**Recommendation system for improving educational performance in primary students based on quizzes.**

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Project Proposal Report

Jayasekara J.A.Y.V. - IT20645748

Supervisor - Mr. Samadhi Rathnayaka

Co-supervisor - Dr. Dharshana Kasthurirathna

B.Sc. (Hons) Information Technology Specialized in Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

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We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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| Name | Student ID | Signature |
| J.A.Y.V. Jayasekara | IT20645748 |  |

The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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| --- | --- |
| Name | Signature |
| Supervisor:  Mr. Samadhi Rathnayaka |  |
| Co-supervisor:  Dr. Dharshana Kasthurirathna |  |

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## **Abstract**

The focus of e-learning systems is to deliver knowledge effectively to students, particularly in a user-friendly and flexible manner. This challenge becomes more intricate when dealing with primary students, necessitating a highly intuitive interface. This study aims to address these complexities by creating an adaptive learning system tailored to enhance the educational performance of primary students.

My contribution involves the development of a recommendation system geared towards improving students' educational outcomes. This innovative system administers subject-specific and general knowledge quizzes, meticulously tracking the resultant data. Leveraging this data and employing a machine-learning model to gauge educational performance levels, the system channels this information through a recommendation system. This, in turn, furnishes recommendations in alignment with the student's educational proficiency. Recommendations encompass various mediums such as questionnaires, books, video lessons, and other relevant materials, each selected to elevate the student's educational aptitude. Notably, the system aims to enhance user engagement by elucidating the rationale behind each recommendation. By providing transparency in the recommendation process, it enables students to comprehend the basis for the suggested learning materials. The interplay of data-driven insights, machine-learning techniques, and comprehensive recommendations marks a significant advancement in fostering primary students' learning journeys.

In conclusion, this research contributes to a comprehensive adaptive learning system tailored for primary students. The integrated recommendation system, guided by student performance data and machine-learning algorithms, offers tailored suggestions to bolster educational growth. By elucidating the reasoning behind each recommendation, the system promotes a deeper understanding of the learning process. This research paves the way for a more personalized and effective approach to enhancing primary students' educational performance in the realm of e-learning.

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1. **Introduction**

* 1. **Background:**

E-learning systems’ main target is to deliver knowledge to students in a very user-friendly and flexible way. When we deal with primary students, the process is more complicated and the system must be very user-friendly. Our system tries to minimise those challenges and make a valuable adaptive learning system to improve primary students' educational performance.

For any educational institution, students are a critical asset in providing high-quality education. To achieve this, it is essential for every college, school or any other institution to check the performance of students. Due to the incredible development of recent technology like social media, students are addicted to it and waste their time in vain. This is often one of the explanations for students' poor performance in academic achievement, which even results in school truancy.[5] Predicting student performance focuses learners on their performance and helps them improve their performance in the future. However, academic performance may vary from student to student as every student has a different level of performance. But we aim to bring students who have a particularly poor educational level, also improve some higher level.[1]

Some other review papers have research in the field of affective recommender systems on learning resources in virtual learning environments and e-learning to help improve content recommendations in virtual education and therefore to improve the virtual learning process to develop a new methodology to enhance the learning level of elementary students. Ultimately more personalized recommendations are needed, and that is why an effective recommender system is analyzed based on the specific needs of each student, their level of expertise, their situation and how they feel during the learning process.[4]

Our system provides a questionnaire based on the subject-wise general knowledge. Students can take quizzes very easily and give answers, Answer checking and providing educational level is fully automated, So teachers can monitor educational performance very easily. The questionnaire is a subject-wise and general knowledge quiz for the students and monitors the relevant results. Based on those monitored results and using a machine-learning model to get educational performance levels to pass through a recommendation system to get the recommendation based on the relevant student’s educational level.[2] It can analyse student performance and guide them by displaying suggestions for improvement. This recommendation may be another questionnaire, book, video lesson, or other suitable material to improve the educational level. In addition, this system tries to explain why that recommendation came and what happened inside the recommendation system using explainable AI.[3]

## **Literature Survey**

Most research work is aimed at students in universities or other higher education. Many of their research papers use students' previous performance to predict educational levels. Several research papers were conducted on how to improve the e-learning process and some others are only based only recommendation systems. Also, some of the research papers predict educational performance but do not give any recommendations on how to improve educational performance.

P Ramya, S G Balakrishnan and M Kannan propose a recommendation model for higher education students using machine learning algorithms. They use Random forests, Decision-tree and Naive Bayes Classifiers to reach maximum accuracy and their accuracy level is between 68% to 79% for the techniques they used. Throughout this paper, the prediction of scholar performance is finished utilizing making use of Apriori type strategies WEKA tool[1]. A variety of methods like content-based, collaborative filter-based, and knowledge-based recommendations and observations can be used to better understand the current development and future direction of recommendation systems in e-learning[2].

In addition, collected information is preprocessed and data cleansing is accomplished after that a reference model is built for each of the routes for the usage of logistic regression and is saved in the database which is then used for category. Here the whole pupil details are being used to categorise into two instructions specifically dropout or non-dropout. Here they have completed an analysis of linear regression and multilayer perceptron models with the usage of the WEKA tool package. They've used undergraduate scholar data in information gadget management. The dataset includes 50 statistics information. The information is processed in the WEKA device itself and the algorithms needed for the model production also are available inside the tool[1].

According to the paper of Jiahong Su and Weipeng Yang artificial intelligence (AI) tools are increasingly used in the field of early childhood education (ECE) to improve learning and development among young children. Previous proof-of-concept studies have shown that AI can effectively improve teaching and learning in ECE. These publications are reviewed to evaluate, synthesize, and showcase the latest literature on AI in ECE. This review analyzed 17 eligible studies conducted in different countries from 1995 to 2021. Although few studies have been found on this critical issue, the available references provide up-to-date insights on various aspects. Many studies have shown that AI has significantly improved children's conceptions of machine learning, computer science, robotics, and other skills such as creativity, emotional control, collaborative inquiry, literacy skills, and computational thinking. This development of literacy and knowledge can be introduced as a special importance of e-learning education[4].

Shanshan Wan and Zhendong Niu provide a paper, A Hybrid E-Learning Recommendation Approach. In this study, they propose a hybrid filtering (HF) recommendation approach (SI-IFL) combining the learner influence model (LIM), self-organization-based (SOB) recommendation strategy and sequential pattern mining (SPM) for recommending learning objects to learners. The method works like LIM is applied to acquire interpersonal information by computing the influence that a learner exerts on others. LIM is independent of ratings a SOB recommendation strategy is applied to recommend the optimal learner cliques for active learners by simulating the influence propagation among learners. This SOB recommendation approach achieves a stable structure based on distributed and bottom-up behaviours of individuals. The experimental results demonstrate that hybrid RS can provide personalised and diversified recommendations[2], and it shows promising efficiency and adaptability in e-learning scenarios[3].

The paper of Fergyanto E Gunawan discusses a learning recommendation to improve the electronic textbook learning experience. This study falls under the category of Technology Enhanced Learning (TEL). TEL is recognized as one of the most dynamic areas of inquiry in education. TEL aims to design, develop and test socio-technical innovations that support and enhance learning practices. Specifically, TEL is about recommender systems designed to improve learning experiences. For example, a recommendation system was developed to provide learners with a list of relevant materials like electronic textbooks for a given course. Currently, most textbooks are available in electronic form and the majority of students at Bina Nusantara University in Indonesia, for example, consider it the easiest and most suitable way.[6]

J. Bobadilla, F. Serradilla and A Hernando propose Collaborative filtering adapted to recommender systems of e-learning. In the context of e-learning recommender systems, they suggest that more knowledgeable users have more weight in the recommendation calculation than less knowledgeable users. To achieve this objective, we have created several new equations in the memory-based collaborative filtering kernel, extending the existing equations to gather and process information relative to the scores obtained by each user from a variable number of level tests.[2],[7]

Regardless of the method used in the CF phase, the generally followed technical objective is to minimize the prediction errors by making the accuracy of the RS as high as possible. One of the ideas emphasized in the working philosophy of RS is based on the equality between its users, not only on their ability to access the service but above all on the contribution of each of them to the recommendations that the rest can receive. A typical RS generates recommendations for each user based on the ratios provided by the users with the most similar contribution to them.[7]

Salman Fraihat and Qusai Shambor provide a paper, A Framework of Semantic Recommendation System for E-learning. This paper proposes a framework of a semantic recommender system for e-learning which will assist learners in finding and selecting the relevant LOs to their field of interest. The proposed framework utilizes the intra and extra-semantic relationships between LOS and the learner's needs to provide personalized recommendations for learners. The semantic recommendation algorithm is based on the extension of the query keywords by using the semantic relations, concepts and reasoning means in the domain ontology. The proposed system can be used to reduce the time and effort involved in finding suitable LOS, and thus, improve the quality of learning.[8]

The benefits of introducing e-learning recommendation systems go beyond the achievement of learning goals. Based on the literature review, the advantages of e-learning recommendation systems can be classified in several ways, but mainly we can say that it improves the educational performance of students.[2],[8] Our proposed method is more useful in raising the level of education for primary students in the right way.

## **Limitations, Challenges and Data Collection**

The availability of quality and diverse educational data for primary students might be limited, which could impact the performance of machine learning models and the breadth of recommendations. In addition, Educational levels and performance might not be solely determined by quiz scores. Other factors like individual learning styles, external influences, and socio-economic background could also play a significant role. Also, Highly interpretable models might sacrifice predictive accuracy.

  The main challenge is Choosing and implementing appropriate explainability techniques that can effectively communicate the reasoning behind predictions and recommendations. Also designing a recommendation system that can provide personalized recommendations for each student's unique learning needs and preferences.

We plan to collect data from primary students' quizzes including the questions asked, answer choices, and the corresponding correct answers. Also aims to collect and gather educational content such as textbooks, worksheets, online resources, and learning materials relevant to primary education.

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## **Research Gap**

According to the information that we have extracted from the research papers previously done, none of them related to real-time educational monitoring. All of them are considered previously done test marks and only input directly into their systems. But our solution we will monitor educational levels using quizzes.

According to the available research papers[2] and resources, there are some researches developed for recommendation systems, some of them are related to e-learning systems[1],[2],[7], but none of them touches primary education enhancement using recommendation systems. Also, very few of them provide papers to enhance childhood education, but their solution is based on AI.[4] According to the extracted information we provide knowledge-based recommendations as the best method to implement solutions in our system. Some research papers talk about knowledge-based methods but they do not implement them in e-learning systems to give recommendations.[2] In addition, we will classify educational levels using ML algorithms and then provide them to the recommendation models. Some research done in the past gives recommendations for improving educational levels using machine learning algorithms only.[1] They didn't use any specific recommendation mechanism to give recommendations.

All of the information we extracted from the research papers and resources in recommendation systems only provides recommendations and one of them provides some justification but that paper did not use proper recommendation methods. But in our case, we use knowledge-based recommendation techniques and we will provide the reason behind the recommendation. In doing that process we use explainable AI techniques and try to explain the reason behind the relevant recommendation and why that recommendation exactly given to improve the educational performance of the students.

To do that process and success in our research we use explainable AI and it helps to revive as a topic of active research by the need to convey safety and trust to users in the “how” and “why” of automated decision-making in different applications.[9] Also, It helps characterize model accuracy, fairness, transparency and outcomes in AI-powered decision-making.

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*Table 1 - Research Comparison*

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## **Research Problem**

Development of the technology is useful for every region and it helps to avoid mistakes when done by humans. Automated systems are very useful and it is a very time-saving thing in this busy lifestyle. The education system is also much improved by using technology these days. E-learning systems are playing a vital role in it. But when in e-learning, higher education students have their own responsibilities and they can manage this e-learning phase and continue their education. But for primary students, it is quite difficult to get the maximum of this e-learning. There aren't any techniques to monitor primary students' educational level and cause of this their education may be going the wrong way. In addition, sometimes parents could notice their students' bad educational performance, but they could not have a better idea of what exactly to improve student's educational level.

This is a funding problem that parents face, and they often use extra classes as a solution. This can be a method that further exhausts the child and does not achieve the desired results. So if we can monitor students' educational levels in real-time and if they are in a weak position, we can give suggestions on how to improve their educational level to a better level without much worry. This process is a fully automated one, not only for parents but also for teachers to help guide students in a much better way. If it’s not only focusing on online learning, we can provide this system for the schools as well.

Referring to previous articles, and review papers we come up with a solution for this. It is an adaptive learning system for enhancing primary students' educational performance and it provides questionnaires for the students subject-wise and gives the results. Based on the results system monitors the educational level using some machine learning techniques and based on the educational level gives a recommendation for how to improve students' performance using the recommendation system. But we don't know what happened inside the recommendation system, so using explainable AI techniques try to provide a reason behind the recommendation.

1. **Objectives**

## **Main Objective:-**

* One of the main objectives of this application is to develop a recommendation system to enhance primary students' educational performance in the adaptive online platform. Online learning is very famous these days and it's very useful for t students. But when it applies to primary students there are some issue that comes up. The main problem is that students' educational performance goes down and there is no perfect way to improve it.
* As a solution to this problem, a questionnaire-based recommendation system where students teachers or parents can see current educational performance and what are recommendations along with the reason for the recommendation, he or she has to improve educational performance. To implement this we use Machine Learning techniques and some recommendation mechanisms as well as advanced AI-based techniques like explainable AI.
  1. **Sub Objectives:-**
* How to collect students' academic performance more efficiently?
  + To do this process we make a fully automated questionnaire, which provides various type of quizzes take the answers, and give output as a result.
* Which type of questionnaires can be used to monitor students’ performance?
  + We are going to provide subject-wise quizzes like mathematics or English, maths quizzes could have several parts like multiplication and division. Also, type of General knowledge quizzes are also there because they would help to improve overall educational performance.
* How to classify educational levels based on the results more accurately?
  + To do this, using the data set preprocess the data train the model and apply the results to the trained ML model.
* What is the best recommendation model we can use to provide a recommendation based on students' educational performance?
  + Create a knowledge graph that links educational levels to specific learning strategies, resources, and activities. Based on the predicted educational level, query the knowledge graph to retrieve recommendations tailored to that level.
* How to connect RS to the explainable AI model and provide a reason.
  + For the recommendations generated, provide explanations for why certain resources or strategies are suggested based on the predicted educational level. Explain the connections in the knowledge graph or rules that led to the selection of those recommendations.

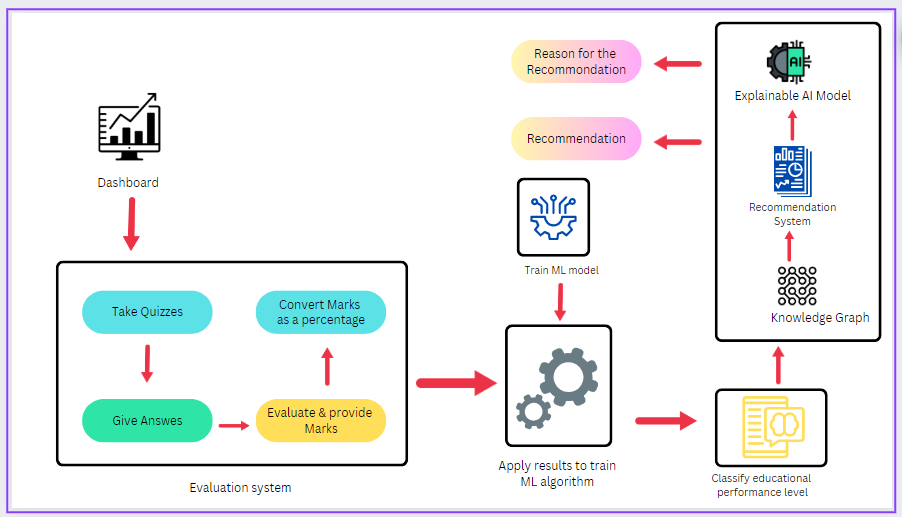
1. **Methodology**

The proposed web application is an “Adaptive online learning platform to enhance primary education”.

* Give the best recommendation to improve students’ educational performance.
* Using explainable AI to provide a reason behind the recommendation.

Also, this system monitors students’ real-time educational level using quizzes, classifying it using machine learning algorithms and giving recommendations on how to improve their educational level. This recommendation may be another quiz, video lesson, book or any other suitable material. This system minimises human interaction and more importantly, is time-saving and user-friendly.

* 1. **System Diagram**



*Figure 1 - High-Level Architecture Diagram*

* 1. **Development Process**

The first phase of this process is requirement gathering. The main goal of this process is to understand the expectations of the end-users and stakeholders of the system. Then developing our application, we need data. So we have to collect data. This component needs primary student educational data, especially exams-related data to train the model to predict educational level. To do that we have to get data in primary school or manually collect.

In the development process, we have to make a question bank and automated evaluation system to capture students' educational levels. Then we have to preprocess the collected data set and using that data train the ML model to get a prediction. Once the model has been trained, must test it and make sure it works well. In addition, check the accuracy value to determine how efficiently work the model. Then pass that data to the recommendation system and explainable AI model. In summary, we need to follow the success of our research,

1. Requirement Gathering and Analysis
2. Data Collection
3. Data Cleaning and Preprocessing
4. Training the model
5. Testing the model
6. Deploying the Model
7. Build recommendation system
   1. **Technology Selection**

To implement our system we discussed to use of technologies and services mentioned below.

* Python - Is significant and easy to use for machine learning because of its simplicity, flexibility, and strong libraries, which make it simple to construct and use sophisticated algorithms and models.
* REST API - enabling the backend server and web application's communication.
* Google Colab – Jupyter Notebook environment that is hosted in the Google Cloud platform.
* Visual studio code
* Amazon Web Services (AWS) -Providing the backend functionality as well as hosting lesson-related data for the application.
* GitLab – For version controlling
  1. **Deployment**
* Web Application -
* One of the Key Goals is to deploy the model in a real-world setting so that it can be used to categorize task descriptions for new ones that are fed into the system.
* The model can be integrated into a web application via APIs. The aim of this is to reach a maximum number of uses.

1. **Project Requirements**
   1. **Functional Requirements**

* Provide relevant quizzes subject-wise using a question bank.
  + Question bank, There are various questionnaires based on subject and users can select the quizzes they want.
* Predict educational levels based on the results that were taken using the ML algorithm.
  + Results that students took their quizzes and converted them into percentages. This percentage value passes through a trained ML algorithm to predict the educational performance level.
* Use Knowledge-based recommendations to give recommendations.
  + Based on the predicted educational level, use to knowledge-based recommendation mechanism to provide suitable recommendations to the students. This recommendation may be another quiz, book or video lesson.
* Use Explainable AI to provide reasons.
  + In this section try to explain the recommendation the user gets. Using an explainable AI mechanism tries to provide the reason behind the relevant recommendation.
  1. **User Requirements**
* The user should be able to log into the system.
* Users should be able to navigate the educational menu.
* The student should be able to choose quizzes in subjects and there should be several sections in one subject section.
* Users should be able to see the results and mark their quizzes.
* Users should be able to see the recommendation based on their educational performance along with the reason behind the recommendation.
  1. **Non-functional Requirements**
* Usability
  + User interface design shall be simple.
* Availability
  + The application should be up and running, and anyone should be able to connect with it from anywhere.
* Security
  + The application ought to have protection against unauthorized modification of knowledge through user credentials.
* Scalability
  + The system needs to have the ability to perform well under increasing or expanding workloads.

1. **Gantt Chart**

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*Figure 2 - Gantt chart*

1. **The ability of commercialization**

* Target Users -
  + This system's main target is primary students. In addition, teachers and parents are partial users.
* Marketing Process -
  + We aim to market this product as a non-profitable product because our major target is to improve student's educational performance.
  + Also, we hope to use advertisements among teachers, students and parents.
  + In addition, we discussed giving some sponsorships to the schools and education centres to promote our product.
  + As a marketing approach, aim to use social media networks and arrange some awareness sessions as well.

1. **Reference**

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1. **Work breakdown structure**

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*Figure 3 - Work Breakdown Structure*