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Academic Study Plan Recommender and Simulator System Using Forward Chaining and Heuristic Algorithms

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Abstract— The Academic Study Plan Recommender and Simulator System introduces an innovative approach to academic planning, combining Forward Chaining and Heuristic Algorithms to generate personalized and optimized study plans. Forward Chaining enables the dynamic evolution of plans by iteratively applying rules based on individual academic goals, elective preferences, and constraints. Heuristic Algorithms enhance this process by prioritizing courses based on factors such as relevance, difficulty, and scheduling, ensuring optimal decision-making and improved user satisfaction. The system's simulator component further empowers students by enabling them to explore various academic scenarios and adapt to changes like elective choices or shifts in majors. Feedback from IT experts revealed a 90% call for algorithmic improvements, emphasizing the need for enhanced reliability and performance, even though satisfaction with the system reached 76.8%. Functional suitability received an overall satisfaction rating of 4.27, with high ratings for functional correctness and appropriateness from both faculty and irregular students. Performance efficiency and usability achieved similarly strong ratings, averaging 4.26 and 4.21, respectively. Key usability factors like appropriateness recognizability, operability, and user interface design contributed significantly to user satisfaction. Additionally, reliability and security scored highly, averaging 4.40 and 4.26, underscoring the system's dependable and secure operations. Flexibility and compatibility were also commended, with average ratings of 4.27, reflecting the system's adaptability and seamless integration with other tools and processes. Maintainability received a high score of 4.23, demonstrating the system's ease of modification and testing. Faculty and irregular students particularly appreciated features such as modularity, operability, and learnability, which align with studies highlighting the importance of these factors in educational technologies. By digitizing the academic planning process, the system reduces manual effort for instructors and students while delivering accurate, adaptive study plans tailored to individual needs. The results affirm the system's capability to enhance user experiences and support educational success through personalized and optimized planning.

Keywords— Academic Study Planning, Forward Chaining, Heuristic Algorithms, Usability and Satisfaction Educational Technology Optimization

I. Introduction

In the evolving educational landscape, students face challenges in creating effective study plans due to factors like learning styles, academic performance, time constraints, and resource availability. Algorithmic systems, particularly those using forward chaining and heuristic algorithms, offer a structured yet flexible approach to study planning. Forward chaining logically sequences courses based on prerequisites, while heuristics optimize time management, task prioritization, adaptability, and study plan efficiency. The system dynamically allocates study time by analyzing available hours and recommending structured sessions using techniques like spaced repetition and Pomodoro strategies to maximize retention. It prioritizes subjects based on student performance, ensuring areas needing improvement receive more focus. Additionally, it adapts to individual learning preferences by recommending study subjects to focus on, to tailor to the student's engagement style. Through heuristic optimization methods like greedy algorithms, simulated annealing, and genetic algorithms, the system generates the most efficient study sequences, balancing workload and prerequisite requirements to prevent academic overload. This research aims to bridge theoretical principles with practical applications by developing a personalized, adaptive, and optimized study plan recommender and simulator system, ultimately improving academic efficiency and student outcomes.

Significance of the Study

The following shall benefit from this study:

1. Students. The study aims to create a system that specializes study plans based on individual students' academic history, constraints, and academic needs. This customization can lead to more effective learning experiences, addressing the diverse needs of students with varying learning styles and capabilities. On the other hand, students may experience

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reduced stress and anxiety related to academic performance. Knowing that they have a structured approach to their studies can contribute to a more positive and focused learning environment.

2. Academic Advisors. Advisors play a crucial role in guiding irregular students through their academic challenges. They use the study plan recommender system to gain insights into students' academic progress, strengths, and areas that need improvement.

3. Institutional Administrators. Decision-makers within educational institutions endorse and integrate the study plan recommender system into the academic support infrastructure. They oversee the system's implementation, ensuring that it aligns with the institution's goals for supporting irregular students. Administrators may also allocate resources and provide institutional support for the system's ongoing development and improvement. Researchers/Developers. This study may serve as a valuable case study for future researchers and developers by providing insights into algorithmic development, user-centric design, adaptive learning environments, interdisciplinary collaboration, ethical considerations, and continuous improvement in the realm of educational technology. This foundation can inspire further innovation and advancements in the field.

Scope and Delimitation

The scope of this study includes the development and implementation of an Academic Study Plan Recommender and Simulator System that utilizes Forward Chaining and Heuristic Algorithms. The system is designed to help students and academic advisors by allowing them to review past study plans and generate customized study schedules based on individual academic histories. One of its key features is its ability to specifically assist students who have failed one or more subjects, helping them restructure their study plans to improve performance. By analyzing a student's academic records, the system generates a study schedule that optimizes course sequencing, ensuring that students can catch up efficiently while meeting institutional requirements.

The delimitation of this study defines its boundaries, limiting the system's functionality to generating study plans within the Academic Study Plan Recommender and Simulator System. The study does not extend to creating educational materials such as textbooks, video lectures, or interactive learning modules. Instead, it focuses on recommending and simulating study schedules based on available course offerings, academic performance, and prerequisite requirements. Additionally, the system does not involve academic counseling, direct intervention in curriculum decisions, or automated grading. These exclusions ensure that the research remains targeted and efficient, concentrating solely on providing structured academic planning rather than expanding into unrelated areas. By maintaining this well-defined scope, the study ensures that the system remains focused on its core purpose—enhancing students' ability to plan and improve their academic journeys through personalized, data-driven recommendations.

II. Methodology

This study employed a quantitative research approach with elements of mixed-methods research, integrating structured surveys and statistical analysis to assess the development of an academic study planning tool. A comprehensive literature review was conducted to explore existing methodologies in study planning and recommender systems. The system, incorporating forward chaining and heuristic algorithms, was designed and developed to generate personalized study plans. Purposive sampling was used to select faculty members and irregular students as participants, ensuring diverse insights into study plan creation. Faculty members contributed expertise in academic structuring, while irregular students provided user-centered feedback for system improvement.

System effectiveness was evaluated using ISO 25010 standards, measuring performance through precision metrics, and validated through user feedback surveys. A questionnaire, incorporating Likert scale items and open-ended questions, captured data on participants' academic preferences and study habits. Statistical analysis was conducted to identify correlations between study plan recommendations and academic performance. Through these integrated methods, the study aimed to develop a personalized, data-driven academic planning tool to enhance students' learning experiences.

Respondents of the Study

The respondents of the study may include undergraduate and graduate students from various academic disciplines enrolled in State Universities or Colleges offering diverse courses. These students may be irregular in their academic progress or seeking personalized study plans to accommodate their unique needs and preferences. Additionally, educators, academic advisors, and administrators involved in academic planning and curriculum development may also serve as respondents to provide insights into the effectiveness and usability of the study plan recommender and simulator system.

Frequency and Percentage Distribution of Respondents

The qualitative phase of the study gathers insights from students, educators, academic advisors, and administrators to understand academic planning challenges, particularly for irregular students and those needing personalized study plans. Through interviews and open-ended survey responses, key themes such as flexible scheduling, subject prioritization, and study material preferences are identified, ensuring the system aligns with user needs. To analyze respondent demographics, the study employs frequency and percentage distribution, categorizing participants by educational level, enrollment status, field of study, and academic role. This

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statistical method determines representation balance, with frequency showing respondent counts per category and percentage distribution measuring proportions relative to the total sample. For example, if 60% of respondents are irregular students, their high representation validates the study's focus on personalized academic planning. These findings help refine the *study plan recommender and simulator system*, ensuring it effectively addresses user needs.

Sampling Techniques

The study used a quantitative research approach to develop and implement an academic study planning tool, integrating forwarding chaining and heuristic algorithms. A comprehensive literature review was conducted to explore existing methodologies in study planning and recommender systems. Participants were selected using purposive sampling to provide diverse academic backgrounds. The system's effectiveness was evaluated using ISO 25010, focusing on precision, and user feedback was gathered through online surveys. A questionnaire was developed to capture participants' academic preferences and study habits, and statistical analysis identified patterns between academic performance and study plan recommendations, aiming to improve personalized learning experiences.

Frequency and Percentage Distribution of Respondents

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Locale of the Study

The locale of the study encompasses a diverse range of State and College Universities (SUCs), including Adamson University, Bulacan State University, Centro Escolar University, ICCT Colleges, Lyceum of the Philippines University, Our Lady of Lourdes Technological College, Pamantasan ng Lungsod ng Valenzuela, PMI Colleges, Inc., Rizal Technological University, Santa Isabel College of Manila, Technological University of the Philippines, Universidad De Manila, University of Makati, University of the Philippines – Diliman, and the University of Santo Tomas. This study was conducted in collaboration with these institutions to develop the Academic Study Plan Recommender and Simulator System using Forward Chaining and Heuristic Algorithms.

Instruments of the Study/Data Collection

The primary tool for data collection will be a survey questionnaire designed to quantitatively assess the competencies and practices of individuals within State Universities and Colleges. Utilizing a 5-point Likert scale, the questionnaire will gauge the perspectives and practices of these individuals across various criteria and domains using ISO 25010, the questionnaire consists of three parts:

Part I: Demographic information of participants, including their institution of enrollment, course, current year of study, and the year they became an irregular student, along with the reason for this status.

Part II: Assessment of participants' practices in using and creating manual study plans every semester.

Part III: Evaluation of users' perspectives on competencies across domains using the ISO 25010. These instruments serve as the foundation for data collection, analysis, and validation, thereby ensuring the accuracy and reliability of study outcomes. By using appropriate instruments specialized to the study's objectives, the researcher can gain valuable insights into the efficacy and usability of the study plan recommender and simulator system, ultimately contributing to advancements in educational technology.

Data Collection

This study utilizes a survey-questionnaire method as the primary data collection approach to obtain insights from participants regarding their academic planning experiences and preferences. The survey-questionnaire method allows for a structured and standardized way of collecting data, ensuring consistency and comparability across responses. This approach enables researchers to gather quantifiable data while also capturing participants' subjective experiences related to study planning.

To interpret the collected responses, the study employs a 5-Point Likert Scale Method, which provides a standardized framework for measuring participants' attitudes, perceptions, and preferences. Each response is assigned a numerical value, typically ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), ensuring a clear and consistent method of quantification. This allows for a more precise analysis of trends and patterns in participants' feedback. The Likert Scale also helps in identifying the degree of agreement or disagreement with specific statements related to the system's usability, effectiveness, and impact on academic planning.

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The survey is designed to include *both closed-ended and open-ended questions. Closed-ended questions, utilizing the Likert Scale, facilitate statistical analysis by providing numerical data that can be examined for patterns and correlations. Meanwhile, open-ended questions allow participants to provide qualitative feedback, offering deeper insights into their experiences and suggestions for system improvement.

By employing this structured data collection method, the study ensures that the gathered information is reliable, quantifiable, and reflective of participant experiences, ultimately aiding in the evaluation and refinement of the Academic Study Plan Recommender and Simulator System.

Table 1. 5-point Likert Scale

Response Categories	Numerical Value
Strongly Agree	5
Agree	4
Neither Agree nor Degree	3
Disagree	2
Strongly Disagree	1

Additionally, to understand respondents' perspectives on competencies across domains using ISO 25010. The study utilized another 5-point Likert Scale to serve as a straightforward method for clarifying data and simplifying the evaluation of competencies, aiding in the study's analysis and interpretation, with the numerical ranges interpreted as follows:

Table 2. 5-point Likert Scale for Effectiveness of the System

Response Categories	Numerical Value
Ver Satisfied	4.21 - 5.00
Satisfied	3.41 - 4.20
Neutral	2.61 - 3.40
Dissatisfied	1.81 - 2.60
Very Dissatisfied	1.00 - 1.80

By categorizing responses in this manner, the study can easily assess the level of satisfaction and effectiveness regarding the utilization of the study plan recommender and simulator system, providing insights into competencies and areas for potential enhancement.

III. Results and Discussions

This chapter provides interpretation of the data collected throughout the study. Its primary goal is to offer insights into how the study and system tackles the complexities and challenges identified in preceding chapters. The presentation of findings is structured to offer a cohesive narrative of the study's operational dynamics within real-world educational contexts. It critically evaluates the system's strengths, weaknesses, and potential avenues for improvement, informed by empirical data and user feedback.

Results

Quantitative Phase

For clarity and consistency, the data are presented in the sequence of the research questions outlined in Chapter 1: (1) respondents' profiles (age, gender, academic rank, position, years of teaching, and educational qualifications); (2) their perspectives on the system's competencies based on ISO 25010 quality domains (functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability); (3) practices of the system's competencies in communication, decision-making, adaptability, task management, and empowerment; and (4) analysis using the Weighted Mean to interpret results and implications.

1. Profile of Respondents: This section provides a comprehensive overview of the respondents' backgrounds to understand the diversity and distribution of the sample population involved in the study.

School/University: Table 3 presents the distribution of respondents by school/university. The largest group (7.40%) was from Adamson University, followed by Arellano University (7.33%) and Bulacan State University (7.25%). Other institutions, such as Centro Escolar University, ICCT Colleges, and several others, each accounted for around 7%. The smallest group was from the University of the Philippines – Diliman, with 2.49%.

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Table 3. Frequency and Percentage Distribution of Respondents in Terms of School/University

School/University	Frequiency	Percent	Rank
Adamson University	101	7.40%	1
Arellano University	82	7.33%	2
Bulacan State University	100	7.25%	3
Centro Escolar University	101	7.18%	4
ICCT Colleges	103	7.18%	4
Lyceum of the Philippines University	99	7.11%	5
Our Lady of Lourdes Technological College	100	7.11%	5
Pamantasan ng Lungsod ng Maynila	80	7.11%	5
Pamantasan ng Lungsod ng Valenzuela	102	7.11%	5
PMI Colleges, Inc.	99	7.11%	5
Rizal Technological University	100	7.04%	6
Santa Isabel College of Manila	100	7.04%	6
Technological University of the Philippines	100	5.83%	7
Universidad De Manila, University of Manila	104	5.69%	8
University of the Philippines - Diliman	35	2.49%	9
Total	1406	100.0	

2. Perspectives on the Recommender System: The competencies of the Academic Study Plan Recommender and Simulator System are evaluated based on the ISO 25010 quality model, which provides a standardized framework for system assessment. This approach ensures consistency, facilitates comparability across projects, and establishes clear quality benchmarks, promoting better communication among stakeholders regarding expectations and outcomes (Abran et al., 2021). The system's competencies are categorized into eight domains: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

Table 4 shows high satisfaction with the system's functional suitability. Functional correctness was rated "satisfied" by professors (WM = 3.92) and "very satisfied" by students (WM = 4.33), with an overall rating of "satisfied" (WM = 4.13). Functional appropriateness received similar ratings, with an overall "satisfied" rating (WM = 4.18). These results demonstrate the system's effectiveness in academic planning.

Table 4. Weighted Mean Rating on the Perspectives of the Respondents in Functional Suitability

Functional Suitability	Faculty Members WM NV	Irregular Students WM NV	Overall	NV
1. Functional Correctness	3.92 S	4.33 S	4.13	S
2. Functional Appropriateness	4.14 S	4.21 S	4.18	S
Average Mean	**4.03**	**4.27**	**4.155**	**VS**

Table 5 shows high satisfaction with the system's maintainability. Modularity and modifiability were rated "very satisfied" overall (WM = 4.34 and WM = 4.26, respectively), while analyzability was also rated "very satisfied" (WM = 4.22). Reusability and testability received "satisfied" ratings (WM = 4.08 and WM = 4.17). These results highlight the system's robustness and adaptability for academic planning.

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Table 5. Weighted Mean Rating on the Perspectives of the Respondents in Maintainability

Functional Suitability	Faculty MembersWM NV	Irregular Students WM NV	Overall	NV
1. Modularity	4.28 VS	4.4 S	4.34	VS
2. Reusability	4.07 S	4.08 S	4.08	S
3. Analyzability	4.14 S	4.29 VS	4.22	VS
4. Modifiability	4.29 VS	4.21 VS	4.26	VS
5. Testability	4.14 S	4.19 S	4.17	S
Average Mean	**4.18**	**4.23**	**4.23**	**VS**

Overall, the respondents perceived a very high level of satisfaction with the maintainability of the system, with an average weighted mean of 4.23, categorized as very satisfied. This suggests that the system is considered easy to maintain, modify, and test, contributing to its overall reliability and efficiency in use.

Qualitative Phase

The quantitative phase of the study involved rigorous data collection and analysis to complement the qualitative insights gained earlier. Following the principles outlined by Australian Aid (2019) for mixed-methods research, this phase aimed to quantify and validate the findings from the qualitative phase through structured surveys and statistical analysis. ISO 25010 was utilized for robust data analysis and interpretation. The quantitative findings provided valuable insights into the effectiveness and user perceptions of the Academic Study Plan Recommender and Simulator System.

Table 6. Insights of the Respondents using Qualitative Phase for Impact and Outcome Needs

Questions	Respondents Response	Respondents who Agreed
1. How effectively do the recommended study plans align with your specific academic goals and career aspirations?	"The study plans align well with my academic goals and career aspirations."	1051
	"The study plans show moderate alignment with my goals, requiring additional customization."	355
2. What is the perceived impact of using the Academic Study Plan Recommender and Simulator System on your academic success, efficiency in course planning, and overall satisfaction with your academic journey?	"I have experienced significant improvements in academic success, course planning efficiency, and overall satisfaction."	1153
	"I have seen moderate improvements in academic success and course planning efficiency, with some increase in overall satisfaction."	253

Table 6 presents insightful qualitative data on respondents' perspectives regarding the impact and alignment of the system with their academic goals and satisfaction levels. In response to the alignment with academic goals and career aspirations, the findings indicate that a significant number of respondents (1051) felt the recommended study plans aligned well with their specific academic and career objectives. This suggests that the system effectively tailored study plans to meet their needs. However, 355 respondents mentioned that while the study plans showed moderate alignment, they believed additional customization was necessary for better alignment with their goals, highlighting the diversity in user expectations and needs.

Table 7. Insights of the Respondents using Qualitative Phase for Customization and Personalization Needs

Questions	Respondents Response	Respondents who Agreed
1. How effectively do the recommended study plans align with your specific academic goals and career aspirations?	"The study plans align well with my academic goals and career aspirations."	1051
	"The study plans show moderate alignment with my goals, requiring additional customization."	355

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2. What is the perceived impact of using the Academic Study Plan Recommender and Simulator System on your academic success, efficiency in course planning, and overall satisfaction with your academic journey?	"I have experienced significant improvements in academic success, course planning efficiency, and overall satisfaction."	1153
	"I have seen moderate improvements in academic success and course planning efficiency, with some increase in overall satisfaction."	253

Table 7 presents qualitative insights into how users perceive the customization and personalization features. Regarding the customization of study plans, most respondents (1066) indicated that the system allows a high degree of customization to fit their individual academic needs and constraints. This positive feedback suggests that these users find the system flexible and responsive, enabling them to personalize their study plans effectively. However, 340 respondents expressed that the system offers only limited customization options, which they found challenging to adapt to their specific academic requirements.

IV. Conclusions and Recommendations

Summary of Findings

The key findings of this study have been summarized and are presented in accordance with the research questions and statement of the problems in Chapter 1. The significant findings of this study are as follows:

Conclusions

Upon evaluation of the study, the researcher derived the following conclusive findings:

1. Algorithms personalize study plans by analyzing data points such as prerequisites, performance, learning styles, and curriculum requirements. Using forward chaining and heuristic techniques, they develop accurate schedules, evidenced by high ratings in Functional Stability, Performance Efficiency, and Usability. Continuous evaluation ensures plans adapt to students' evolving needs.
2. Heuristic optimization enhances decision-making by integrating learning styles, pace, and feedback, ensuring study plans meet individual needs. High ratings in Functional Stability and Performance Efficiency reflect its effectiveness. Adaptive heuristics provide practical, flexible solutions that evolve with new data.
3. Study plan constraints include academic history, performance, curriculum requirements, time availability, credit loads, and deadlines. These ensure tailored and feasible plans aligned with institutional standards and academic goals.
4. Forward chaining uses initial data to infer additional insights, generating dynamic, personalized study plans that evolve with student progress. It ensures logical course sequencing and an achievable academic path.
5. Feedback mechanisms under ISO 25010 standards continuously improve system performance and usability through surveys, user input, and monitoring. Regular updates ensure study plans remain user-centric and effective.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are provided to enhance the system's effectiveness and usability:

1. Educational institutions should integrate advanced algorithms into academic advisory systems to create personalized study plans using data like prerequisites, performance, learning preferences, and curriculum requirements. Regular monitoring ensures these plans adapt to evolving student needs and institutional goals.
2. Institutions should implement feedback loops where students contribute to refining study plans, enabling heuristic algorithms to adapt effectively. Collaboration with academic advisors ensures recommendations align with institutional standards, fostering student success and satisfaction.
3. Establishing clear constraints for study plan generation ensures alignment with academic policies and curriculum requirements. Institutions should regularly update constraints, communicate them transparently, and provide guidelines to help students make informed decisions.
4. Forward Chaining algorithms enhance study plan recommendations by dynamically building on initial data to provide precise and adaptive plans. Institutions should implement these algorithms, train advisors, and regularly refine inference rules for optimal effectiveness.
5. Adopting the ISO 25010 framework helps institutions evaluate and improve study plan systems. Structured feedback mechanisms, like surveys and focus groups, enable continuous improvement, boosting functionality, user satisfaction, and system effectiveness.

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