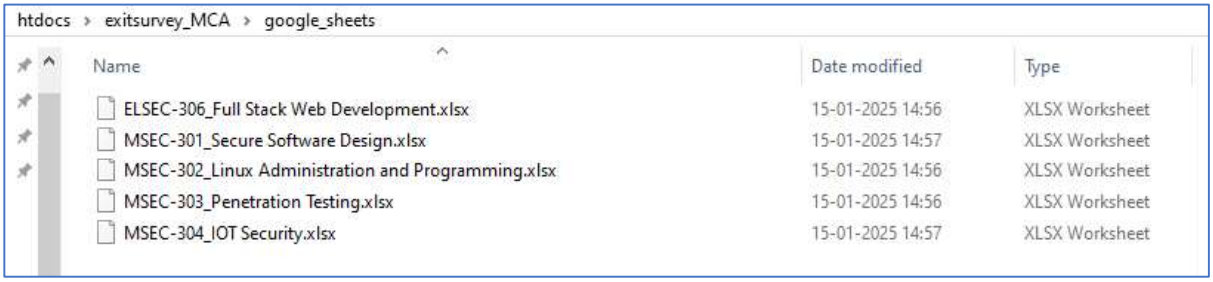
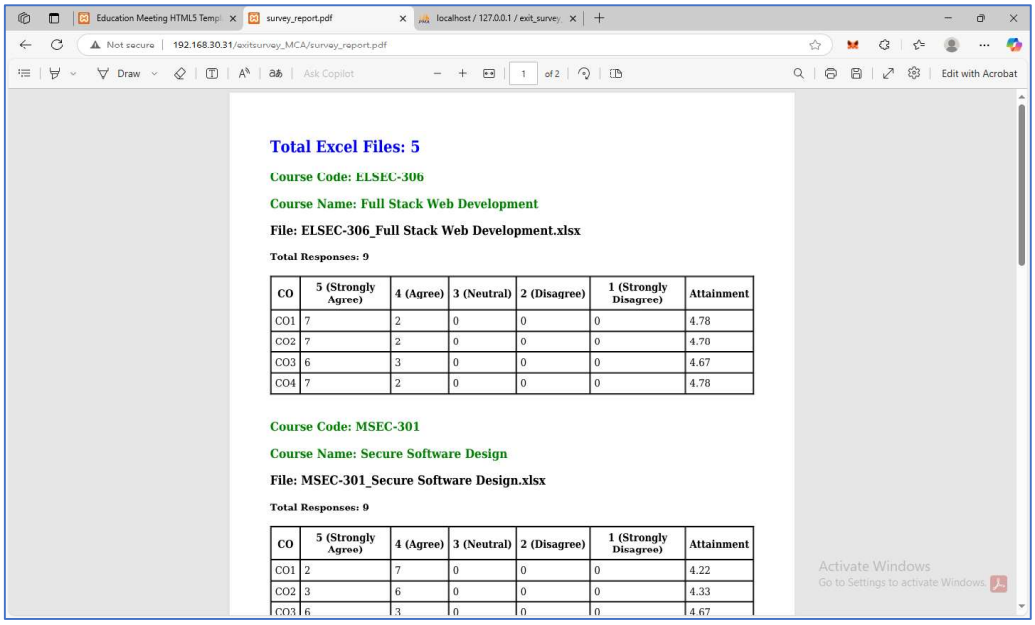


Fig. 18. Naming Convention Used for Google Sheets

Fig. 19. shows the report exported to PDF format.



Total Excel Files: 5

Course Code: ELSEC-306

Course Name: Full Stack Web Development

File: ELSEC-306_Full Stack Web Development.xlsx

Total Responses: 9

CO	5 (Strongly Agree)	4 (Agree)	3 (Neutral)	2 (Disagree)	1 (Strongly Disagree)	Attainment
CO1	7	2	0	0	0	4.78
CO2	7	2	0	0	0	4.78
CO3	6	3	0	0	0	4.67
CO4	7	2	0	0	0	4.78

Course Code: MSEC-301

Course Name: Secure Software Design

File: MSEC-301_Secure Software Design.xlsx

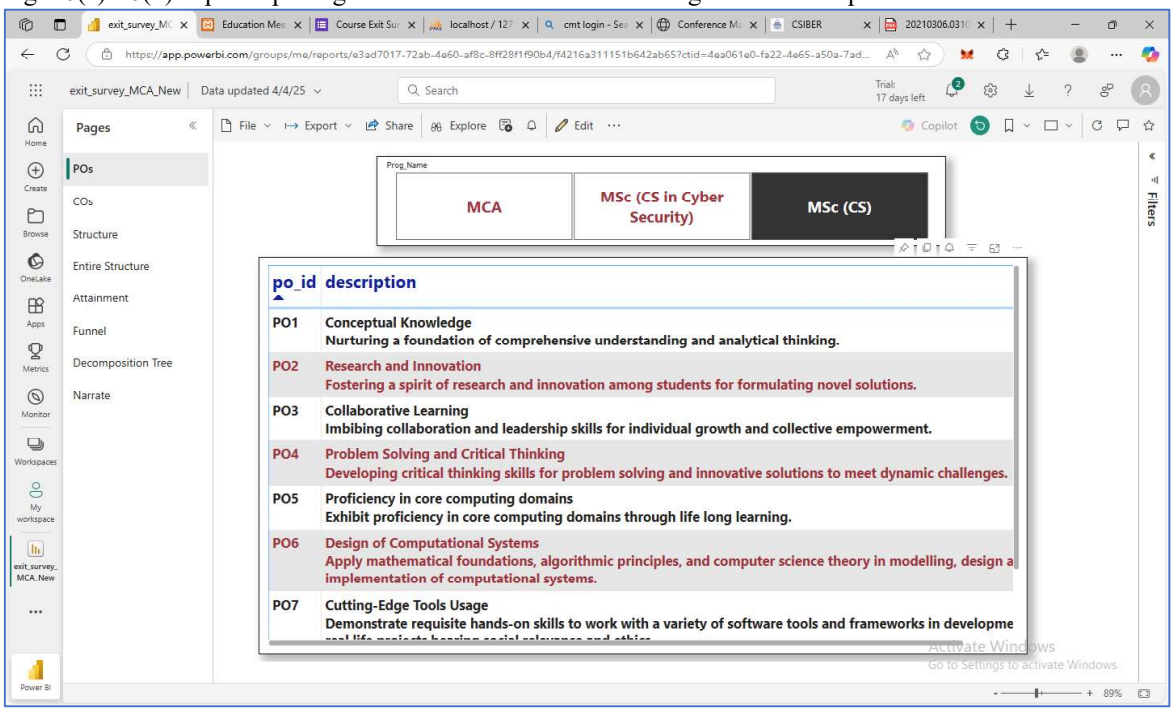
Total Responses: 9

CO	5 (Strongly Agree)	4 (Agree)	3 (Neutral)	2 (Disagree)	1 (Strongly Disagree)	Attainment
CO1	2	7	0	0	0	4.22
CO2	3	6	0	0	0	4.33
CO3	6	3	0	0	0	4.67

Fig. 19. Exit Survey Report in PDF Format

Viewing Power BI Reports

Fig. 20(a)-20(d) depict reports generated in Power BI for viewing attainment reports in different charts.



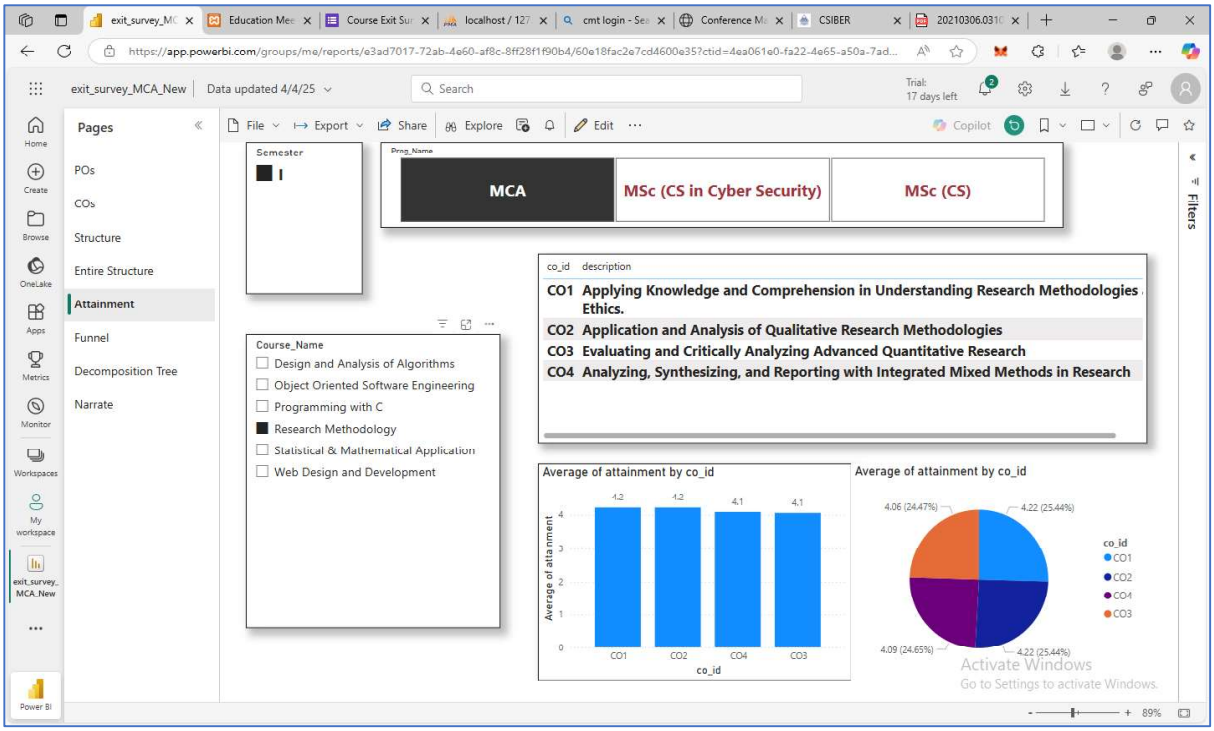


Fig. 20(a)-20(b) Power BI Reports for Viewing Course-wise Indirect Attainment

Viewing the Indirect Attainment in a Decomposition Tree

Decomposition tree page can be used to view the indirect attainment score in a hierarchical tree-like structure.

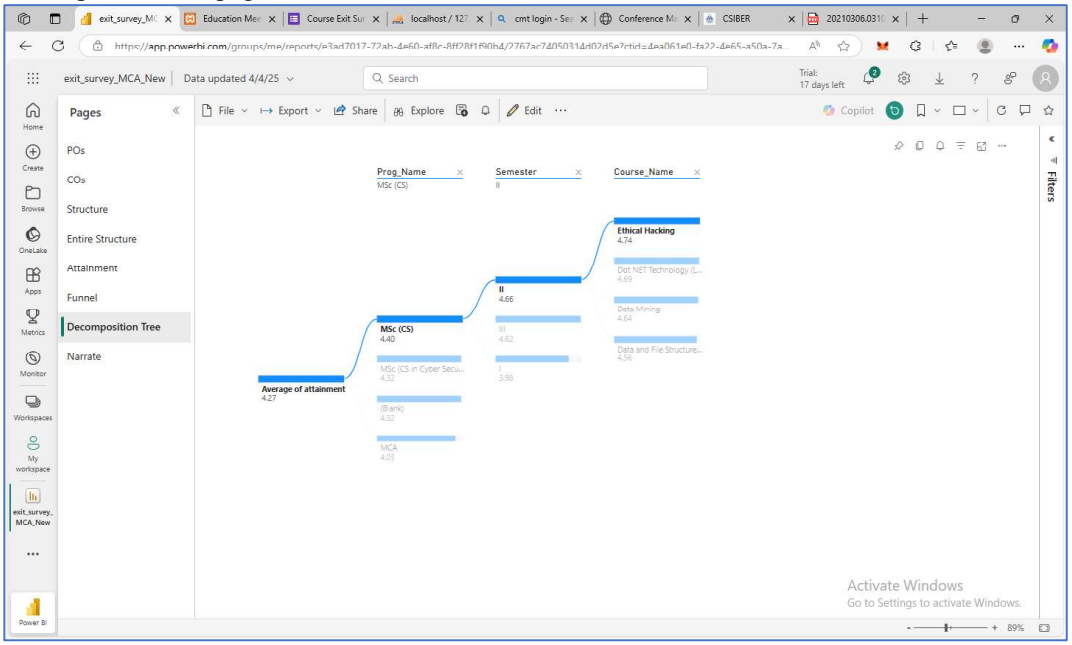


Fig. 20(c) Viewing the Indirect Attainment in a Decomposition Tree

Viewing a Summary Using Narrate

Narrate page provides the narration of the average indirect assessment of all the courses of the selected program and semester.

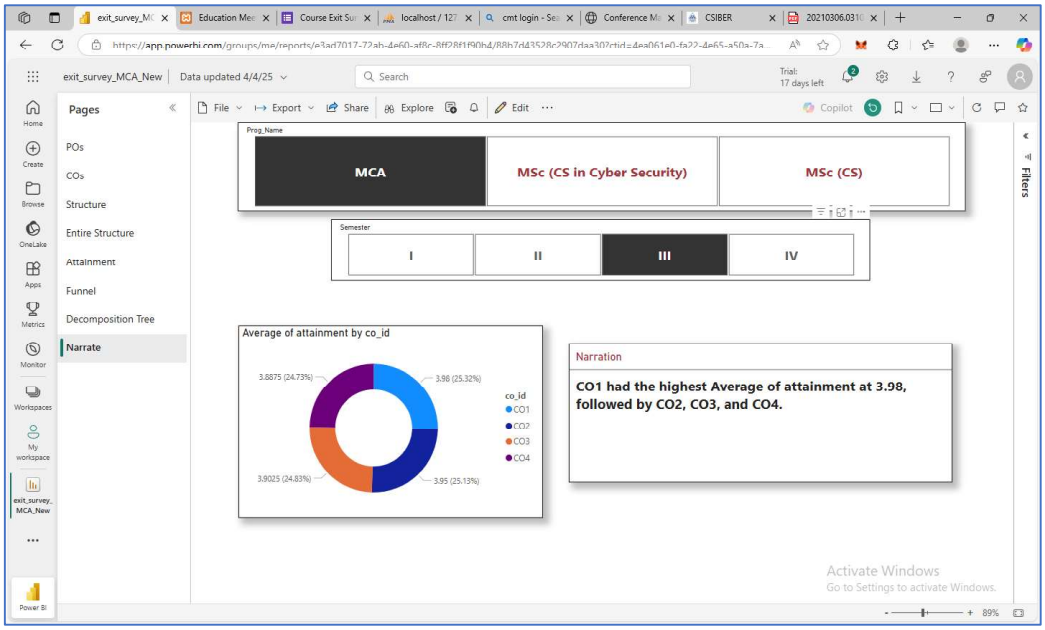


Fig. 20(d). Viewing a Summary Using Narrate

Accessing Application in Mobile App Using ngrok

Ngrok creates a secure tunnel from your local machine to the internet, allowing external access to a locally running server by exposing it through a public URL. It is commonly used for testing webhooks, demos, or accessing local apps remotely.

Setting Up the Authtoken

Following command is employed for setting up authtoken for authenticating local ngrok client with the ngrok account as outlined in Fig 21.

ngrok config add-authtoken 2jVW26vc2cqt3TKmv3cq0aPiQvE_2Xb8unPSpWjr7uqiiSQco

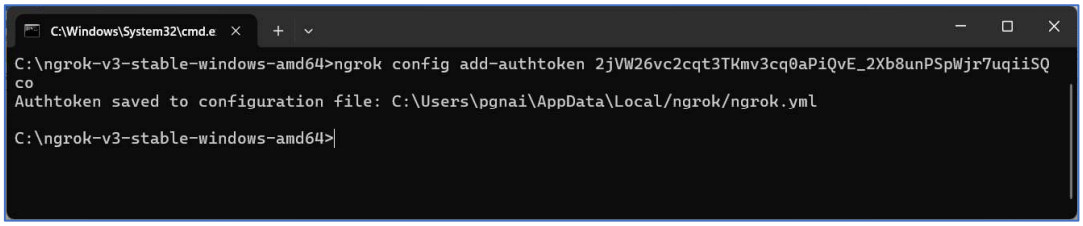


Fig. 21. Setting Up Authtoken in Ngrok

The setup is verified by running ngrok using the following command as depicted in Fig. 22.
ngrok http 192.168.1.8

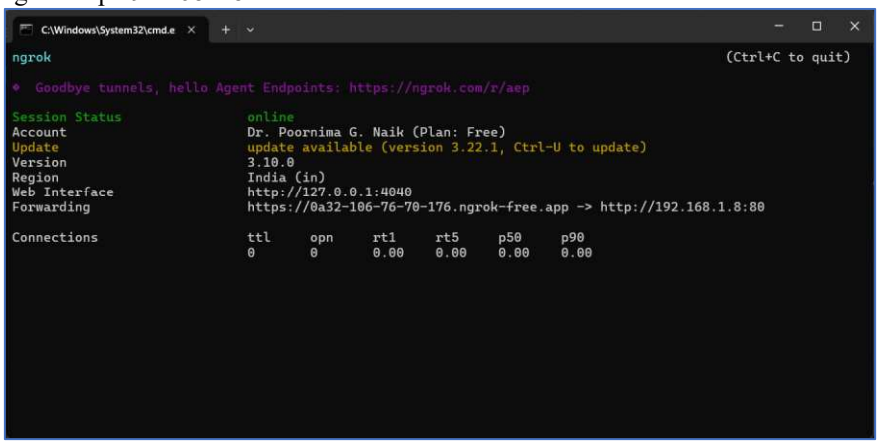


Fig 22. Using Ngrok for Secure Tunneling

Now, the application is served on the internet using the following URL.
https://0a32-106-76-70-176.ngrok-free.app
To test the following URL is accessed in the address bar of a browser. The web access page is displayed as shown in Fig. 23.
https://0a32-106-76-70-176.ngrok-free.app/exitsurvey_MSW/home/

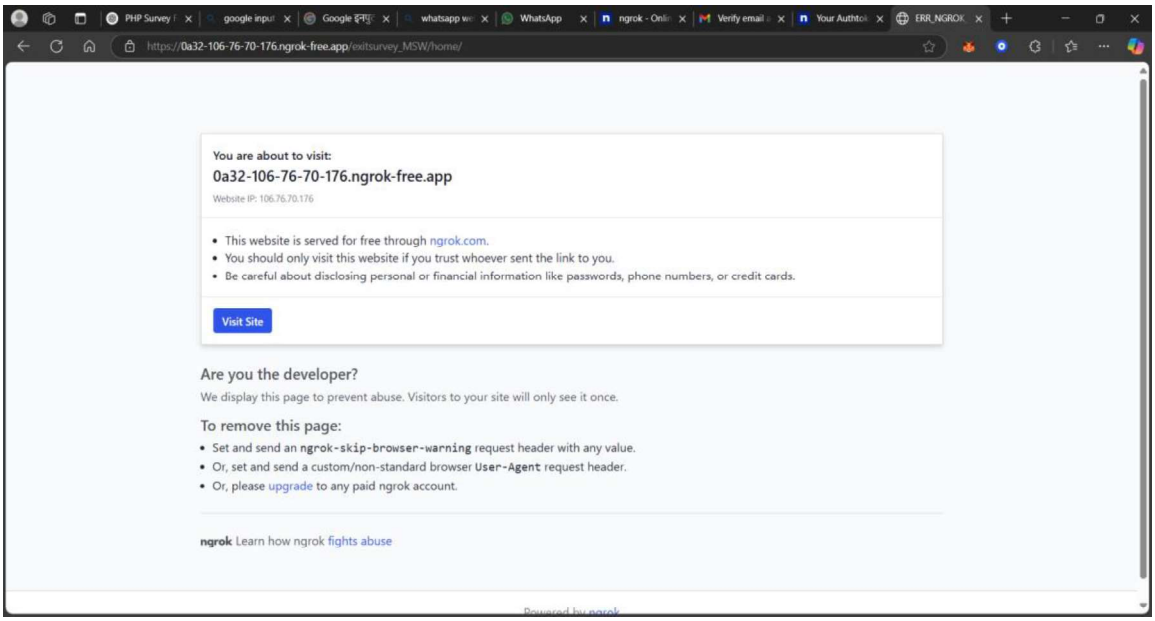


Fig. 23. Ngrok Web Access Page

On clicking the 'Visit Site' button the local webapp is served remotely by establishing a secure channel by ngrok.

Conclusion and Scope for Future Work

Conclusion

The integration of Outcome-Based Education (OBE) with automated systems for assessing and managing course and program outcomes provides a significant advancement in higher education. By leveraging tools like Google Forms for student feedback, MySQL for data storage, and Power BI for real-time visualizations, the system offers a comprehensive solution for both direct and indirect assessment. This approach ensures continuous improvement and alignment with industry needs, enhancing the relevance and effectiveness of educational programs. The automation of feedback collection, analysis, and reporting streamlines the entire OBE evaluation process, empowering educators and administrators to make informed decisions that drive curriculum improvements and better prepare students for professional challenges.

Scope for Future Work

Future work can expand the current system by integrating more advanced data analysis techniques, such as machine learning models, to predict student performance and outcomes based on historical data. Further, the system can be enhanced to support more interactive feedback mechanisms, such as peer reviews and real-time surveys during the course. The integration with more Learning Management Systems (LMS) and broader accreditation frameworks could further streamline OBE implementation. Expanding the system's capabilities to track long-term graduate success, such as employment outcomes and industry engagement, would also provide a more holistic view of program effectiveness.

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