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IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: 24-25J-257

1. Topic (12 words max)

Personalized E-Learning for Biology Subject for A/L Students in Sri Lanka Leveraging AI & ML.

2. Research group the project belongs to

Autonomous Intelligent Machines and Systems (AIMS)

3. Research area the project belongs to

E-learning and Education (ELE)

4. If a continuation of a previous project:

Project ID	-N/A-
Year	-N/A-

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

In Sri Lanka, A/L Biology students face considerable issues in understanding complex biological concepts because the current learning methods primarily rely on static resource books and standardized examinations, which, more often than not do not cater to the diversity in different student learning styles and paces. This quite usually leads to gaps in the understanding of students, mainly in such a detailed and detail-oriented subject as biology.

The study aims to propose a new e-learning platform using advanced ML technologies to enhance biology education for A/L students educated in the English medium of Sri Lanka. Its innovative features are crafted to give a more personalized experience with an interactive learning environment that would automatically adapt to one's needs and learning preferences.

At the heart of the design, this platform offers components that can lead to increased learning efficacy and higher levels of learner engagement. Spaced repetition, enabled by digital flashcards, allows students to master biological vocabulary and concepts over time. The system automatically schedules review sessions according to each individual's learning progress and memory retention so students can effectively engage with the material for deeper understanding and long-term retention.

Additionally, the system features advanced voice and text input capabilities for student responses. Students can either type their answers or use voice input, which are then analyzed for accuracy by a trained AI model. This model assesses both the correctness of the answer and the pronunciation, providing immediate and detailed feedback. By combining spaced repetition with sophisticated accuracy assessments, the system ensures a comprehensive and engaging learning

experience. This approach makes learning practical, connects theoretical information with its real-world application, and nurtures a deeper appreciation of the diversity and structure of biology.

Another innovative feature of the platform is its text summarization tool, which generates concise summaries of complex biology topics from literature in PDFs and Word documents. It does not only focus on critical concepts but also supports auditory learners through voice output options, making it easily and quickly reviewable for a better understanding of critical biological principles contained in the government-approved A/L Biology Resource book series.

It further contains an adaptive quiz system that will adjust the question difficulty depending on the dynamic performance of the student. This not only challenges students up to their appropriate level of skill but also has the potential to effectively identify their knowledge gaps. Using the provided comprehensive analysis tools, reports can be easily generated with the required details to show individual strengths and weaknesses, hence in a position to allow educators as well as students to make personalized learning paths and ensure learning outcomes are maximized.

In terms of assessment, the platform evaluates both structured and essay-type questions, providing detailed feedback and constructive suggestions for improvement. This approach ensures that students receive personalized support to enhance their understanding and academic achievement effectively. By integrating these advanced technologies and pedagogical approaches, the platform sets a new standard for biology education in Sri Lanka, aiming to empower A/L students with the skills and knowledge they need to succeed academically and beyond.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

The proposed solution is a personalized e-learning platform for A/L Biology students in Sri Lanka that leverages ML and AI technologies. The platform will feature several key components,

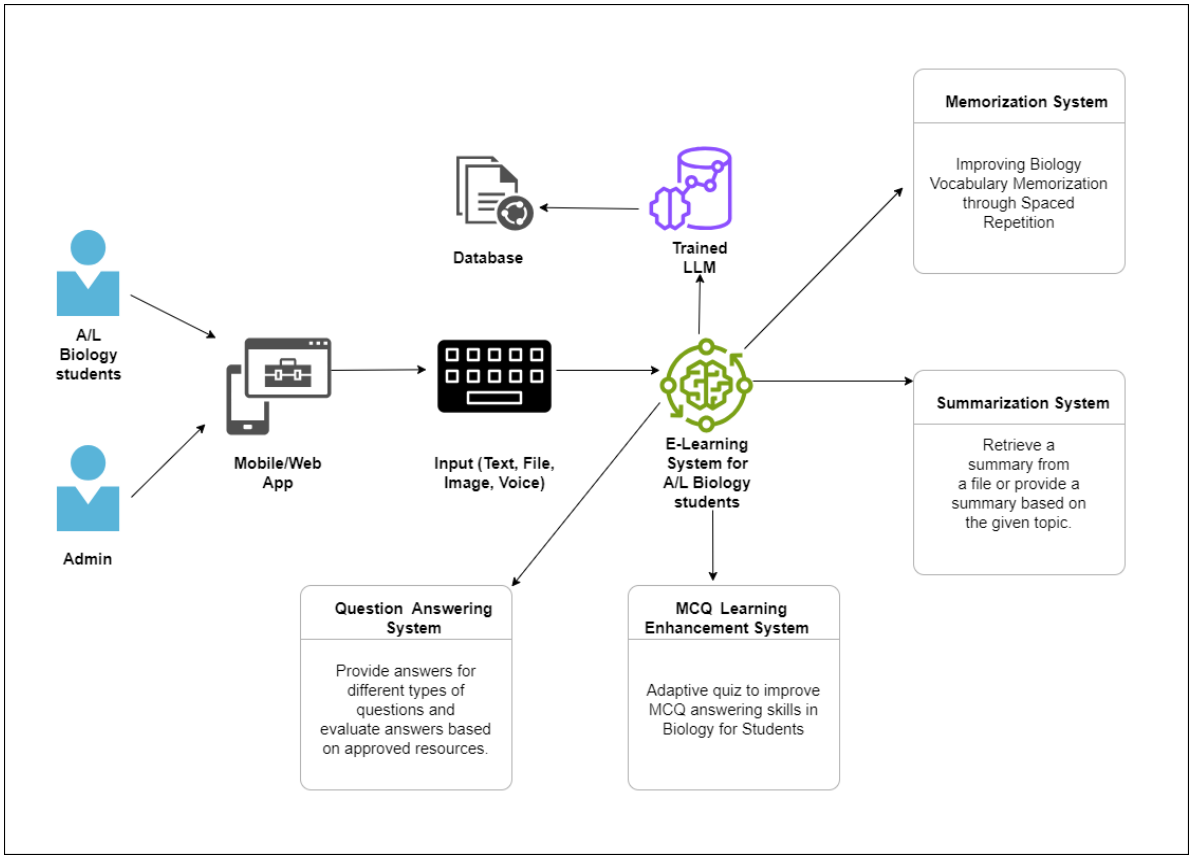
Improving Biology Vocabulary Memorization through Spaced Repetition: The component is an interactive e-learning tool focused on improving biology vocabulary memorization for A/L students in Sri Lanka. It employs digital flashcards with images and hints, enhanced by a spaced repetition algorithm to optimize review intervals. Students can respond by typing or using voice input, which a trained AI model then analyzes for both answer accuracy and pronunciation. This dual-mode interaction and detailed feedback system ensure comprehensive learning, helping students to not only recall biological terms but also pronounce them correctly. The personalized feedback and adaptive learning paths create an engaging and effective educational experience, linking theoretical knowledge with practical application.

Advanced Text Summarization: A Summarization Tool for Biology is designed to generate concise summaries of complex biology topics from PDFs and Word documents, highlighting key concepts and terms. It features voice output for auditory learners and on-the-go review. When given a specific topic, the tool references government-approved A/L Biology resource books to ensure accuracy and adherence to educational standards. This user-friendly tool supports diverse learning styles, aiding students, educators, and professionals in efficiently understanding and reviewing biology content.

The Adaptive MCQ Quiz Platform: An intelligent system that adjusts question difficulty dynamically based on student performance, focusing primarily on multiple-choice questions (MCQs). This adaptive feature stimulates various cognitive approaches, identifies knowledge gaps effectively, and offers targeted practice to enhance both performance and confidence. Additionally, the platform includes comprehensive performance analysis tools that generate detailed reports. These reports provide valuable insights into individual strengths and weaknesses, facilitating personalized learning pathways and maximizing learning outcomes.

Answer Generation and Evaluation: Equipped to assess both structured and essay-type questions, offering detailed feedback and constructive suggestions for improvement. Evaluations include percentage correctness for objective assessments, while also guiding students through additional study resources tailored to their performance. When questions are provided, the system generates accurate answers, and when both questions and answers are supplied, it analyzes correctness comprehensively. Students can optionally submit additional notes, pending administrative authorization, to enrich their learning experience and further personalize their study materials. This approach ensures students receive targeted support to enhance their understanding and academic achievement effectively.

Conceptual Diagram



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

The development and implementation of the personalized e-learning platform require specialized expertise in several domains,

1. Machine Learning: Expertise in ML and AI is crucial for developing models for spaced repetition algorithms and vocabulary accuracy detection, adaptive quizzes, advanced text summarization and, question answering and answer evaluation.
2. Educational Technology: Knowledge of educational theories and instructional design will ensure that the platform is pedagogically sound and meets the learning needs of A/L Biology students.
3. Biology Subject Matter Expertise: Expertise in A/L Biology curriculum and content is essential to develop accurate and relevant educational materials, quizzes, and evaluation tools.
4. Software Development and UX/UI Design: Skilled software developers and UX/UI designers are needed to build a user-friendly, engaging, and efficient e-learning platform.
5. Data Requirements: The platform requires extensive datasets for training ML models, including:
    - Government approved resources and books.
    - Text documents related to Biology topics.
    - High-quality images of biological specimens that can be used in flashcards.

By integrating these specialized domain expertise and data requirements, the proposed e-learning platform aims to provide a comprehensive, personalized, and interactive learning experience for A/L Biology students in Sri Lanka.

8. Objectives and Novelty

Main Objective

The main objective of this research is to develop a personalized e-learning platform for Advanced Level (A/L) Biology students in Sri Lanka by leveraging Machine Learning (ML). This platform aims to enhance the learning experience by providing tailored educational content, interactive learning tools, and adaptive assessments that cater to the individual needs of students. By integrating digital flashcards, spaced repetition, specimen identification using image processing, advanced text summarization, adaptive quizzes, question answering and detailed answer evaluation, the platform seeks to improve knowledge retention, understanding of complex biological concepts, and overall academic performance.

Member Name	Sub Objective	Tasks	Novelty
Srirajan G. A	Improving Biology Vocabulary Memorization through Spaced Repetition	Create flashcards with images or hints related to biology vocabulary. Integrate a spaced repetition algorithm to determine the optimal intervals for reviewing each flashcard based on individual student performance. Design an intuitive user interface that allows students to interact with the	The novelty of this component lies in the use of spaced repetition algorithm specifically tailored for aiding the memorization of biology vocabulary, an area where it has not been used before. Incorporating a trained ML model to provide accurate feedback on both the correctness of the answer

		flashcards through typing or voice input. Implement a system to evaluate the accuracy of student responses, providing immediate feedback. Train and incorporate an ML model to assess the accuracy for text inputs and voice inputs.	and pronunciation, ensuring comprehensive learning. Utilizing images and hints on flashcards to enhance memorization through multiple sensory inputs and continuously adjusting the difficulty and frequency of flashcards based on individual performance data, ensuring an optimized and personalized learning journey.
Dharane S	Retrieve a summary from a file or provide a summary based on the given topic.	Develop a comprehensive summarization tool that accepts both PDF and Word documents for processing. When a specific topic is provided, the tool will generate a focused, topic-based summary. Users have the option to specify the desired word count, and a summary of	The novelty of this component lies in choosing architectures that can be used to create the component and researching which architecture would be ideal with proper justification. Furthermore, the integration of advanced text summarization

		approximately that length will be generated. The tool will offer the capability to provide the summary with voice output, enhancing accessibility and user experience.	capabilities with a Large Language Model (LLM) to generate concise and accurate summaries. Summaries could be generated according to the user-specified word count. Additionally, the incorporation of voice output features provides audible summaries, enhancing usability and accessibility for a diverse user base.
Sujitha S	Adaptive quiz to improve MCQ answering skills in Biology for Students	Develop a sophisticated, real-time adaptive quiz platform based on approved educational resources. Implement a variety of MCQs based on difficulty level to stimulate different cognitive approaches, ensuring a comprehensive assessment experience.	The novelty of this component lies in its ability to generate quizzes dynamically based on user performance, creating a personalized experience for students by adjusting the quiz difficulty. Questions are generated using advanced large language models (LLMs) to enhance students' skills in

		Quizzes will dynamically adjust in difficulty and content based on the student's performance, providing a personalized learning journey. The platform will feature detailed performance analysis report generation and continuous performance tracking to improve MCQ knowledge.	answering multiple-choice questions for A/L examinations.
Sajeevan S	Provide answers for different types of questions and evaluate answers based on approved resources.	Additional information, when provided by students, will be evaluated by the administrator and added to the database. When users ask structured or essay-type questions, answers will be provided in a proper way containing necessary keywords. Questions and answers provided by the student will be evaluated based on approved resources, with	The novelty of this component lies in its utilization of multiple models for implementing and storing image details within the provided content. Additionally, the platform offers detailed comparisons of answers, including percentage correctness, and provides suggestions for improvement. This multifaceted approach not only enhances the accuracy and depth of

		detailed suggestions provided for improvement of answers.	content analysis but also aids users in identifying areas for improvement with precise feedback, thereby fostering a more comprehensive and effective learning experience.

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9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Dr.	Sanvitha	Kasthuriarachchi	
Co-Supervisor	Miss.	Karthiga	Rajendran	
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.