

# Adaptive Academic Guidance System via Student Activity Performance Analysis and Profiling

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**Abstract**—In the ever-evolving landscape of education driven by rapid technological advancements, e-learning has emerged as a transformative force. However, it faces challenges, notably the difficulty of personalizing education in a digital environment. This paper introduces an innovative adaptive academic guidance system called "StudyMate." The system analyzes student activity, performance, and profiles to enhance the e-learning experience. The objectives encompass extensive research, surveys for primary and secondary data collection, algorithm development for student analysis, foundational database creation, source code development, and online system hosting. StudyMate leverages learning management system (LMS) functionalities to offer tailored learning experiences and demonstrates its efficacy in the digital realm. The literature review explores adaptive e-learning systems, highlighting the need for personalized education and referencing related research projects. The methodology outlines planning, design, implementation, testing, and critical evaluation phases, including sample code snippets and test cases. The findings confirm the successful implementation of adaptive concepts in StudyMate, addressing the academic question effectively. The limitations lie in the system's scope, primarily focusing on student views, leaving room for future enhancements such as lecturer and admin functionalities. The paper concludes with the potential for expanding StudyMate's features and improving its usability, making it a valuable solution for personalized e-learning.

**Keywords**—Adaptive Academic Guidance System, Performance Analysis, E-learning, Personalized Education, Learning Management System (LMS)

## I. INTRODUCTION

In the era of rapid technological advancement and shifting paradigms in education, e-learning has emerged as a dynamic force reshaping the landscape of both technology and academia. Traditional teaching methods have encountered limitations, and circumstances necessitate the exploration of innovative learning avenues. Consequently, students increasingly turn to e-learning technologies to meet their educational needs. However, as e-learning systems gain prominence, so do their inherent limitations. One of the key challenges lies in the inherent difficulty of recognizing each student's unique talents, weaknesses, strengths, and learning preferences. The traditional educational model, characterized by face-to-face interaction, allows educators to gauge student progress with relative ease. In contrast, the digital realm introduces a considerable gap between students and lecturers, making it arduous to measure individual progress accurately.

In a typical e-learning environment, students are furnished with uniform learning resources, but often lack personalized guidance. The need for adaptability becomes apparent and this is where the concept of an adaptive e-learning environment enters the trends. An adaptive e-learning system is a burgeoning area of study dedicated to crafting methods that cater to students' individualized learning preferences. It envisions a learning ecosystem where each student's educational journey is personalized based on their performance, activities, interests, and goals.

In light of these considerations, this paper embarks on a comprehensive exploration of adaptive e-learning systems, with a primary focus on the development of an innovative system titled "StudyMate." The development of this web-based platform marks a pivotal phase of the project, forming the system's foundational framework. Emphasis will be placed on creating a well-structured user interface, prioritizing an intuitive and user-friendly user experience. The ultimate goal is to bridge the gap between students and their educational mentors in the digital realm.

### A. Aims of the Study

The central objective of this study is the implementation of an adaptive academic guidance system within the e-learning landscape. This system, referred to as "StudyMate," is envisioned to analyze students' activity, performance, and profiles, thereby revolutionizing the e-learning experience.

### B. Objectives

The study's objectives are multifaceted, encompassing crucial elements such as conducting extensive research into adaptive e-learning systems, conducting two surveys for primary and secondary information gathering, developing an algorithm to analyze students' activity and knowledge, crafting the foundational database structure and source code for StudyMate, and ultimately, hosting the system online to evaluate its performance in its designated digital environment. These objectives collectively contribute to the study's overarching goal of enhancing the e-learning experience through adaptability and personalized guidance.

### C. Scope

The primary scope of this study centers on the development of StudyMate—an adaptive, web-based learning system that strives to enhance students' knowledge and provide invaluable guidance to educators. StudyMate will leverage the basic functionalities of a learning management system (LMS) to offer a tailored learning experience. This study aims to demonstrate the system's efficiency within its intended environment by hosting it on the internet through an online hosting service.

In the pursuit of educational innovation, this study endeavors to explore the frontiers of adaptive e-learning systems and chart a course toward personalized learning experiences by bridging the gap between students and educators in the digital age.

## II. LITERATURE REVIEW

The literature review provides a comprehensive exploration of learning-style-based adaptive e-learning systems, emphasizing the growing need for personalized education in higher learning institutions. The review highlights the persistence of challenges in implementing adaptive e-learning, where traditional systems fail to cater to individual learning styles and interests. Instead, they offer uniform tools and resources to all learners. The foundation of adaptation in e-learning systems involves meticulously crafted procedures tailored to educational content.

Numerous studies have affirmed the efficacy of adaptive e-learning in delivering content that aligns with learners' needs and preferences, facilitating knowledge acquisition, interactions, and advanced intellectual development.

### A. Similar Projects

Several research projects in the realm of adaptive e-learning offer valuable insights and serve as foundational knowledge for the development of personalized online learning systems.

The "Intelligent Student Profiling with Fuzzy Models" study by presents the application of fuzzy logic to gauge students' knowledge levels. Fuzzy logic-based models, including content models, student models, and learning plans, contribute to personalized learning experiences [1]. A multidimensional characteristic analysis approach is employed to build a profiling system, complete with real-time monitoring capabilities for learner data extraction [2]. Generic user models that offer personalized learning materials and resources. This study delves into the creation, maintenance, and updating of learner profiles [3]. D.R. Robert Joan's investigates flexible learning schedules and their impact on educational design [4]. It focuses on pedagogical, technical, and managerial aspects of flexible learning, highlighting the challenges associated with online learning and delivery [5]. Maja Pivec, Christian Trummer, and Juergen Priff's pioneers' adaptive e-learning using eye-tracking and content-tracking

technology, offering a comprehensive understanding of real-time monitoring features [6].

Eiman Aciad and Farid Meziane's study provides a foundation for designing broad learning environments for students pursuing non-traditional study programs [7]. Moiz Uddin Ahmed, Nazir Ahmed Sangi, and Amjad Mahmood introduce an adaptive learner model based on a learner survey to capture profiles and preferences [8]. K.K. Thyagarajan and Rathnamanjari Nayak address the challenge of personalization in e-learning systems, proposing a strategy based on ontology and service-oriented infrastructure [9]. Mushtaq Hussain employs machine learning techniques to monitor student engagement and its effect on assessment scores [10].

Hassan A. El-Sabagh develops an adaptive e-learning system tailored to students' learning styles and evaluates its impact on student engagement [11]. Apart from e-learning, additional resources like "SQL Cookbook" and "Practical SQL" offer practical guidance on SQL, while "Web Design with HTML, CSS, JavaScript, and jQuery Set" and "Headfirst PHP & MySQL" delve into web design and PHP for beginners, enriching the knowledge base for those exploring the technical aspects of e-learning systems [12,13,14,15].

## III. METHODOLOGY

### A. Planing

The core objective of this study was the development of StudyMate, a web-based adaptive academic guidance system. StudyMate aims to guide students by assessing their interests, weaknesses, activities, and performance, offering personalized modules, quizzes, recommended readings, courses, and feedback from lecturers. Each student's learning experience within the StudyMate system is unique and adapts to their needs.

To initiate the adaptation process, a student completes a registration form, providing information about challenging modules and areas of interest. This data is stored in the system's database, serving as the initial data gathering step. The StudyMate system then employs three triggers to personalize the learning experience.

1) *Trigger 1:* Two days before a lecture, the system identifies relevant lectures and associated modules, locates students with challenging modules, retrieves pre-quiz resources, identifies user email addresses, and sends emails with the required materials.

2) *Trigger 2:* After each lecture there will be a quiz and when quiz scores are updated, the system assesses quiz scores, updates module hardness levels, retrieves post-quiz study materials, identifies user email addresses, and sends emails with post-quiz resources.

3) *Trigger 3:* Every Saturday, the system identifies lectures held seven days prior, determines students interested in those modules, retrieves motivation resources, identifies

user email addresses, and sends motivational materials via emails.

The StudyMate system is designed to enhance student motivation, provide personalized resources, and track student progress. If a student's quiz scores do not improve after three attempts, a warning is sent to both the student and the lecturer. Lecturers can upload resources and questions for their modules. The Fig 1, illustrate the process of adaptation of StudyMate created in the study.

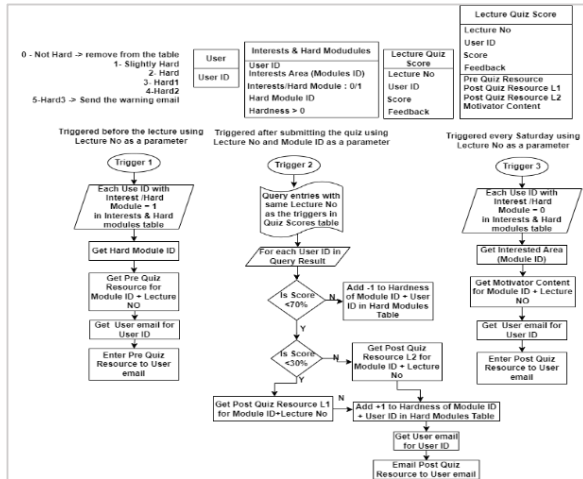


Fig. 1. Flow Chart of Adaption

### B. Identifying Business Values

StudyMate brings forth substantial advantages for students, educators, and educational institutions alike. Students benefit from a tailored learning journey that hones in on their individual strengths and weaknesses. Lecturers gain the ability to efficiently mentor and track students within the online teaching landscape, transcending the challenges of remote instruction. Meanwhile, educational institutions can elevate the quality of their online educational offerings, leading to enhanced student outcomes and overall satisfaction.

In terms of feasibility, StudyMate demonstrates robust technical feasibility as it leverages readily available technologies like PHP and MySQL, initially hosted on a cost-effective web service. While short-term costs remain minimal due to open-source technologies, consideration of long-term hosting expenses is essential. Furthermore, operational feasibility is affirmed by surveys among students and educational institutes, which underscore the system's high relevance and need. Legal feasibility is upheld through strict data protection measures, ensuring compliance with legal requirements. Finally, the study's agile approach empowers it to remain on track for completion by the end of September, allowing continuous development and feature integration.

### C. Designing and Implementation

In the designing phase of StudyMate, key aspects include the physical design illustrating data flow, the architecture

design delineating user interactions and data flow, and the user interface design emphasizing user-friendliness and an optimal experience.

The StudyMate system was implemented based on planning, analysis, and design phases. It involves creating the database structure, coding the system in PHP using Visual Studio Code, and designing the user interface. Fig 2 illustrate the deployment diagram of StudyMate and Fig 3 denotes the architecture of the system.

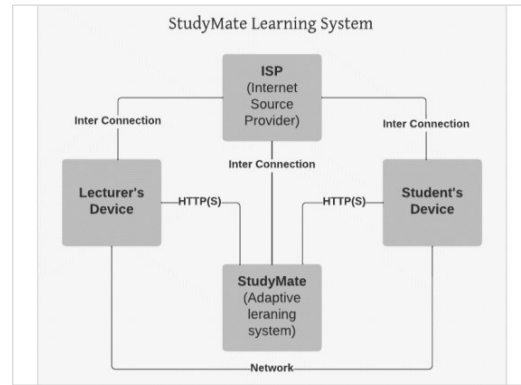


Fig. 2. Deployment Diagram

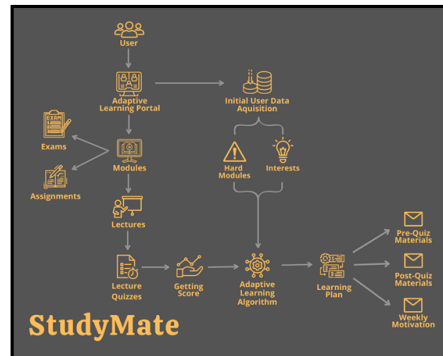


Fig. 3. System architecture

### D. Testing

In the development process, rigorous testing is paramount. Unit testing involves assessing the algorithm, database, and code for accuracy. Integration Testing scrutinizes the interactions among various StudyMate components, such as user registration, module viewing, and email functionality. Lastly, System Testing ensures the holistic functionality of the system, validating its user-friendliness, reliability, and real-world usability while conducting thorough bug checks and validation assessments.

## IV. RESEARCH FINDINGS

The primary focus of this study was to address the academic question: "How to implement a concept to adapt an e-learning system for students which could provide adaptive academics and guidance." The proposed solution for this academic inquiry was the development and implementation of the StudyMate system, aimed at introducing adaptive

learning and guidance features into an e-learning environment. The StudyMate system incorporates three key concepts designed to adapt the e-learning experience for students:

1) *Support for Improvement in Weak Areas:* The StudyMate system identifies areas in which learners are struggling within a specific module. It collects data on lectures, their associated module IDs, and the users who find certain modules challenging. By analysing this data, the system offers tailored support to help students improve in these areas.

2) *Individualized Learning:* StudyMate provides personalized guidance to each learner. It identifies and aligns users with modules that match their interests, fostering motivation and engagement in the learning process.

3) *Automated Communication:* The system automates communication processes by sending pre-quiz, post-quiz, and weekly motivational emails to users. These emails are designed to provide guidance, encouragement, and support to students, enhancing their overall learning experience.

The StudyMate system successfully addresses the study's academic question by introducing these adaptive learning concepts and guiding students in their e-learning journey. Fig 4 given below shows the final reveal of the application, "StudyMate".

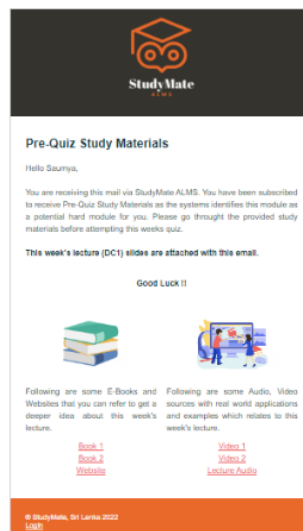
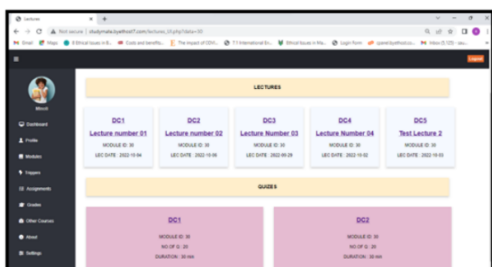
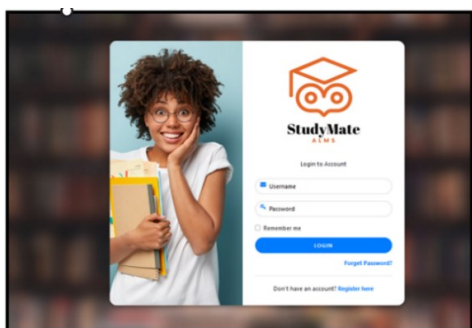


Fig. 4. Sample interfaces of the application

#### A. Sample Code - Triggers

1) *Trigger 1-Daily Lecture Reminders:* This trigger operates daily at 2:00 AM. It checks the lecture dates from the "Lectures" table and identifies lectures that are scheduled for two days in the future. It then compiles a list of these upcoming lectures and identifies users interested in hard modules related to these lectures. Finally, it sends reminder emails to these users. Fig. 5 denotes sample codes for trigger 1.

```

start at 2.00 am - daily

check field "Lecture_Date" from table "Lectures",
collect "Lecture_NO" and "Module_ID"s of Lectures,
where "Lecture_Date" - current day = 2,
create list of lectures "Lecture_NO".

according to the list of lectures,
check field "User_ID" from table "interest_hard_modules",
where Module_ID matches that of list of Lectures
collect "User_ID"s of interest_hard_modules,
where "Type" = "Hard".

check field "Path_Filename" from table "resources",
collect "Path_Filename" of resources",
where "Resource_Type" = "Hard",
for Module_ID from list of lectures.

check field "Email" from table "Users"
collect "Email" of Users.

according to the "User_ID" of "interest_hard_modules",
check field "Email" from table "Users" through "User_ID"
collect "Email" of Users,
composing Email to the template.

send Email.

```

Fig. 5. Trigger 01

2) *Trigger 2 - Quiz Score Update:* This trigger operates after a user submits a quiz in a lecture. It collects quiz scores, lecture numbers, and module IDs. Based on the quiz score, it adjusts the "hardness" of modules in the "interest\_hard\_modules" table and sends emails to users,

providing feedback and guidance. Fig. 6 denotes sample codes for trigger 2.

```

start after submitting the quiz in Lectures

check field "Score" from table "quiz_score",
collect "Users_ID", "Score", Lecture_NO
where "Score" is updated.

check fields "Module_ID" and "Lecture_NO" from table "quiz",
according to the "Quiz_ID" of "table quiz_score"
collect "Module_ID" and "Lecture_NO".

check field "Score" of tables "quiz_score",
if "Score" > 70%,
  check field "Users_ID" + "Module_ID" of table "interest_hard_modules",
  where "Users_ID" + "Module_ID" matches to data of table "interest_hard_modules",
  add a -1 to "hardness" of "interest_hard_modules";
else ("Score" < 70%),
  check field "Users_ID" + "Module_ID" of table "interest_hard_modules",
  where "Users_ID" + "Module_ID" matches to data of table "interest_hard_modules",
  add a +1 to "hardness" of "interest_hard_modules".

According to the "Module_ID" and "Lecture_NO" of "quiz",
check field "Path_Filename" from table "resources",
collect "Path_Filename" of resources,
where "Resource_Type" = "Hard".

according to the "User_ID" of table "quiz_score",
check field "Email" from table "Users" through "User_ID"
collect "Email" of Users.

composing Email to the template.

send Email.

```

Fig. 6. Trigger 02

3) *Trigger 3 - Weekly Motivational Emails*: This trigger runs every Saturday at 2:00 AM. It identifies users interested in certain modules and sends them motivational emails related to their areas of interest. Fig. 7 denotes sample codes for trigger 3.

```

start at 2.00 am - every Saturday

check field "User_ID" and "Module_ID" from table "interest_hard_modules",
collect "User_ID" and "Module_ID",
where "Type" = "Interest".

check field "Path_Filename" from table "resources",
collect "Path_Filename" of resources,
where "Resource_Type" = "Interest".

according to the "User_ID" of "interest_hard_modules",
check field "Email" from table "Users" through "User_ID"
collect "Email" of Users.

composing Email to the template.

send Email.

```

Fig. 7. Trigger 03

### B. Test Cases

The study includes several test cases to ensure the functionality of the system. These test cases cover key interactions and functionalities of the StudyMate system, including login, registration, module access, lecture selection, quiz submission, and email triggers.

1) *Test Case 01 - Login*: This test case verifies the login functionality, including scenarios where inputs are empty, incorrect, and correct. It ensures that users are directed to the homepage upon successful login.

2) *Test Case 02 - Request for Registration*: This test case examines the registration process. It checks scenarios where input fields are empty and where all fields are correctly filled,

ensuring that users receive appropriate warnings and successful registration messages.

3) *Test Case 03 - Access Module Page*: This test case verifies that users can access the module page by clicking on the module button.

4) *Test Case 04 - Selecting a Lecture*: This test case checks if users can successfully select and view the content of a lecture by clicking on its name.

5) *Test Case 05 - Submitting Quiz*: This test case ensures that users can submit quizzes by clicking on them, allowing them to progress in their e-learning journey.

6) *Test Case 06 - Getting Pre-Quiz Mail*: This test case checks if users receive pre-quiz emails when clicking on trigger 1.

7) *Test Case 07 - Getting Post-Quiz Mail*: This test case verifies if users receive post-quiz emails upon clicking trigger 2.

8) *Test Case 08 - Getting Weekly Motivational Mail*: This test case examines whether users receive weekly motivational emails by clicking trigger 3.

## V. CONCLUSION

### A. Important Outcomes

The main aim of this study was finding a method to implement an adaptive academic guidance system (e-learning) which analyze Student's activity, performance, and profiling. For that, a method to provide adaptive learning was needed. For those, three concepts were implemented using PHP programming language and MySQL. The environment was implemented as an e-learning system using basic e-learning features.

As important outcome, according to the three concepts, three algorithms were created to develop the adaptation.

### B. Limitation

In this study, the scope was to develop web based adaptive e - learning system. Now it is clear that through this study the researchers have found a method to provide adaptive e-learning environment. The implemented system covered a wide area of factors although only few were adopted during the study according to the scope of the study.

### C. Critical Evaluation

In this study, there are several objectives. Such as conducting research, secondary information gathering through surveys, algorithm creation according to the scope of the study etc. At the end of the study all the objectives of the have been achieved. The system was well specified. And the StudyMate was developed with the use of free open-source tools for certain related functionalities. The performance of

the system was in a good satisfactory level, but it could have been more if the system is developed with the admin and lecturer view. The final output could meet the business need firmly.

#### D. Future Work

Since the StudyMate e-learning system implemented to meet the minimum requirements of the problem, many other future enhancements could be applied to it. Such as this StudyMate only built up with the student view to present the adaptation concept but developing the system with the lecturer view and admin view to make the system more functional.

Also, implementing other features of an e-learning system (LMS), to this StudyMate system could enhance the usability of the implemented system of this study. Such as resetting user credentials, feature to do the quizzes which enables user to have a normal LMS experience with unique feature relates to adaptation, making it a perfect solution for the future.

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