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Learnverse: A Computational Performance Prediction Tool in a Learning Environment

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Declaration

I declare that this is our own research thesis, and this thesis does not incorporate without acknowledgement any material previously published 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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ABSTRACT

Learnverse is a web application designed to help Sri Lankan students prepare for the Advanced Level (a/l) examination by identifying their weak competencies and generating customized exam papers. With over 316,000 (3.5 Number Literate and Literacy Rates by Census years & Sex, 2015) students taking the a/l exam each year, the majority of whom rely on mass classes that lack personalized attention, many struggle to identify areas for improvement and find relevant practice materials. Learnverse uses machine learning algorithms to analyze past student performance data and identify the most important topics within a course that a student needs to focus on. By generating personalized exam papers and offering a platform for teachers and students to collaborate, Learnverse aims to improve student outcomes and break the boundaries of traditional classrooms. The model achieved 76% accuracy in identifying students' weak competencies.

Keywords: Multiple-choice questions, Education, Exam Paper Generation, Linear Regression

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CHAPTER 1: INTRODUCTION

1.1 Chapter Overview

The GCE A/L exam is one of the most challenging and competitive exams Sri Lankan students face resulting in too much stress and uncertainty with the outcome. The question paper consists of a series of 50 MCQ questions which accounts for 50% of the final mark. The students who obtain lower marks for the MCQ's would most probably lead to low or average marks in the exam. Hence it is safe to conclude that it would be beneficial for the students if there was a web application which was capable of:

- Improving student's performance with the use of modeled past papers
- Predicting student's a/l results based on performance
- Creating an interactive environment for students and teachers

However, the existing methods do not propose reasonable solutions which can cover up all the above requirements. In our research, we propose an education system based on web services which can satisfy these requirements.

1.2 Problem Domain/Background

Around 316,737 (3.5 Number Literate and Literacy Rates by Census years & Sex. (2015)) students take a/l exam each year in Sri Lanka. Among them, most students cover the a/l syllabus from schools and private institutes. Most private institutes conduct classes under two categories. Mass classes which consist of minimum 250 students and group classes which consist of maximum 50 pupils. Very minimal number of students go for group classes and individual classes so that teachers can give their full focus on students while most students don't get attention from their teachers. Therefore, students struggle hard to figure out which skills they need to improve and which lessons they must additionally focus on.

Even if a student realizes which lessons or skills they are weak at, it would be a time-consuming task for them to find questions from past papers and model papers related to those specific lessons. When the a/l exam gets closer, some students may need to communicate with the teacher very often to clarify their doubts about lessons. But it's not possible to meet the teacher regularly.

1.3 Problem Definition

This study focuses on improving the performance of GCE AL students who study ICT as a main subject. The students studying for the examination have to study a vast range of subject areas related to the ICT subject. With the limited time available, making the study time productive is a

must to score well in this competitive examination. With the busy schedule of studies and extracurricular activities, students are confronted with difficulties with time management and study planning. When the exam is getting closer, students need to focus on areas where they can score more and the areas where they are weak at.

Without concentrating on the study areas and skills that need more focus, scoring in the examination is very challenging. Therefore, making this process less stressful and more straightforward should be done. Using a model to acquire questions which have a higher chance of appearing in the examination, helps students to score more in the a/l exam. From this method, students who tend to score lower and fail the examination can easily improve themselves and score higher in the examination.

This approach is usually taken by the tuition class teachers. But the accuracy of their questions are questionable. And most of the time those questions are merely based on the examination, not on the areas that should be focused more by the specific student individually. Therefore, building a model for this task is a must to make better predictions and to increase students' performance.

1.4 Research Motivation

Each year more than thousands of students face the Advanced Level examination in Sri Lanka. Here, only a small percentage of the students achieve higher results, while others reach for lower averages or failing grades. This research project focuses on guiding the students for better results by analyzing the performance of the students and recording the progress of each student. Unlike in physical classes, any student who is lacking behind shall be recognized by the system itself and will assist those students to work more on the lessons which they are struggling with. Up until now there has not been a system which has been able to do these tasks, therefore it is safe to assume that this project shall benefit both students and teachers breaking the boundaries of traditional classrooms.

1.5 Existing Work

The G.C.E Advanced Level examination of Sri Lanka is one of the most competitive examinations in the world, where a lot of hard work and dedication is involved. Yet there is no specific-automated method to assist the traditional learning system. However, there are some few research projects that have been brought up which perform similar tasks in the following research project.

Citation	Technology / Algorithm	Advantages	Limitations
(Vachev et al., 2022)	Matching the question with the answer using the	Automated MCQ paper generation to minimize time	The subject contents were taken as the basic data input for

	MASK token.	wastage.	the preparation of the question papers.
(Xu and Liao, 2021)	MVC Framework	Generating Random and fair Question papers for the students.	Low Question quality.
(Rahim et al., 2017)	Genetic Algorithms	Preparing high quality exam questions.	Questions are not specified according to the individual students' performance.
(Wu et al., 2020)	Genetic Algorithms and Deep Knowledge Tracing	Able to predict students' performance based on the past questions he/she has answered.	Students are not able to get questions based on their preference.

Table 1.1 Existing work

1.6 Research Gap

Students who are facing A/L exams most often identify their weak areas through teachers. The skills that students do not have vary from one student to another. Therefore, teachers must give attention to each and every student individually to figure out which skills they are lacking, and which lessons they must focus on. It is not possible for a teacher to pay attention to each pupil. A system is therefore needed to identify students' weak points and improve them.

Many research studies have investigated the implementation of generating automated MCQ papers. However, few studies have examined the generation of MCQ papers on the basis of students' weak competencies. Therefore, we propose a system which generates MCQ papers based on students' past performance.

Another thing is that existing systems do not produce MCQ papers to evaluate specific competencies. For example, a student wants to do more questions from the lesson" logic gates" even though he's good at that lesson. But existing systems aren't capable of identifying students' requirements and producing papers which only consist of questions related to "logic gates".

In this system, students' requirements will be collected via the information provided through chatbot and generate model papers based on those requirements.

1.7 Contribution to the body of knowledge

1.7.1 Technological Contribution

Our educational system will use supervised machine learning algorithms such as regression to predict lessons where the student is weak and use SQL to retrieve questions along with a correct answer and additional incorrect answers (distractors) from the database. An Angular web application will be created using HTML, CSS, JS to demonstrate the algorithm. Flask REST API will be used to create the web API.

Furthermore, the analysis of the performance of the students shall be processed with python programming with the help of python libraries.

1.7.2 Contribution to domain

With the use of above-mentioned technologies, we will design a user-friendly system which is capable of making model papers based on skills students are weak at.

For example, a student will do an ICT model paper and once he completes it, the system identifies that the student has answered questions related to “operating systems” subject incorrectly. So next time, he will get a paper that includes more questions related to “operating system” lesson.

Planning to use an AI chatbot to gather information from students regarding lessons they want to study further. This will help students to develop their skills and knowledge on related areas.

For example, a student can communicate with an AI chatbot and let it know that he wants papers related to logic gates. Therefore, the system itself generates MCQ based model papers which only consists of questions related to “logic gates”.

Apart from that, this project also provides teachers to track the progress of their students by answering model papers given by the system. Unlike any other system, here each students’ progress is analyzed and displayed to the teacher so that he/she can see which lessons have to be revised in the future.

1.8 Research Challenge

- Due to the unavailability of direct research papers for the project, the researchers have to make their own datasets from referring to the G.C.E Advanced Level Examination past papers. Further assistance can be taken to overcome this challenge by referring to the past papers categorized by Pesuru Publications Ltd.

- Implementing a user-friendly interface for the students to assure the acceptance by clients. In order to overcome this, the researchers have decided to use a web interface, since the

interface can be styled into a more preferable scope using CSS styling and other web developing software programs.

- Establishing a synchronized online classroom for the teacher and his/her students for setting the paper class is a major challenge that the researchers have to face. In order to deal with this, many research papers have to be gone through to identify the specific technologies. The technologies used here might lead to a publication since the research papers are taken by different journals such as Computers & Education(www.sciencedirect.com, n.d.)

- One of the major challenges would be in preparing the customized model papers for the students by means of their performance. Here, the concepts of machine learning shall be used to train data into the system.

- Implementing the chatbot to understand the requirements of the student and assist them when in need would be a troublesome task considering the time availability of the due time for the whole project.

1.9 Research Questions

- RO1: Which algorithm is best for predicting students' results based on their performance?

- RO2: How does an AI bot understand a student's requirements and provide a solution for them?

- RO3: Which methodology can be used for building an online platform for students and teachers?

- RO4: How can students' performance be used to generate MCQ based papers for them?

1.10 Research Aim

This proposed system will identify students' weak competencies based on how he/she performs in model papers and generate new model papers including more questions related to areas that student is weak at. Furthermore, AI chatbots will be used to get information about lessons which students require for further improvement and generate special papers only consisting of questions related to those specific lessons.

1.11 Research Objectives

Research Objectives	Explanation	Learning Outcome
Problem Identification	**RO1**: Identifying the best algorithm to model the question paper according to the students' performance. **RO2**: Selecting the best computational strategy for improving the accuracy of the students' exam result prediction. **RO3**: Designing a lenient web interface for the users to work. **RO4**: Building the dataset, which consists of questions categorized according to the lesson. **RO5**: Implementing a communication platform for the teacher and students, and analyzing the performance of the student **RO6**: Selecting a suitable technology to implement an AI chatbot for the students.	LO1
Data Gathering and Analysis	• Self-set data gathered from G.C.E A/L I.C.T past papers. • Data gathered from previous Research papers from Google scholar, IEEE, ResearchGate etc. • Journals.	LO1, LO3
Research Design	Quasi- Experimental Design will be used as the Research design as it aims to establish a cause-and-effect relationship between dependent and independent variables (Thomas, 2020).	LO4, LO3
Implementation	Different Implementations in this research project are as follows: • Implementation of a web application to answer modeled MCQ papers for the students based on their performance. • Student Profile to check their progress and predicted grades for the A/L exam. • AI chatbot for assisting students with academic work. • Implementation of virtual classrooms to evaluate the class performance.	LO2, LO3, LO4
Testing and Evaluation	Surveys and questionnaires shall be used for testing and evaluation of the research project. Surveys are used to get the opinions and feedback from the students and teachers in order to evaluate the quality of the research project (QuestionPro, 2019).	LO2, LO4

Table 1.2: Research Objectives

1.12 Project Scope

1.12.1 In Scope

No	Description
1	Predict the model paper formats from past papers.
2	Provide a set of practice questions related to the requested study area of the subject.
3	Create a virtual classroom where the teacher can view the performance of students.
4	Predict a student's grade based on the model paper marks.

Table 1.3: In Scope

1.12.2 Out Scope

No	Description
1	Creating the model for many subjects and languages.
2	Generate entirely new model questions
3	Creating the virtual classroom which can manage all the other subjects as well.
4	Predicting the Z score of the student in the examination.

Table 1.4: Out Scope

1.12.3 Prototype Diagram

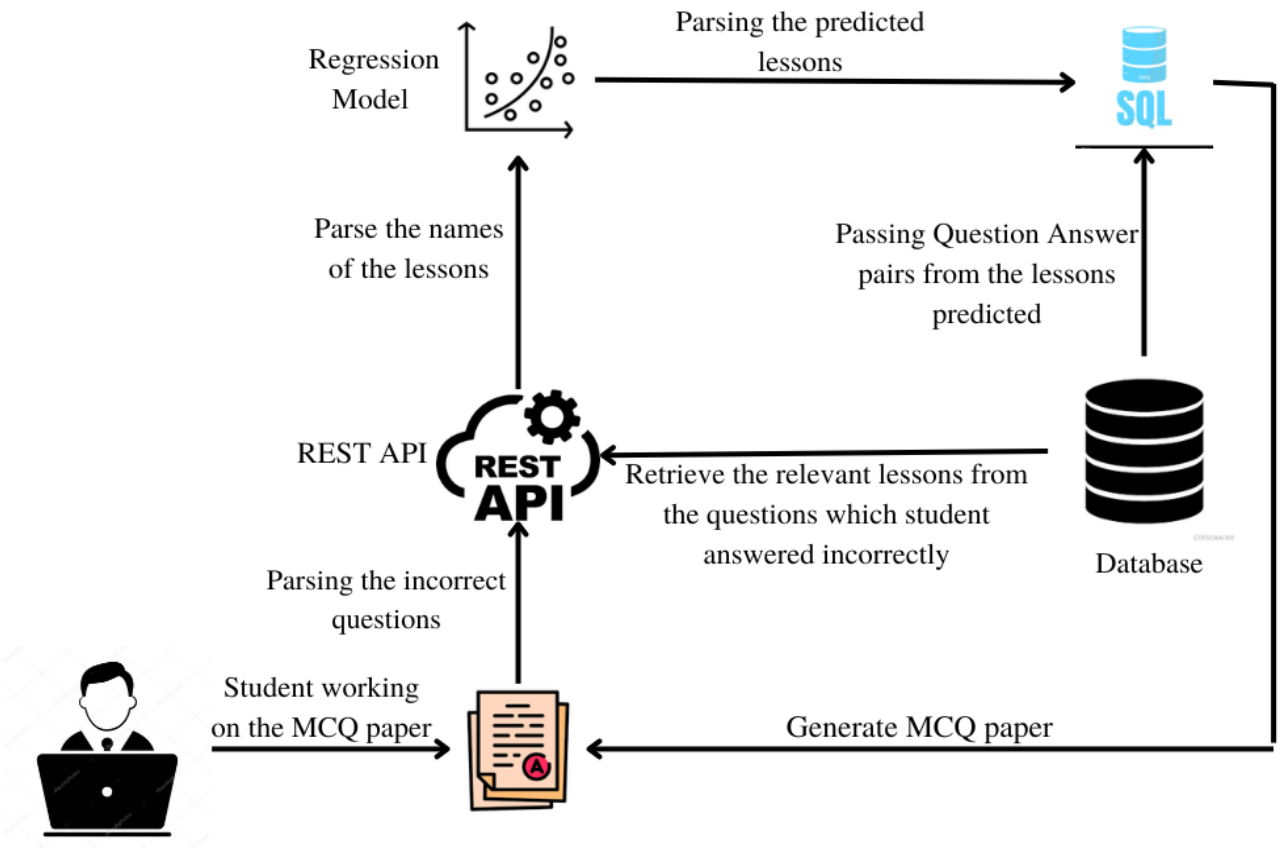


Figure 1.1: Feature Prototype

Process

- Prerequisite: 1st paper is generated manually

1. Student will work on the MCQ paper through the website created.
2. After that, questions which he answered incorrectly will be parsed from the REST API.
3. Retrieve the names of the lessons for the questions which the student answered incorrectly from the database.
4. Parsing the names of the lessons to the regression model.
5. The regression model will predict the number of questions a student will make faults from the lessons he's weak at.
6. SQL will retrieve question - answer pairs along with other incorrect answers from the database.
7. Generating MCQ papers from the questions retrieved from the database. These questions were added based on the weightage given to each lesson.

1.13 Resource Requirements

Hardware Requirements

- **CPU** (**Intel Core i7 7th generation processor or high**)- To get more powerful and high performance.
- **16GB RAM or high** - To train heavy algorithms.
- **Storage (minimum 256GB SSD / 1TB HDD) -** To store a large amount of data.

Software Requirements

- **Python** - Python was the main programming language utilized in the development of the proposed system. This language was chosen due to its exceptional error handling capabilities and the broad range of libraries that were available to support the development process.
- **PyCharm Enterprise** - used for developing proprietary and commercial software.
- **SQLite**– To manage databases and servers.
- **HTML**- To structure the webpage.
- **CSS** – used to style and layout web pages.
- **JavaScript** – used for scripting the webpage.
- **MS Word** – To write documents.
- **PHP** – to develop dynamic and interactive websites.
- **Windows Operating System** – To handle huge computational functionalities**.**

Data Requirements

- Since we are focusing on the advanced level ICT exam in Sri Lanka, there are no suitable datasets found for our project. Therefore, our team must create our own dataset that is suitable for a/l ICT students.

Skill Requirements

- Searching for information
- Time management
- Problem solving
- Report writing
- Critical thinking
- Planning and scheduling

1.14 Chapter Summary

The explanation of project stakeholders and their involvement served as the chapter's introduction. To gather requirements, various approaches were researched and used. The system's context and primary use cases were then established. The functional and non-functional needs were gathered and ranked based on the use case specification.

CHAPTER 2: LITERATURE REVIEW

2.1 Chapter Overview

In this chapter, a web application aimed at improving students' exam performance and result prediction system is being explored. The chapter begins by spotlighting the primary focus of using the application by students to measure their current performance to predict their A/L exam results and assist them in achieving better grades. Furthermore, the chapter delves into the integration of an AI chatbot and a Virtual classroom into the application that provides guidance to students and which allows students to write their exam papers while enabling teachers to monitor their progress. Additionally, the chapter discusses the system's analysis of individual student mistakes and the identification of lesson areas that need improvement, providing teachers with valuable insights to guide their students' progress. It also discusses related literature that highlights the importance of using similar technology in improving students' exam performance.

2.2 Relevant Work

2.2.1 Generating MCQ based model papers

Engaging in MCQ questions have proven to be an effective method which can help both learning and student retention. Predicting and generating MCQ questions is a challenging task in educational technology. Related research focuses on Natural Language Processing to generate new questions from text and paragraphs or extract questions from the question bank.

Novel exam paper generation approach was taken by Z.Wu et al(Wu et al., 2020) where dynamic programming named PDP-EG and genetic algorithm named PGA-EG were used to optimize exam papers.Furthermore, Deep Knowledge Tracing was used to predict students' performance based on previously answered question papers.

Preparing multiple-choice questions is a time consuming task which can take up to 50% of an instructor's time.Automated multiple-choice question generation system(Vachev et al., 2022) was introduced to address this problem which takes the course text (subject content) as an input and creates question–answer pairs together with additional incorrect options.

Exam is a part of the assessment that educators provide to their students to evaluate students' performance against their learning outcomes.Genetic algorithms(Rahim et al., 2017) have been used to produce new exam papers and it covers six levels of Bloom's Taxonomy (educational objective categorization system) to generate high quality exam questions. Java is the programming language used to build the prototype and MySQL was used for the structural database to develop the Automated Exam Question Generator.

Online exam system was designed (Xu and Liao, 2021) based on the MVC framework. Random paper constructing algorithm was used here to extract control parameters of test questions in accordance with actual demands, and then randomly selects questions from test banks based on those parameters.

MrunalFatangare et al(Fatangare et al., 2018) build an android application which consists of various modules such as admin and user modules to enable the system to deal with all questions easily. This system generates papers by randomly picking questions based on conditions such as chapter and Bloom's Taxonomy levels. These questions were taken from a specification table which was designed by administrators.

PedroÁlvarez et al (Álvarez and Baldassarri, 2018) proposed a service-oriented system which consists of dynamic strategy of generating distractors(alternatives to the correct answer) and heuristics for scoring the distractors' suitability. This system was based on semantic technologies which does not require the predefined input knowledge database. Instead, the system interacts with online semantic services to create a new specialized knowledge base to generate questions. Google forms will be used to create the test with questions and distractors.

2.2.2 Implementation of Virtual Classrooms

Within the years Virtual classroom concepts are often found, where students and teachers can interact with each other for the academic improvement of the student. This project provides the students of a certain institution, to write for exams while the teacher is able to see the progress of the students in his/her class.

Virtual classroom environment is mainly focused on stimulating a real time classroom for remote participants using audio and video conferencing (Deshpande and Jenq-Neng Hwang, 2001) but, here this virtual classroom concept can be proposed in many other ways.

In an IEEE/ASEE conference, research was conducted for determining the most effective way to get more results in an exam. Here, engaging in online tests got more outstanding results than traditional written tests (Kumar, 1999).

Conducting online tests also favors analyzing students' performance in the class (Ricketts and Wilks, 2002).

For these processes, the data of the students have to be mined in order to proceed the analyzing phase. Two of the data mining methods were introduced in an conference in Sarajevo, Bosnia and Herzegovina (Slanjankic et al., 2009) for similar application which were:

1. Principal Component Analysis (PCA)
2. Disjoint Cluster Analysis (DCA)

A similar approach was taken by a set of experts namely Priscila da Silva Neves Lima, Ana Paula Laboissière Ambrósio, Igor Moreira Félix, Jacques Duílo Brancher, Deller James Ferreira. Here they have used answered question papers, categorized the questions to a theme and analyzed the results in order to get the required data for detecting the academic progress of the student (da Silva Neves Lima et al., 2018).

Another aspect is collective analysis of the subject lessons of the whole class with student progress indications based on Backpropagation Neural Network(BP-NN)(Yang and Li, 2018) which need further improvement.

2.2.3 AI chatbot guide

From the world population, around 51% is already using the internet. Therefore, using the internet for education is very progressive and important. When students are interacting with the system, all the student details can be captured by chatbots (Shukla and Verma, 2019) in Learning Management systems. Using an AI chatbot is helpful to both students and teachers to effectively participate in learning and teaching processes. A chatbot is created using the R language as a query with the help of AIML(Artificial Intelligence Markup Language). In parallel with AIML script, if the query is unsuccessful, then this is framed as a query with the help of SQL lite. If both queries are unsuccessful, then, it is forwarded to a human interface. Overall, the entire concept meant to add value to any LMS system, students, and institutions.

Educators have observed that students usually encounter difficulties in seeking help when they learn and this can affect their performances.(Lee, Hwang and Chen, 2022) Application of AI based chatbots showed an improvement in students' academic performances, learning attitude, self-confidence, and motivation in public health courses. The average performance of the experimental group was 66.33, while the control group performance was 57.8. This process showed students feeling recognized and to help to perform well in academic work, which can make them more successful using AI chatbot. The main reason behind this significant improvement is that chatter bots are able to provide instant feedback by resolving learning problems straight away.

The authors have developed a system that opens the door for multiple students to collaboratively choose sentences to be spoken by the robot to improve teacher-student communication (Shimaya et al., 2020). A mock lecture experiment was conducted for research, and it verified that students who are usually hesitant to ask questions during lectures became less hesitant to ask questions when using their system. Further, the activeness in lectures was increased with the proposed system.

A study was conducted (Smutny and Schreiberova, 2020) to examine educational chatbots for Facebook Messenger to support the learning process.47 educational chatbots based on Facebook Messenger bases on the hierarchy process against the quality attributes of teaching, affect, humanity, and accessibility. The study concludes that the educational chatbots in Facebook

Messenger platform vary from the very basic level of sending personalized messages to suggest learning material. Moreover, the study shows the chatbots which are part of the instant messaging software programs are still in their early stage to become AI based teaching assistants.

Seeing chatbots as an opportunity to act as practice partners, a system was proposed to make a better educational support system for language learners by using robots (Fryer, Nakao and Thompson, 2019) . The system tries to mimic human-human interactions by building a human-chatbot interaction to increase the study quality of language learners.

In the paper (Clarizia, Colace, Lombardi, Pascale, & Santaniello, 2018) an approach to a Chat bot has been proposed. The proposed system's goal is to provide students who follow computer science and computer network courses on an e-learning platform.

(Dutta, D. ,2017) This study has shown the effect on high school students by chatbot tool, on their general knowledge.

In this study (Crown et al., n.d.) a chatbot named Anne G. was introduced to help engineering students to increase their engagement and motivation. This chatterbot helps the students with their learning process and helps them find answers for subject related questions more easily.

The chatbot FIT-EBOT was implemented to give answers to students on behalf of the academic staff (Hien et al., 2018). This system is based on text classification and named entity recognition. It is expected to make it a better support to the students by analyzing and training data using AI algorithms.

2.2.4 Predicting student's results and making student profiles

The student's academic performance focuses on totally different aspects, making analysis a little bit tough. In(Obagbuwa, I. C... (2010)) past years, there has been an increase in the proportion rate of interest and concern over people's utilization of knowledge mining for analysing academic qualities.

They(Wahab, M.O.A. (2021)) enforced three machine learning algorithms with administration for the prediction of success during a course. It absolutely was detected that the "Naive Bayes" classified performed manner higher in call tree prediction and alternative strategies of neural networks. A lot of research in this field investigates the ways for applying techniques linked with machine learning in educational fields. It identifies risky students and also student performance(S. Halder, (2016).They implement 3 Machine learning algorithms with control for the prediction of success in a course. If we found out the name "Naive Bayes" categorized it performed way better in division tree prediction and other methods of neural network(Mian U. Sattar 2020).

The research found that family attributes and academic attitudes were deciding factors for prediction(J. Med. Syst. 2019,43, 162.). The increasing grade point average of students and their external and internal assessment marks were also the most usually used attributes in this survey.

In this study(Natek, S. and Zwilling, M. (2014)), the author starts with a question. Is it possible to predict students' success enrolled in a course with a small dataset? That dataset connected with students is considered a small or big number of students. Student attributes considered in this paper of prediction are the date of birth, registration gender, exam condition, and exam activities.

2.3 Comparison table of relevant work

Research	Author	Year	Dataset	Model Used	Metric
Generating MCQ based model papers					
Exam paper generation based on performance prediction of student group	Zhengyang Wu, Tao He, Chenjie Mao, Changqin Huang	2020	OLIES2011, ASSISTments 2015	PDP-EG model, PGA-EG model	Difficulty score: 0.7 Validity score: 0.9
Leaf: Multiple-Choice Question Generation	Kristiyan Vachev, Momchil Hardalov, Georgi Karadzhov, Georgi Georgiev, Ivan Koychev, Preslav Nakov	2022	SQuAD1.1, RACE dataset	T5 model, sense2vec model	F1 score: 53.26

Automated exam question generator using genetic algorithm	Tengku Nurulhuda Tengku Abd Rahim, Zalilah Abd Aziz, Rose Hafsah Ab Rauf, Noratikah Shamsudin	2017	500 sample questions has been run 50 times to analyze the quality of exam questions	—	Average weightage: 70% Highest weightage: 90% Lowest weightage: 40%
The Online Exam System Research Based on the MVC Framework	Bing Xu, Youcheng Liao	2021	The data collected from teachers and examinees	MVC	—
Android based exam paper generator (Android based E-PAGE)	Mrunal Fatangare, Rushikesh Pangare, Shreyas Dorle, Uday Biradar, Kaustubh Kale	2018	Specific number of questions of a specific subject	—	—
Semantics and service technologies for the automatic generation of online MCQ tests	Pedro Álvarez, Sandra Baldassarri	2018	Data collected from teachers	Semantic knowledge tree, heuristics	Heuristics score: 0.0 - 1.0
Implementation Of Virtual Classrooms					

Introducing Virtual classroom environment for remote participants	Sachin G. Deshpande,Jenq-Neng Hwang	2001	TIE Lecture classes at Washingtons' University	JBIG1 Image encoding system	Intra Media Assessment score 3 from 1-5
Detecting Progress of students	Priscila da Silva Neves Lima, Ana Paula Laboissière Ambrósio, Igor Moreira Félix, Jacques Duílo Brancher, Deller James Ferreira	2018	Set of measurements and graphical representation of the statistics of student results.	SySENADE architecture (3 phases namely: 1. Identification and Cataloging 2. Group By Theme 3. Analysis and results)	Discrimination Index: 100%
Data Mining From Student Results	Emir Slanjankic, Haris Balta, Adil Joldic, Alsa Cvitkovic, Djenan Heric, Emir Veledar.	2009	Information of First year students,courses and Time to prepare for exams from Faculty of Information Technologies (FIT)-Mostar.	SAS Software	—-
Analyzing Students Performance	Fan Yang, Frederick W.B. Li	2018	Subject Results taken by 3 student groups	BP-NN in Student Attribute matrix	Predicted attribute 5.02 where real(first) attribute being 4.82 Accuracy ~85%
AI Chat Bot Guide					

Impacts of an AI-based chatbot on college students' after-class review, academic performance, educational technology research and development.	Lee, Y.-F., Hwang, G.-J. and Chen, P.-Y.	2020	Data from participants of two classes of freshers who took healthcare course in medical university in Northern Taiwan	Deep Learning Models and Techniques	Accuracy: 93.7%
Chatbot learning partners: Connecting learning experiences, interest and competence	Fryer, Nakao and Thompson	2019	91 students (22 Female) participated in the current Study where the students were in their first and second year (between 18 and 20 years of age) at a private university in Western Japan	Longitudinal Regression Modeling and Difference Testing	—
Developing an Intelligent Chat-bot Tool to assist high school students for learning general knowledge subjects	Dutta, D	2017	From Alexa Traffic Ranks	Natural Language Processing (NLP) and Complex Feature Development	—

Chatbots for learning: A review of educational chatbots for the Facebook Messenger	Pavel SmutnyPetra Schreiberova	2020	47 educational chatbots using the Facebook Messenger platform	Lars Satow's Model of Learning Facilitation and AHP package to define and evaluate the model	Ask Frank variant with the total weight of 14.9
ANNE G. NEERING: INTERACTIVE CHATBOT TO ENGAGE AND MOTIVATE ENGINEERING STUDENTS.	Crown, S., Fuentes, A., Jones, R. and Crown, D	2019	3141 unique questions and provided associated responses for 1755 of them	Retrieval Based Database chatbot: NLP (Natural Language Processing) and AI (Artificial Intelligence) techniques	—
Chatbot: An Education Support System for Students.	Clarizia, Colace, Lombardi, Pascale, & Santaniello	2018	The data collected from the LMS users	Following are the key works 1. Build an e-learning ontology 2. Manage queries 3. Map learning object metadata (LOM) instances into ontology	Accuracy: 13%

Robotic question support system to reduce hesitation for face-to-face questions in lectures. Journal of Computer Assisted Learning	Shimaya, J., Yoshikawa, Y., Ogawa, K. and Ishiguro, H.	2020	62 first- and second-year Japanese university students	Behavioral measures, Subjective measures and Regression analysis	Total F value is 13.44
Enhancing LMS Experience through AIML Base and Retrieval Based Chatbot using R Language	Shukla, V.K. and Verma, A.	2019	—	Retrieval Bases Database chatbot.	—
Predicting student's results and making student profiles					
Clustering algorithm for prediction of Students	Oyelade, O. J , Obagbuwa, I. C , Oladipupo, O. O	2021	Academic result of one semester of a university in Nigeria	Deterministic, Fuzzy	Accuracy: 82.22%
Predicting students yearly performance using neural network	Adriano Lino , Amanda Sizo , Alvaro Rocha	2019	1,448 students in Federal University of Para	Decision trees, Naive bayes	Accuracy: 90.00%
Student data mining solution–knowledge management system related to higher education institutions	Moti Zwilling , Srecko Natek	2014	Higher educational institute students (HEI)	Data mining ,Adopted	—

Predicting Academic Performance Using an Efficient Model Based on Fusion of Classifiers	Ansar Siddique , Asiya Jan , Fiaz Majeed , Adel Ibrahim Qahmash , Noorulhasan Naveed Quadri and Mohammad Osman Abdul Wahab	2021	1227 records was collected at Kaggle	Classification	Accuracy: 98.7%
Predicting Student Performance in Higher Educational Institutions Using Video Learning Analytics and Data Mining Techniques	Raza Hasan , Sellappan Palaniappan , Salman Mahmood , Ali Abbas ,Kamal Uddin Sarker and Mian Usman Sattar	2020	772 e- commerce and technologies higher educational institute(HEI) students	Tree-base classification , Predictive , Linear Regression	Accuracy: 88.3%
Predicting Academic Performance of Students Using a Hybrid Data Mining Approach	Bindhia K Francis , Suvanam Sasidhar Babu	2019	Higher educational institutions in Kerala, India	Classification,Clustering	—

Table 2.1: Research Influence

2.4 Chapter Summary

This literature review chapter discusses application designed to enhance students' performance in exams. The project primarily focuses on predicting students' A/L exam results based on their current performance and providing assistance to help them achieve better grades. Additionally, an AI chatbot is integrated into the application to help with giving guidance in the application. The application also includes virtual classrooms that enable students to write their exam papers while allowing teachers to monitor their progress. The system analyses individual student mistakes and identifies lesson areas that require improvement, providing teachers with valuable insights to guide their students' progress.

CHAPTER 3: METHODOLOGY

3.1 Chapter Overview

The current chapter outlines the approaches that were utilized in the research, project management, and development phases of the project. We discuss several distinct methodologies that were employed, as well as provide diagrams that document the rationale behind any adjustments that were made throughout the development process. Additionally, an implementation plan for the project's expected outcome is included.

3.2 Research Methodology

Research Philosophy	The researchers have selected positivism as the research philosophy because the data used for the process of the project are factual. Here, the work of the researchers is limited to data collection and interpretation, which means that they are independent in the following Research Project.
Research Approach	The research follows an inductive approach. Starting with research questions and identifying the patterns of the students' performance in a test, the system theorizes the students' under-achieving lessons and generates untested model papers.
Research Strategy	Quantitative Questionnaires are used as a research strategy, because the analysing of the students' performance can be done only after the student answers a considerable amount of question papers.
Research Choice	This research will be using a mono method where only one method shall be used in gathering data.
Time zone	Cross-sectional Time zone is used because the research goes through a specific data set only a single time.

Table 3.1: Research Methodology

3.3 Development Methodology

This project uses Agile development as it can be used to decompose the entire project into sprints based on user stories (stories are software features in the project) using scrum, which is also an Agile framework. Agile model is capable of testing and delivering software features sprint wise and makes the project more manageable. Iterative development methodology can be used to deliver the project to users. Requirements of this project can be dynamic, therefore Agile is the

most suitable software methodology as it provides a better way of managing the changing requirements. Object-oriented analysis and design(OOAD) is used to design our system, as it uses iterative methodology to refine and extend our design. And since the requirements of our project are dynamic, this will be the most suitable technical approach.

3.4 Project Management Methodology

a. Schedule using the Gantt Chart after doing Work Breakdown Structure

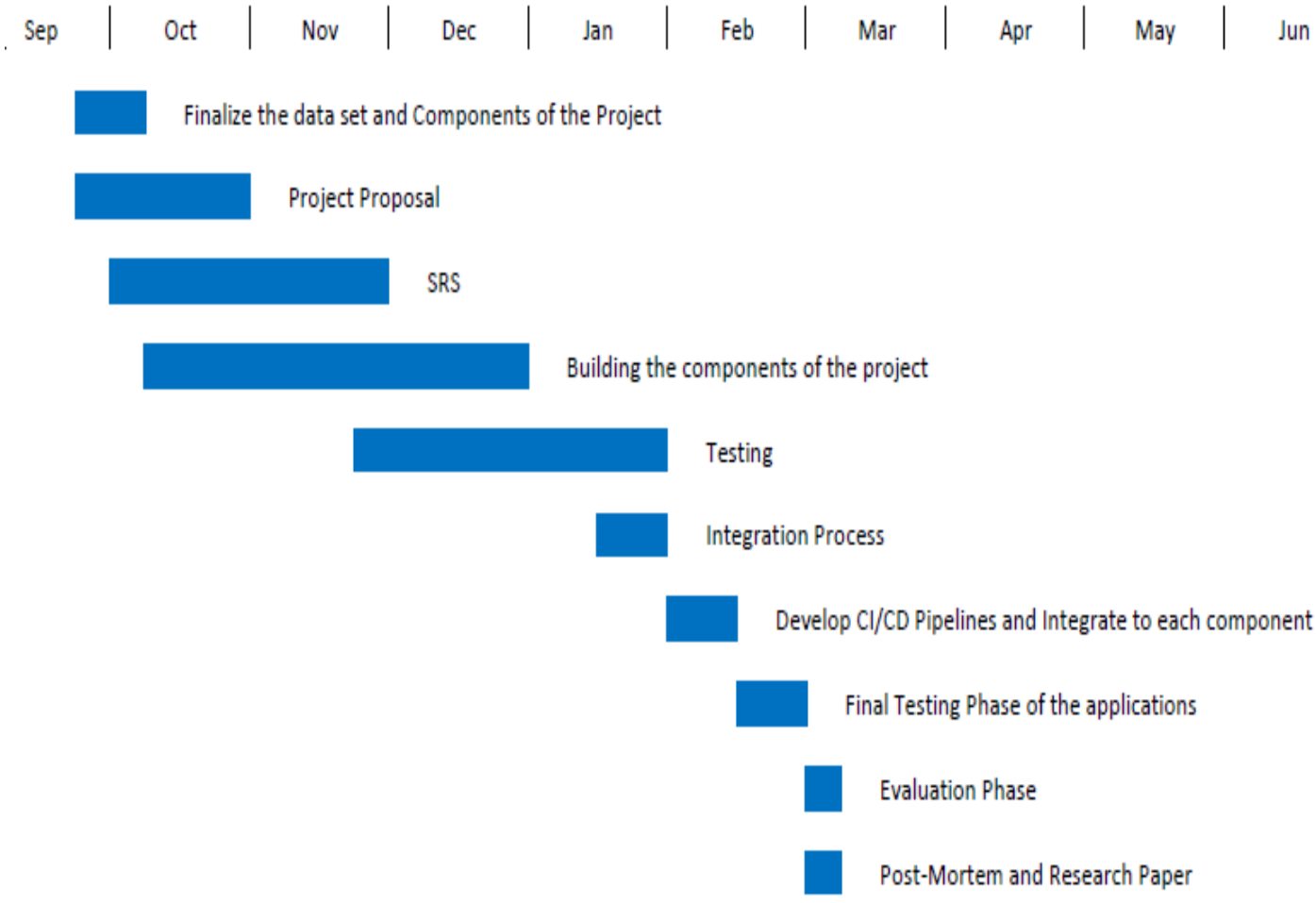


Figure 3.1:GANTT Chart

b. Deliverables, milestones, and dates of deliverables

Deliverable / Milestone	**Due Date**
Datasets and Components of the project	2nd week
Project Proposal	5th week
SRS	9th week
Learning the tech stack	9th week
Building the components of the project	17th week
Testing	19th week
Integration Process	19th week
Develop CI/CD Pipelines and Integrate to each component	21st week
Final Testing Phase of the applications	23rd week
Evaluation Phase	24th week
Post-Mortem and Research Paper	24th week

Table 3.2: Project Delivery Plan

3.5 Chapter Summary

The Advanced Level examinations are one of the most competitive examinations worldwide, but with the aid of the above-mentioned the researchers have given the students a platform to identify their weaknesses in subject matters. This methodology proves to be effective in preparing the students for the upcoming “I.C.T-A/L” examination.

CHAPTER 4: SOFTWARE REQUIREMENTS SPECIFICATION

4.1 Chapter Overview

In this chapter, the focus is on helping the students achieve better results by evaluating their performance and documenting their individual improvement. The stakeholders of the system are named, and their roles are described first. The advantages and disadvantages of various strategies for requirement collection are described and evaluated. The requirement analysis stage also includes the use case diagram and associated definitions. Finally, a scope description is used to specify the needs for the system, which are then divided into categories based on how important they are to the function.

4.2 Rich Picture

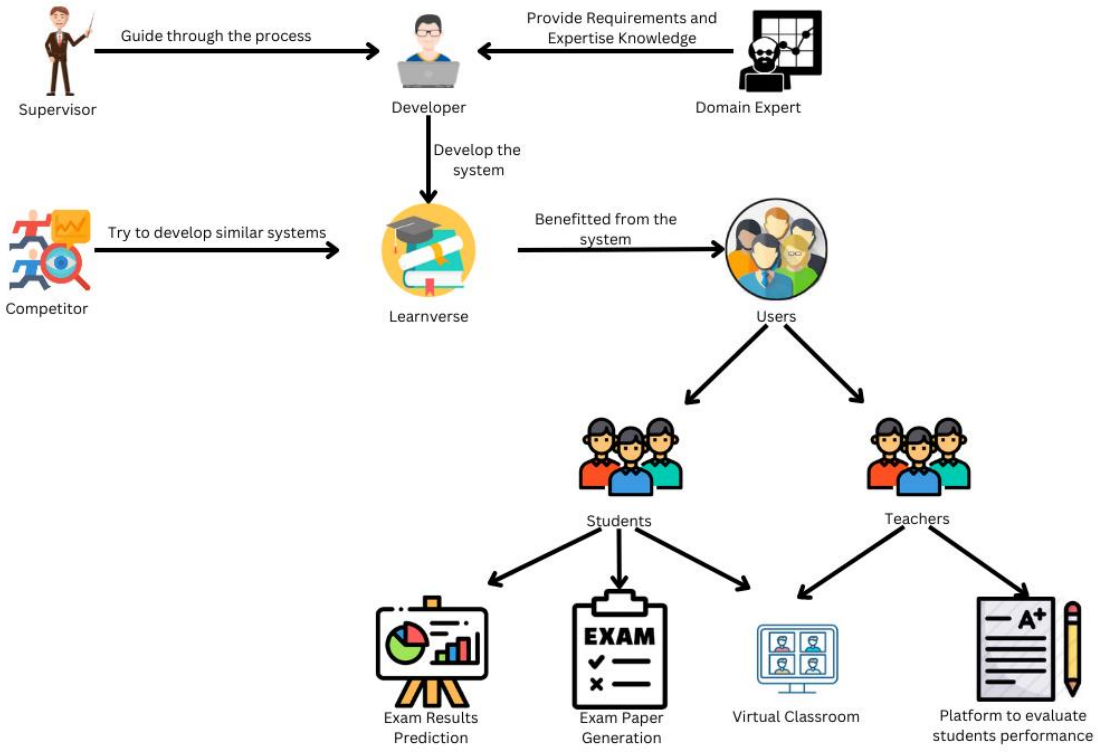


Figure 4.1: Rich Picture (Self-Composed)

4.3 Stakeholder Analysis

The onion diagrams show the established stakeholders who are associated with the system, along with an overview of any stakeholder's position in the system.

4.3.1 Onion Model

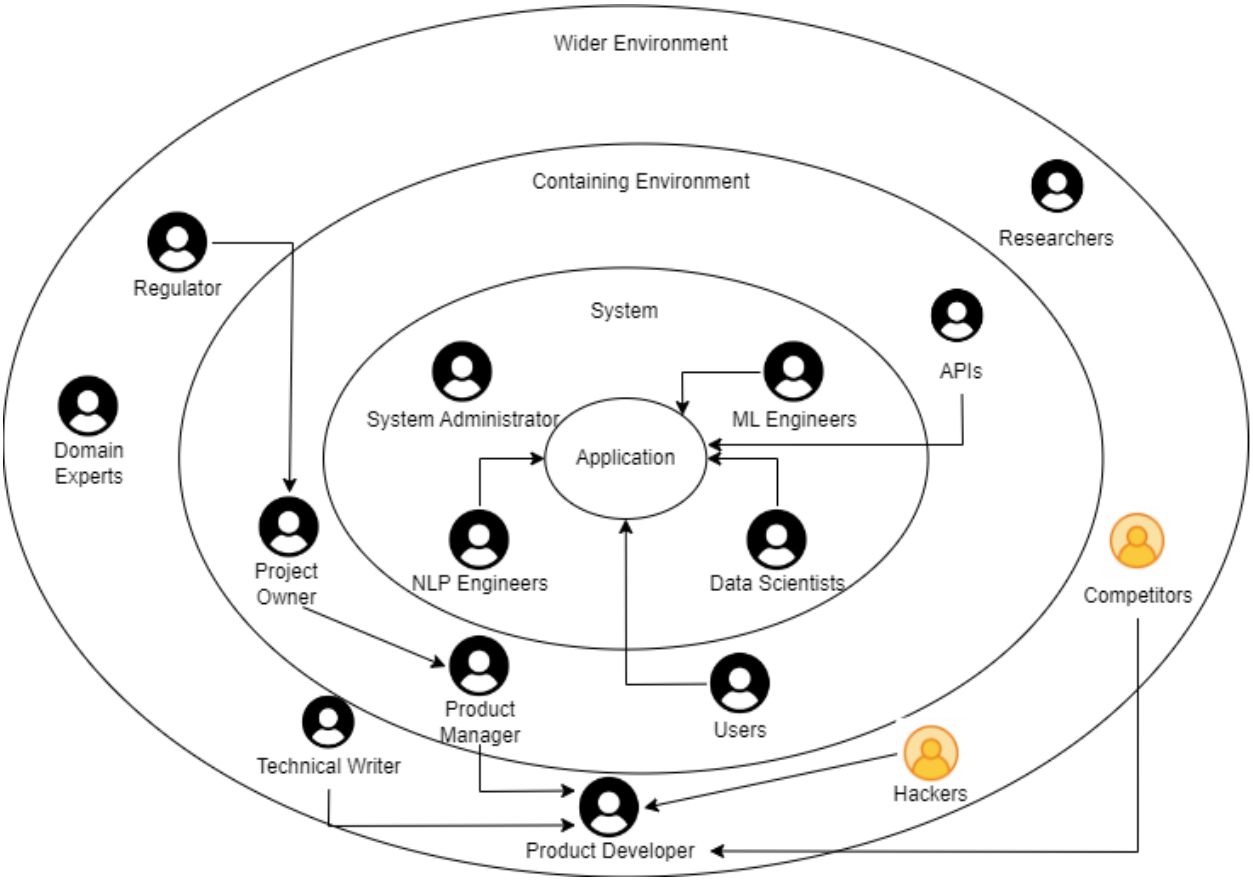


Figure 4.2: Onion Model(Self-Composed)

4.3.2 Stakeholder viewpoints

Stakeholder	Role	Benefits
NLP Engineers, Data Scientists, ML Engineers	Operational Maintenance	Design and develop the ML models and other system processes.
System Administrators	Operational Administration	Allowing the deployment of the system for different environments.
APIs, Users	Functional Beneficiary	Using in the final Learnverse web-application.
Project Owner	Functional Beneficiary	Owner of the Learnverse system.

Product Manager	Managerial Support	Managing all the processes and the flow of tasks in the system.
Product Developer	Developer, Operational Maintenance	Building and maintaining the system.
Researchers	Educational Beneficiary	Review similar systems and their processes to improve current techniques.
Domain Experts	Expert	Providing the Domain view of the project technologies and methodologies.
Regulator	Quality Regulator	Making sure the application handles data according to the privacy policies and avoids miss use of data.
Technical Writer	Operational Maintenance	Support in system document creation.
Hackers	Negative Stakeholder	Creating fallacies in the system application and intending unauthorized access to application data.
Competitors	Negative Stakeholder	Initiating direct competition to the application with different competitors with similar or advanced features.

Table 4.1: Stakeholder Viewpoints

4.4 Selection of Requirement Elicitation Techniques

The various methods of gathering requirements are referred to as requirement elicitation. This segment examines a variety of options, outlining their benefits and disadvantages.

4.4.1 Observing Existing Systems and Literature Review

Across our Learnverse system, the process of collecting requirements may begin with a review of the current systems. Analyzing the existing work in the field, problems that need to be fixed are found.

Advantages	Disadvantages
• In this system, we are planning to minimize time wastage with Automated MCQ paper generation.	• The questions are not personalized to the abilities of the individual student
• Producing fair, random exam questions for the students to practice on.	• Finding MCQs of the highest caliber is challenging.
• Creating exam questions of the highest calibre for students.	• For the purpose of creating the test questions, the topic material was used as the main source of information.
• Possible to predict students' performance based on how they responded to previous questions.	• No questions can be given to students based on their preferences.

Table 4.2: Observing Existing Systems

4.4.2 Surveys and Questionnaires

The target audience of the Learnverse is high school students who are taking ICT as a subject in their AL exams. A questionnaire is a more suitable method to get feedback and ideas from students.

Advantages	Disadvantages
• Inexpensive and more efficient.	• Problems with understanding and interpretation of the question.
• Can acquire results quickly.	• Accessibility issues may occur.
• Scalable according to the size of the target audience.	• May face a low response rate caused by survey fatigue.
• Easy to analyze and visualize data after gathering.	• Respondents may quit in the middle of the survey or skip answering.

Table 4.3: Survey and questionnaires

4.4.3 Interviews

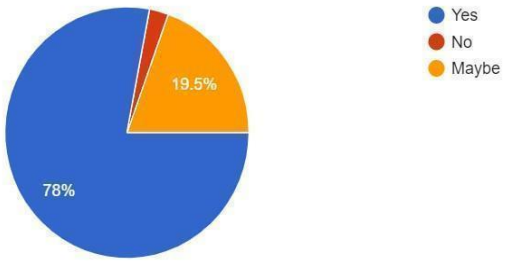
Interviews are a good tool to collect valid and reliable data directly by interviewing people.

Advantages	Disadvantages
• Understanding the stakeholders better	• Misunderstanding the questions and responding incorrectly
• Personal bias ness in answers	• Providing wrong information deliberately
• Has a better response rate	• Highly time-consuming
• Interviewer can collect non-verbal responses	• The questions can be altered and biased when asking the respondent
• Can extract additional information	• The interviewer should be skilled or trained to conduct the interview.

Table 4.4: Interviews

4.5 Discussion of results

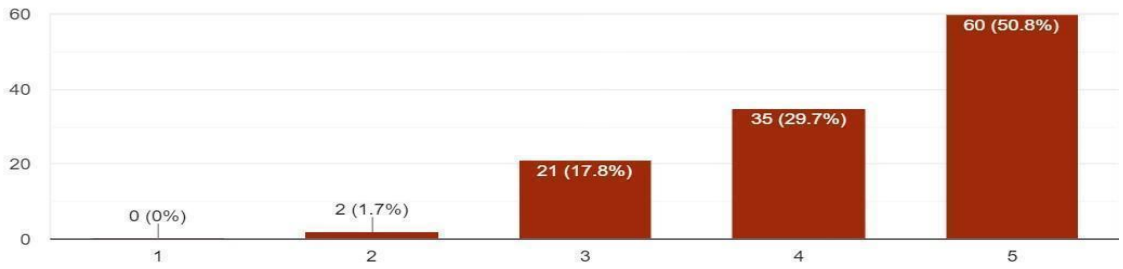
4.5.1 Survey Findings

Question	Would you like to use a web based application to engage in MCQ papers?
Aim Of Question	Identify the likelihood of the audience using a web based application to do MCQs.
Observations	
	According to this survey, 19.5% of students have an undecided idea on using a web-based application, while 78% prefer using a web based application. 2.5% of students have stated that they would not use a web based application.

Conclusion
Majority of the respondents have answered that they would like to use a web based application to do MCQs, while a very small percentage opposed the idea. A considerable portion of the total audience are having a neutral state about the idea.

Question	Do you think it would be helpful to use an application that would help you identify areas of study where you are weak in a subject?
Aim Of Question	To identify to what extent they think that an application would help to identify the areas of study where they are weak at.

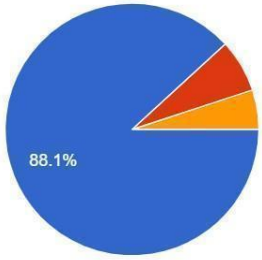
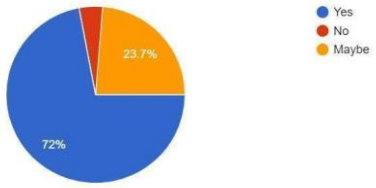
Observations



50.8 % of those surveyed said they highly agree with needing an application. Only 29.7% of respondents indicated that they agreed with the statement; the remainder gave neutral responses.

Conclusion
While none of the respondents has responded that there is no need for an application to find out where they are weak at a certain subject. The majority of the respondents have answered as the use of an application might be moderately to extremely helpful.

Question	Would you like to take part in model papers that deal only with a particular lesson/lessons in a subject where you are weak?
Aim Of Question	Identify if the audience would like to do model papers particular to a specific subject area that they are weak at

Observations	
	From the total population of the respondents, 88.1% claimed that they wanted to examine their areas of weakness in their subjects. 5.1% of the audience have chosen that they have no idea about it, and 6.8% were not interested in doing so.
Conclusion	
More than 75% of the respondents have stated that they would prefer to do model papers related to a specific subject area that they are weak at. And a small portion of the respondents had neutral or opposing ideas.	
Question	Do you think it would be preferable to obtain the help of an AI assistant to convey your needs (if any) related to exams and studies?
Aim Of Question	Identify the need for an AI assistant with the proposed application
Observations	
	It was found that 72% of students believed that AI assistants could assist in identifying their demands in relation to their tests, 4.2% of students said they disagreed, and the remaining 23.7% were undecided.
Conclusion	
Majority of the respondents have answered that it would be preferable if they can get the assistance of an AI assistant. A considerable amount of the respondents think it might help and have a neutral view on that. Around 4% of the respondents have stated that it won't be helpful.	
Question	Would you like to see your academic progress before facing an exam?

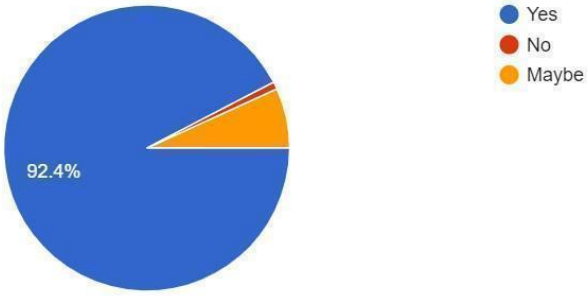
Aim Of Question	Identify if the target population needs to see their academic progress before facing an exam.
Observations	
	Before taking an exam, 92.4% of students would like to see their academic progress, 6.8% of them weren't sure if they want to see it or not, and the remaining 0.8% didn't want to see the progress at all.
Conclusion	
The majority of the respondents to the questionnaire have said that they want to see their progress before facing an exam. A small percentage of the respondents are not sure about the use, and a very small amount stated that they don't need to see the progress. Viewing the progress beforehand boosts up motivation to score more in the examinations, and more people like to use that option.	

Table 4.5: Survey Results

4.6 Summary of findings

Findings	**Literature Review**	**Questionnaire**	**Existing Systems**
Web based models are more loved and used by the users.	X	X	X
There is a void in identifying the subject area in which the students are weak in the specific subject.	X		X

More focus on the weak subject area is needed to score more in exams.	X		
A virtual assistant is needed to get assistance when needed in the application.	X	X	
Viewing the progress before the examination is needed to gain more confidence	X	X	

Table 4.6: Summary of findings

4.7 Context diagram

Identification of the system functions and interactions between the users and the system is a major task. In order to identify these system boundaries and background work of **Learnverse** please refer to the Context diagram given below.

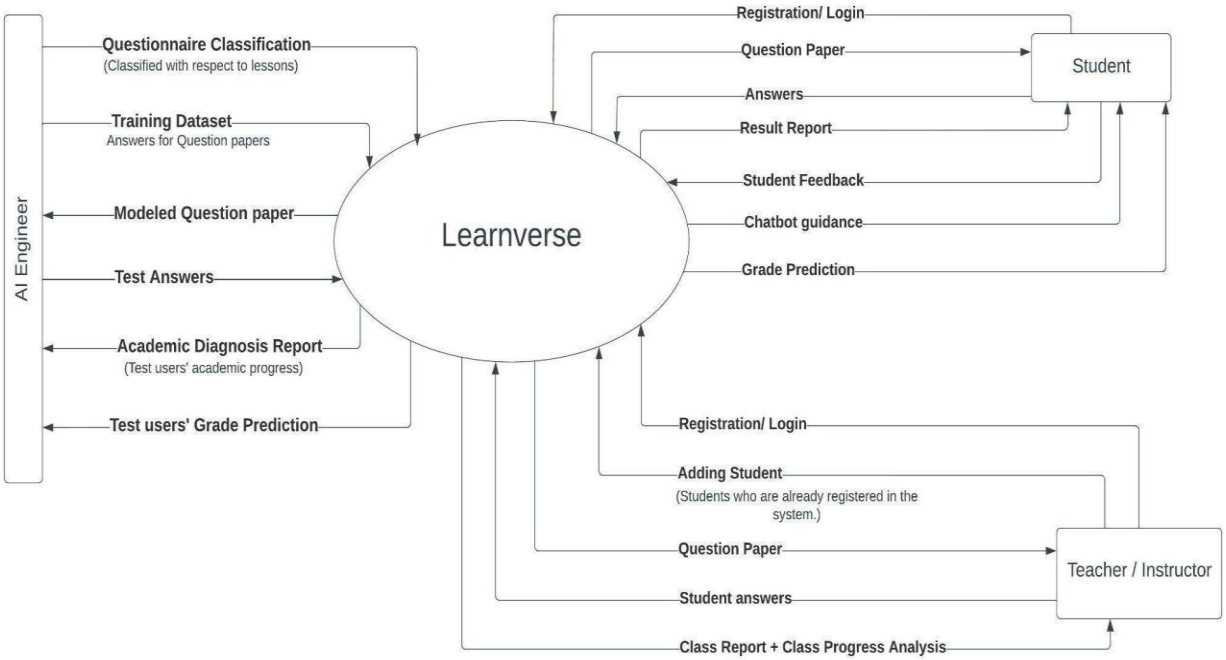


Figure 4.3:Context diagram (Self-Composed)

4.8 Use case diagram

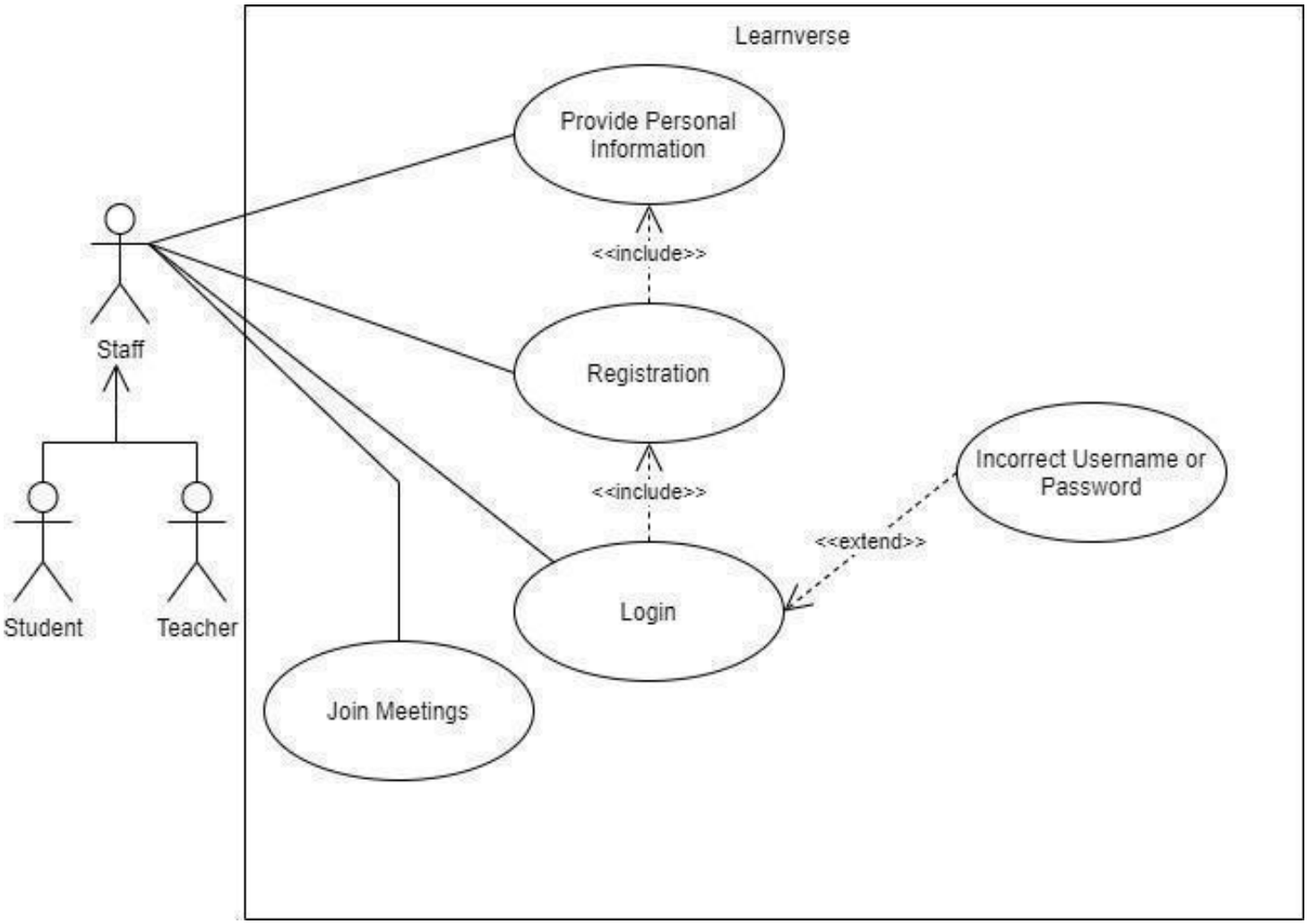


Figure 4.4: Use case diagram 01 (Self-Composed)

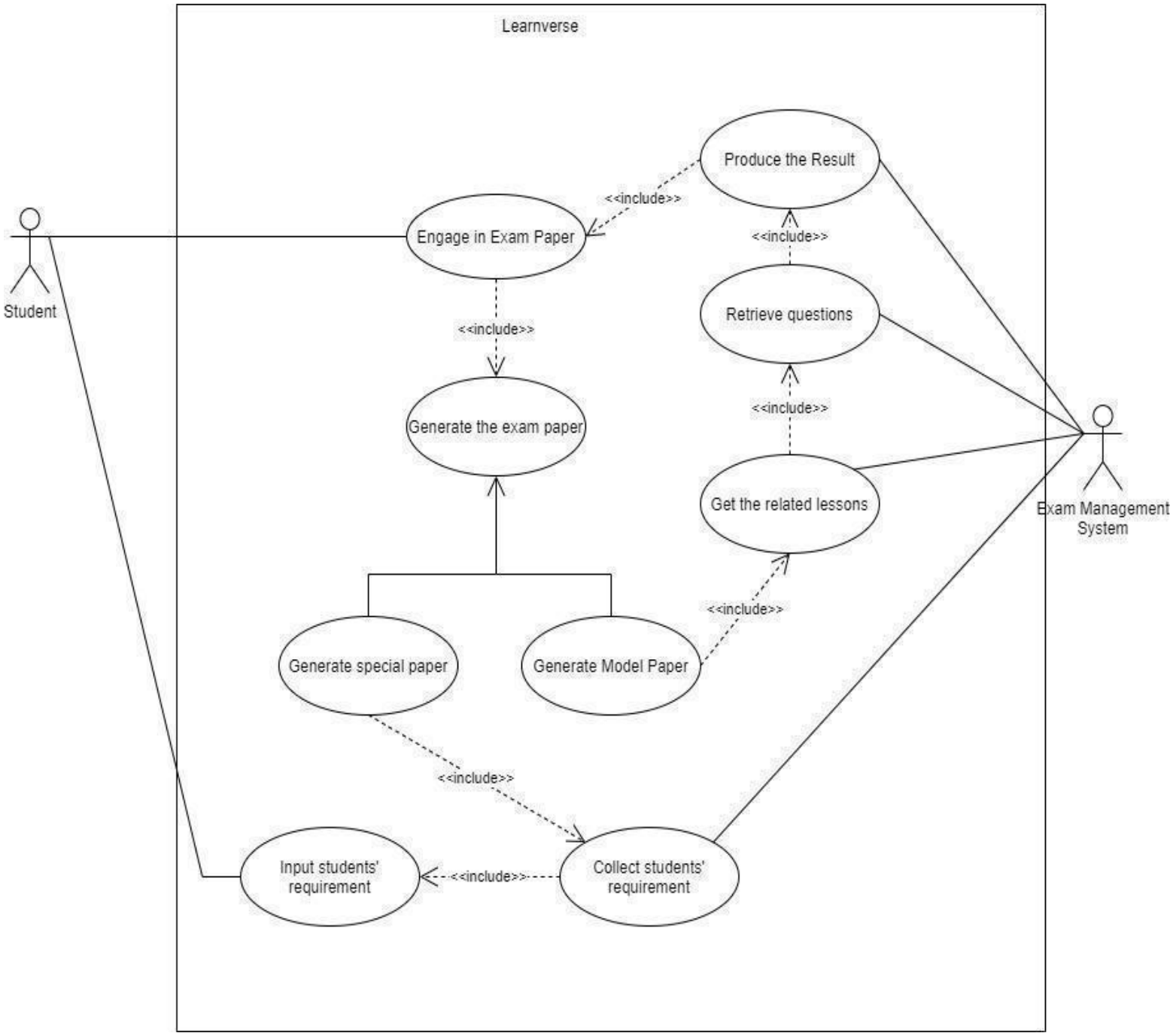


Figure 4.5: Use case diagram 02 (Self-Composed)

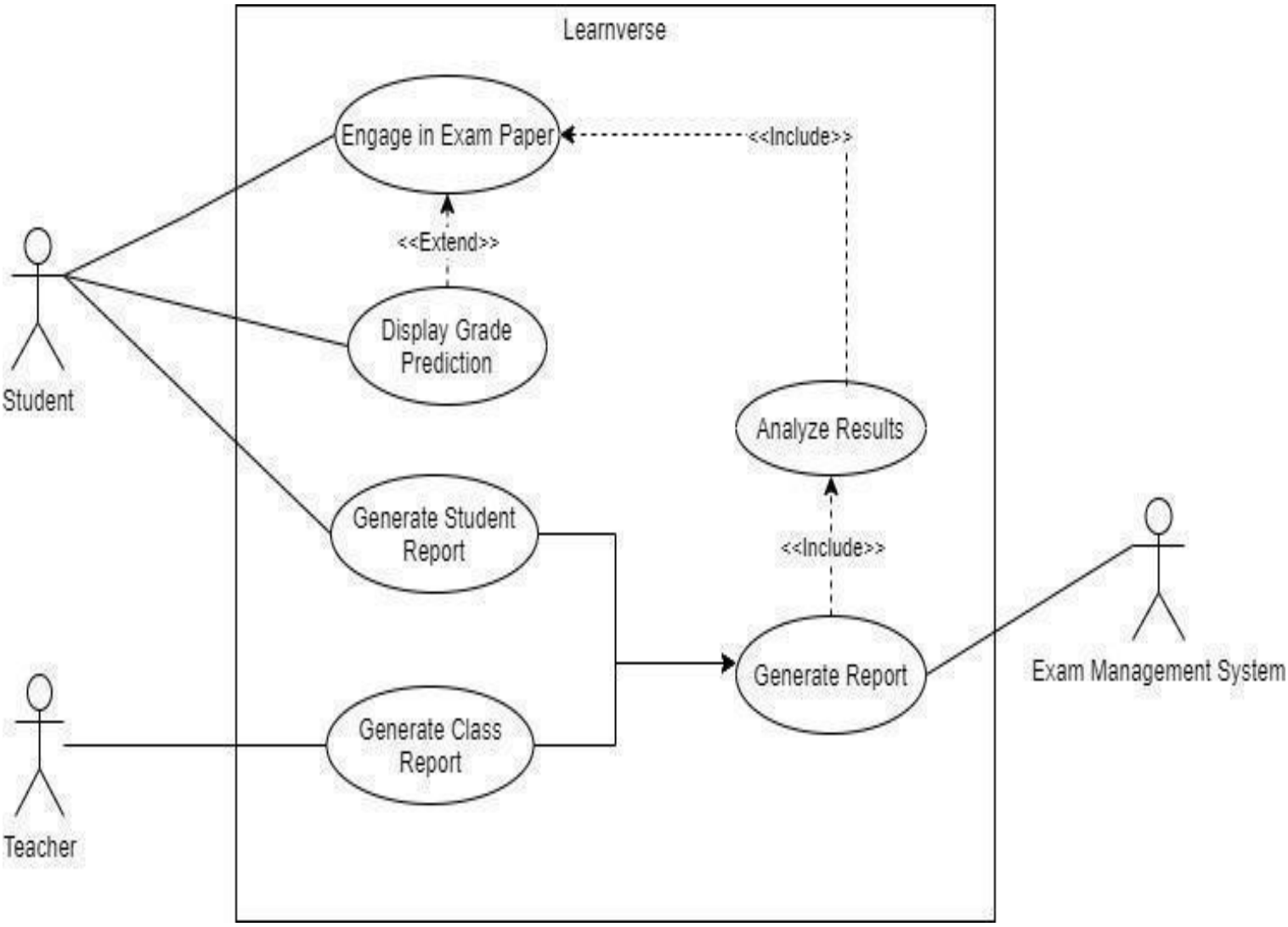


Figure 4.6: Use case diagram 03 (Self-Composed)

4.9 Functional Requirements

The functional requirements of the system are listed in the table below, along with their priority level.

	Requirement and Description	**Priority**
FR01	Accept Personal Information	Critical
	As an input, the device must be able to accept the personal information provided by the user to create a new account.	

FR02	Register user	Critical
	Creating new accounts for users(teachers and students) using their personal information.	
FR03	Login to the system	Critical
	Allowing users to login to the system with the use of username and password.	
FR04	Accept and collect students' requirements	Critical
	As an input, the device must be able to accept students' requirements collected via AI chatbot. These are the lessons which students' need for further improvement.	
FR05	Generating MCQ papers	Critical
	System generates MCQ papers which consist of question - answer pairs along with incorrect answers. System generates MCQ papers under two categories. 1. Generating Model papers: These papers consist of questions which are related to lessons where the student is not performing well. 2. Generating Special papers: These papers consist of questions related to a specific set of lessons requested by the student. Students can pass the lessons they require for further improvement via the AI chatbot.	
FR06	Engage in MCQ papers and produce the result.	Critical
	Allowing students to participate in MCQ papers via the provided interface and generate the score based on performance.	
FR07	Predicting Student grade	Critical
	Generating a prediction of student grade by analysis of results taken from the model tests for his/her Advanced Level examination	
FR08	Generating Student reports	Important

	System generated report for students to check their academic progress.	
FR09	Generating Class reports	Important
	Generate a report for the use of the teacher from the overall analysis of the students in the class to increase the productivity of the virtual classroom.	
FR10	Scheduling Meetings	Critical
	Allowing Teachers to schedule meetings(classroom sessions) on a specific date and time.	
FR11	User Profile	Important
	Allow the users to own a personal dashboard to review their actions	
FR12	Saving answered question papers	Not Important
	Saving the student answered questions in the system to review in the latter time	

Table 4.7: Functional Requirements

4.10 Non-Functional Requirements

Accuracy
When implementing this system, accuracy is a critical component as the students rely on this system to get more accurate predictions. The error or incorrect output leads to degrading the value of the system.

Performance
From the algorithms used to generate questions and suggestions, the model changes its outputs with the user's inputs.

Usability
The user must be able to use all the functionalities (do MCQs, get customized MCQs, use chatterbot, and the virtual classroom) and switch between functionalities easily.

Security
The gathered data of the user must be secured and should not be able to be accessed by a third party.

Reliability and Availability

The system must provide predictions according to the user's performance in the MCQs.

	Requirement and Description	Specification	Priority
NFR01	Higher level of model accuracy is required	Accuracy	Important
NFR02	Model creation, generating questions and suggestions must be done correctly.	Performance	Important
NFR03	The system should be simple enough for ordinary users to use as well.	Usability	Important
NFR04	Data and systems should be protected and restricted from unauthorized access.	Security	Important
NFR05	The system must provide predictions based on user performance.	Reliability	Important

Table 4.8: Non-Functional Requirements

4.11 Chapter Summary

The chapter's introduction gives the explanation of project stakeholders and their involvement. Different approaches were used in research to gather requirements. Then established the system's context and primary use cases. The non-functional and functional needs were collected and ranked based on the use case specification.

CHAPTER 5: SOCIAL, LEGAL, ETHICAL, AND PROFESSIONAL ISSUES

5.1 Chapter Overview

The SLEP analysis is a useful tool for evaluating the various external factors that can affect the development of a product. By taking a holistic view of the larger environment, it allows for a comprehensive understanding of the situation. In the case of the Learnverse project, thorough analysis was conducted on legal, social, ethical, and professional considerations, resulting in effective management of these factors.

5.2 SLEP issues and mitigation

5.2.1 Social Issues

- English shall be the primary language used in the web application since it is an internationally accepted language.
- Data provided by the users shall not be shared with any third parties and only be used within the web application.
- The following web application is an exam preparatory guide, and shall not provide you with questions from the upcoming A/L examination.

5.2.2 Legal Issues

- All the questionnaires used in the web application as datasets are within the copyright rules and regulations.
- Data collected by the users are fully described to them and accepted to our terms and conditions when signing up. No data collected by a user is sent or shared to an external party.
- Related work and research papers used for the literature review was obtained through official sources and the credits were given to their respective authors.
- Terms and conditions of the owners of the APIs' and libraries used in the application are followed.

5.2.3 Ethical Issues

- The user's identity is kept private within the Google forms used for review.
- Predicting multiple-choice questions (MCQs) is related to the assessment's fairness and validity. MCQs are frequently used to assess comprehension and knowledge. But, if the questions are predicted based on incorrect or insufficient data, the evaluation may not truly represent a student's understanding of the subject matter.
- Chatbots can be developed to replicate human communication so successfully that users are unable to recognize that they are conversing with a machine. This raises questions about transparency, as well as the requirement for chatbots to officially identify themselves as such.

- Privacy and confidentiality are important considerations in a virtual classroom. During virtual conversations or chats, students may exchange personal information or discuss sensitive themes, which may be recorded or watched by others. Teachers and administrators must ensure that student information is kept private and confidential

5.2.4 Professional Issues

- The Git and GitHub for version control, and collaboration.
- Official communication was carried out through Emails.
- For faster communication, WhatsApp group chats are used.
- Team collaboration and workflow management is done through Asana application.
- Supervisor meetings were held once a week at a predefined time through Google Meet, and team meetings were held via Zoom twice a week.
- Throughout the development process, the planned deadlines were met.

5.3 Chapter Summary

In this chapter, a detailed examination is provided regarding the social, legal, ethical, and professional issues that are related to the product. It discusses the potential challenges and risks that may arise due to these factors, and outlines the measures taken to mitigate them. By exploring these various issues, it aims to ensure that the product is developed and delivered in a responsible and ethical manner that is compliant with all relevant laws and regulations.

CHAPTER 6: SYSTEM ARCHITECTURE AND DESIGN

6.1 Chapter Overview

In this chapter, you will find the detailed plan and visual representations of the system, which includes the design paradigm, component diagram, class diagram, sequence diagram, UI/UX design, and process flow chart. These illustrations will help you understand the system's structure and how its various components interact with each other.

6.2 Design Goals

The table presented below pertains to the non-functional requirements of the system. This table highlights the system's performance standards and characteristics, such as security,UI/UX, and scalability, rather than its specific functionalities.

Design Goals	**Description**
Website	The website will be developed to be compatible with multiple web browsers. Additionally, the website will be designed to be responsive on desktop devices.
Performance	During model training, the objective is to achieve higher accuracy while also focusing on creating a model with faster inference speed.
Security	Unauthorized parties should not have access to the user's data. For increased security, use two-factor authentication.
Scalability	The website must possess the capability to efficiently incorporate additional functionalities and support a higher number of users as required. Moreover, to ensure the effective management of multiple requests, the AI API endpoint should be integrated with load balancers.
UI/UX	The Website application interfaces will prioritize user-friendliness and incorporate UX techniques like eye movement tracking and accessibility evaluations.

Table 6.1: Design Goals

6.3 System Architecture Design

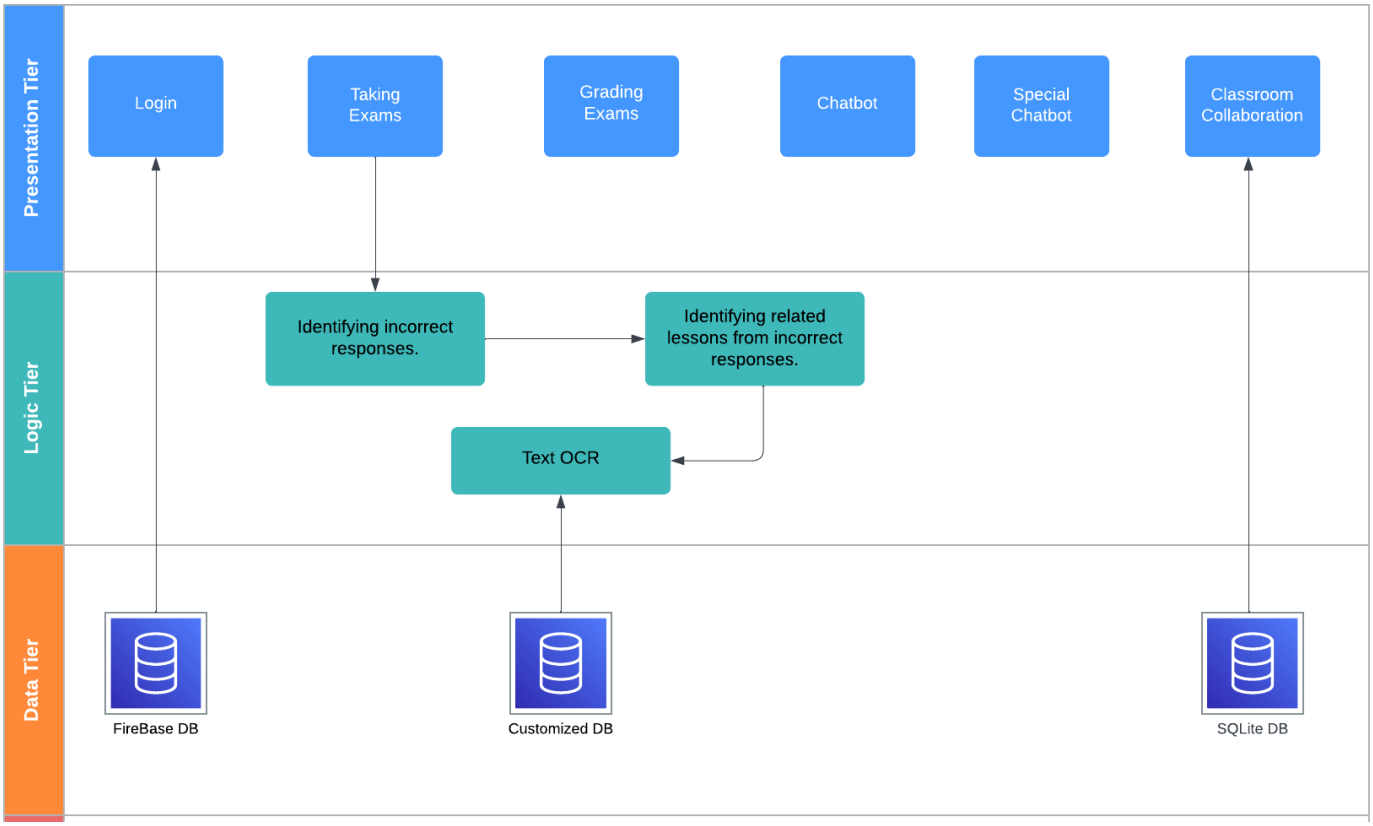


Figure 6.1: System Architecture Diagram

The diagram depicts the architectural layout of a system, which is divided into three main layers, namely the Presentation tier, Logic tier, and Data tier.

1. Presentation Tier:
    a. Login - Enables the users to access the facilities provided by Learnverse.
    b. Taking Exams - Provides the user with exam preparatory questionnaires according to his/her skill levels in subject matter.
    c. Grading Exams - Grading the completed questionnaires and giving a grade prediction for the next exam according to the user's performance.
    d. Chatbot - Provides the users with customary chatbot to aid new users with general information of what Leanverse is and clears doubts.
    e. Special Chatbot - Generates questionnaires from user preferred lessons.
    f. Classroom Collaboration - Provides users (Teacher/Student) with the facility to share resources among other users in a private virtual classroom workspace.
2. Logic Tier:

    The logic tier refers to the section of the system responsible for training the model.

    a. Identifying incorrect responses - The system captures the questions that the user answered incorrectly.

   b. Identifying related lessons from incorrect responses - Lessons related to the incorrect questions collected will be extracted by the system.
   c. Text OCR - The system will provide a set of lessons to the model, which will predict the number of questions the user will answer incorrectly in each lesson.
3. Data Tier:
   a. FireBase DB: A Firebase database will be used to store both the personal information and academic records of the users.
   b. Customized DB: The dataset utilized to predict the number of questions for lessons.
   c. SQLite DB: The purpose of this database is to maintain a separate record of information for teachers and students.

6.4 System Design

System design is an approach that aims to achieve the intended outcomes by satisfying the needs of the end-users. Since software design has its own unique characteristics, it can be categorized into two methodologies:

1. SSADM, which stands for Structured System Analysis and Design Methodology.
2. OOAD methodology, which refers to Object-Oriented Analysis and Design Methodology.

6.4.1 Choice Of Design Paradigm

We have decided to use the Object-Oriented Analysis and Design (OOAD) methodology for our project. OOAD offers more advantages than the Structured System Analysis and Design Methodology (SSADM), which includes consistency and reusability throughout the analysis and design phase.

By following OOAD, we can incorporate various features into our project, making it more robust and flexible. Since our project will use Agile methodology, which is different from the Waterfall methodology that SSADM is based on, using SSADM would not be appropriate.

Moreover, SSADM is more time-consuming compared to OOAD, which could slow down our project's progress. Therefore, OOAD is a more suitable methodology for our project.

6.4.2 Component Diagram

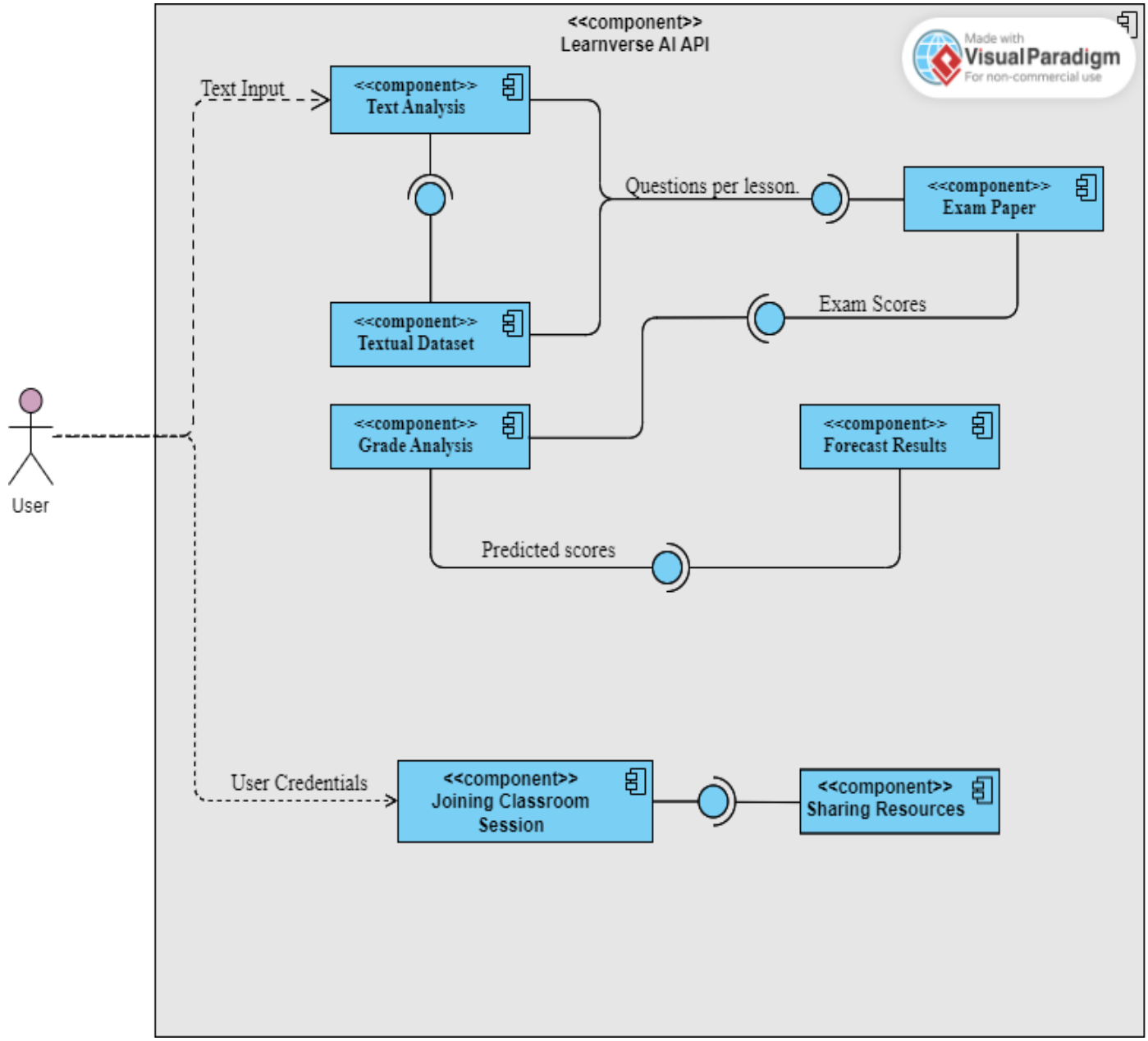


Figure 6.2: Component Diagram

6.4.3 Class Diagram

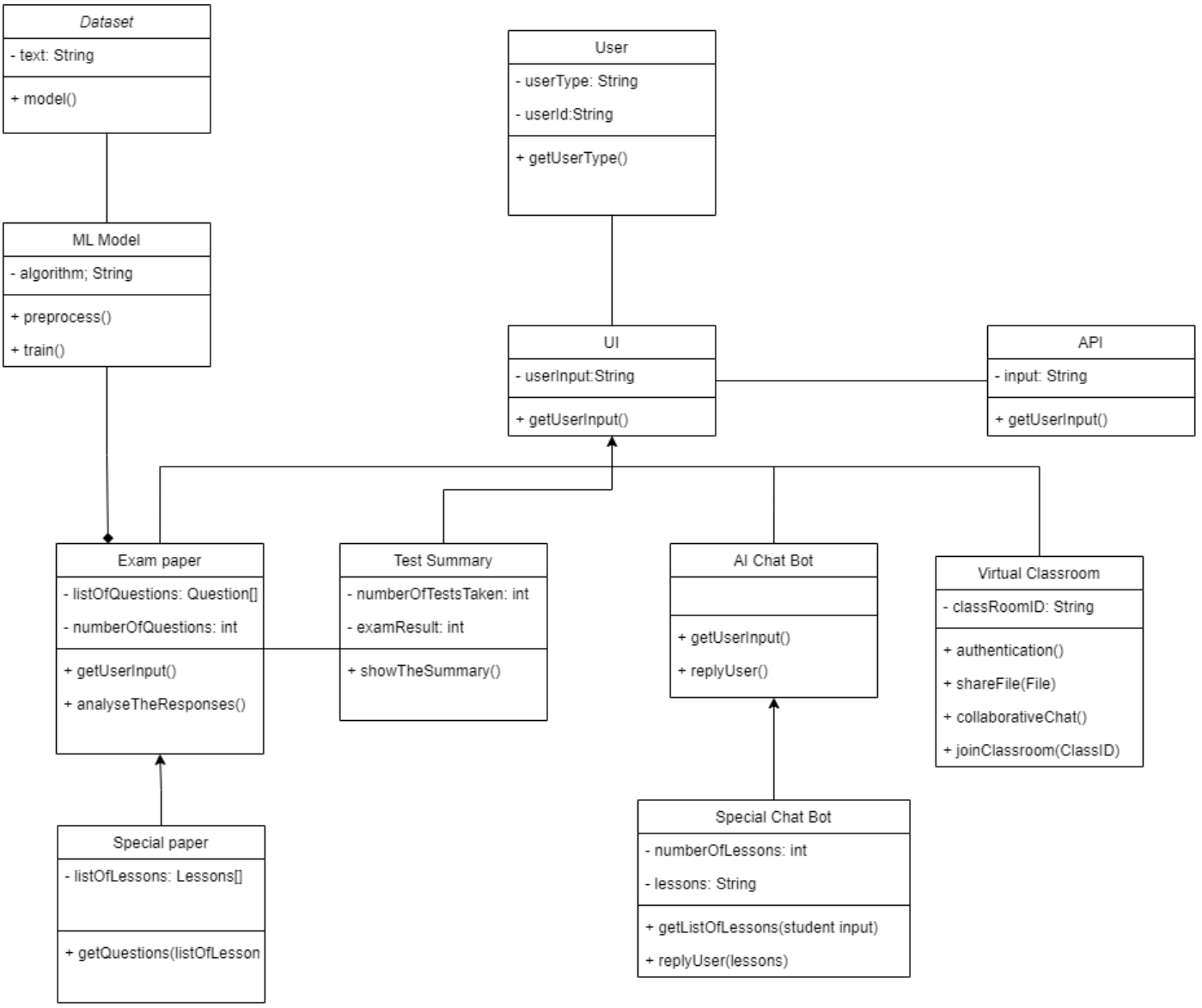


Figure 6.3: Class Diagram

6.4.4 Sequence Diagram

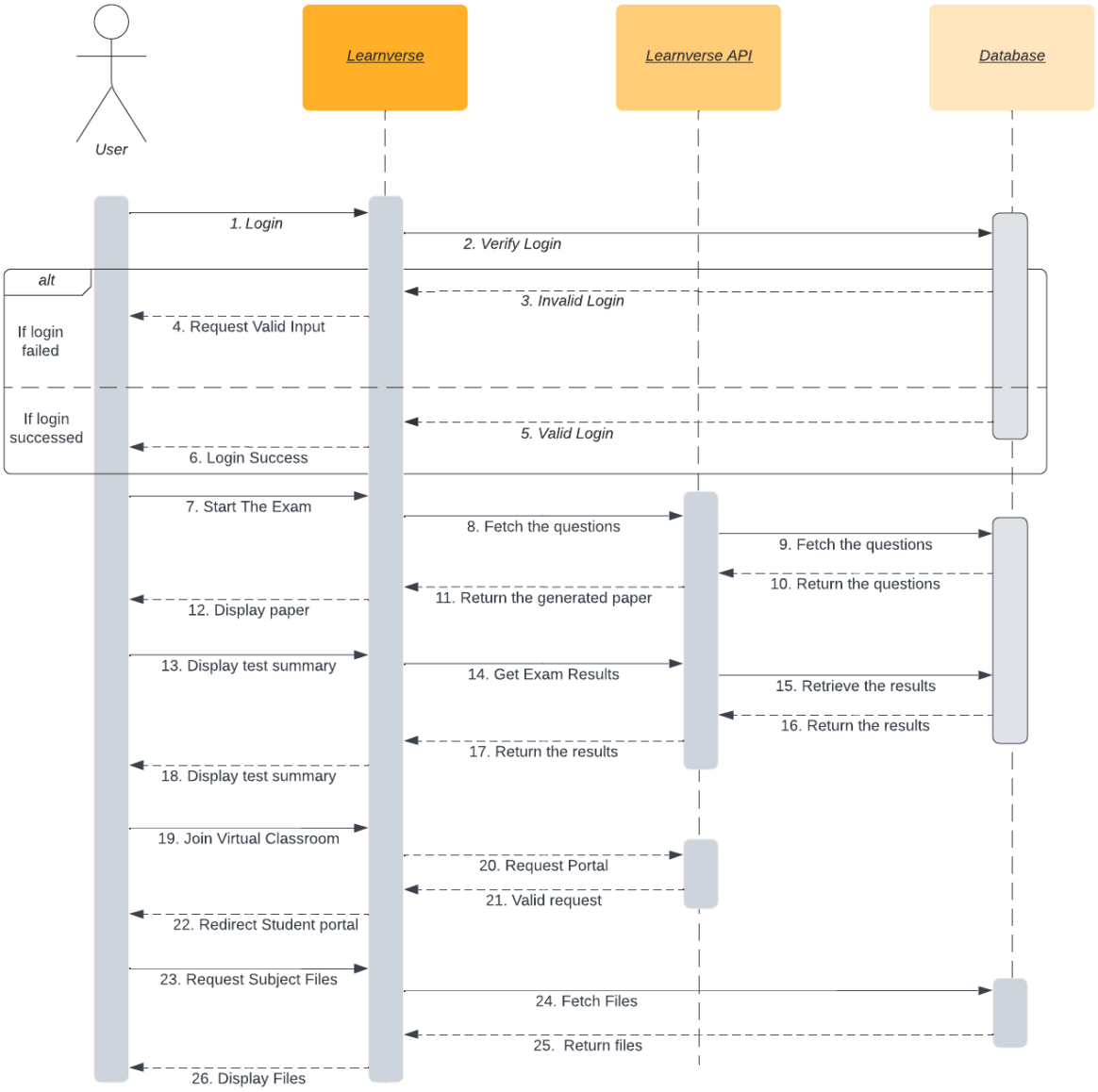


Figure 6.4: Sequence Diagram

6.4.5 UI Design

The system can efficiently interact with the user through inputs and outputs. A high fidelity UI design has been implemented to cover the entire system. Learnverse is a web application that begins by prompting users to login to the system.

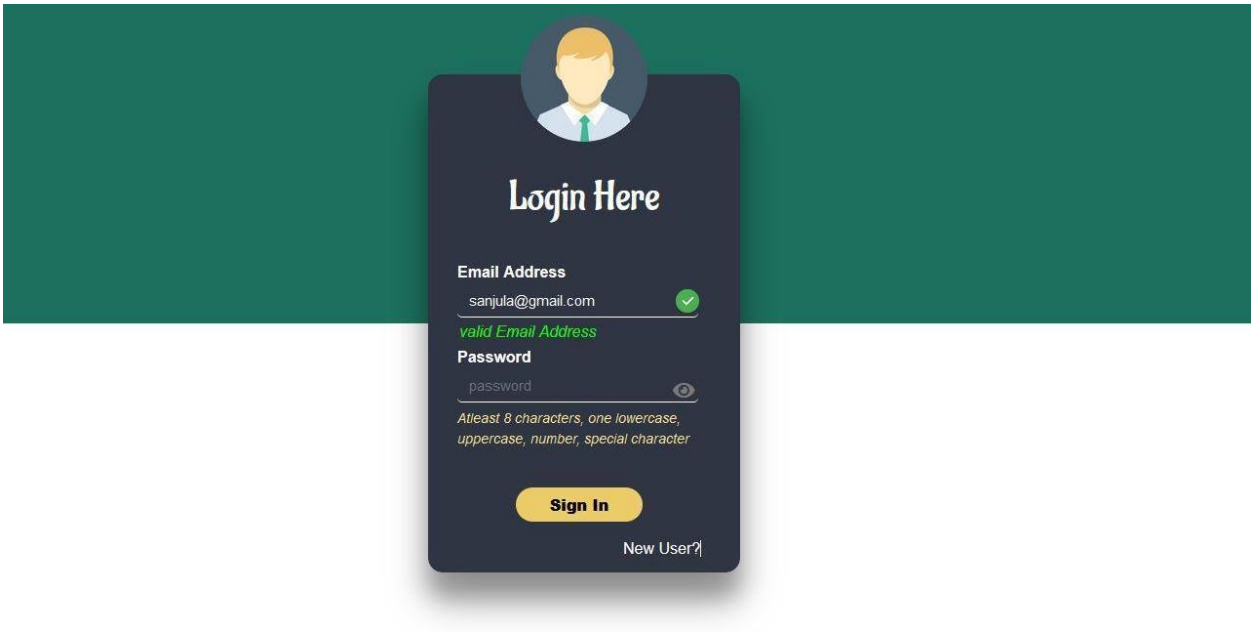


Figure 6.5: Learnverse Web - Login Page

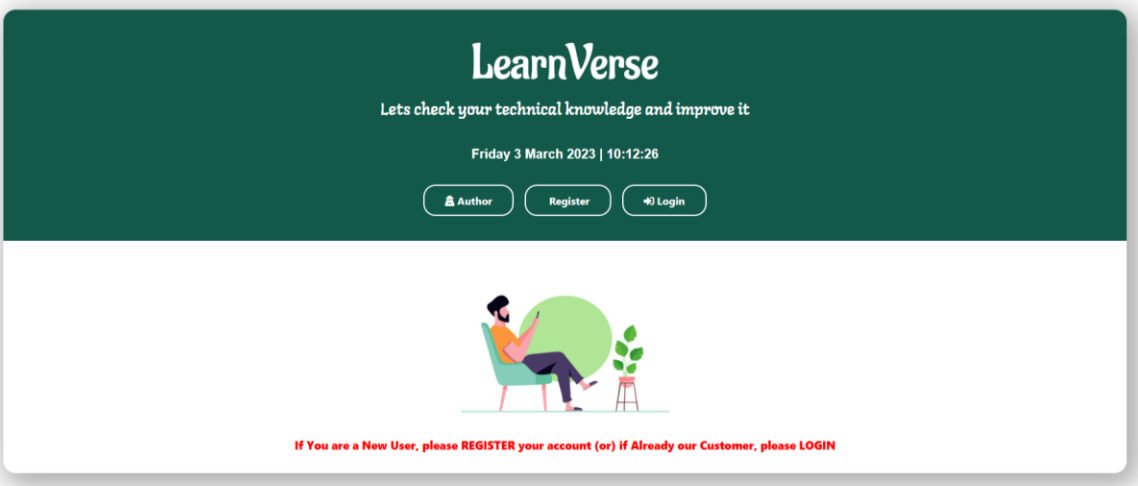


Figure 6.6: Learnverse Web - Landing Page

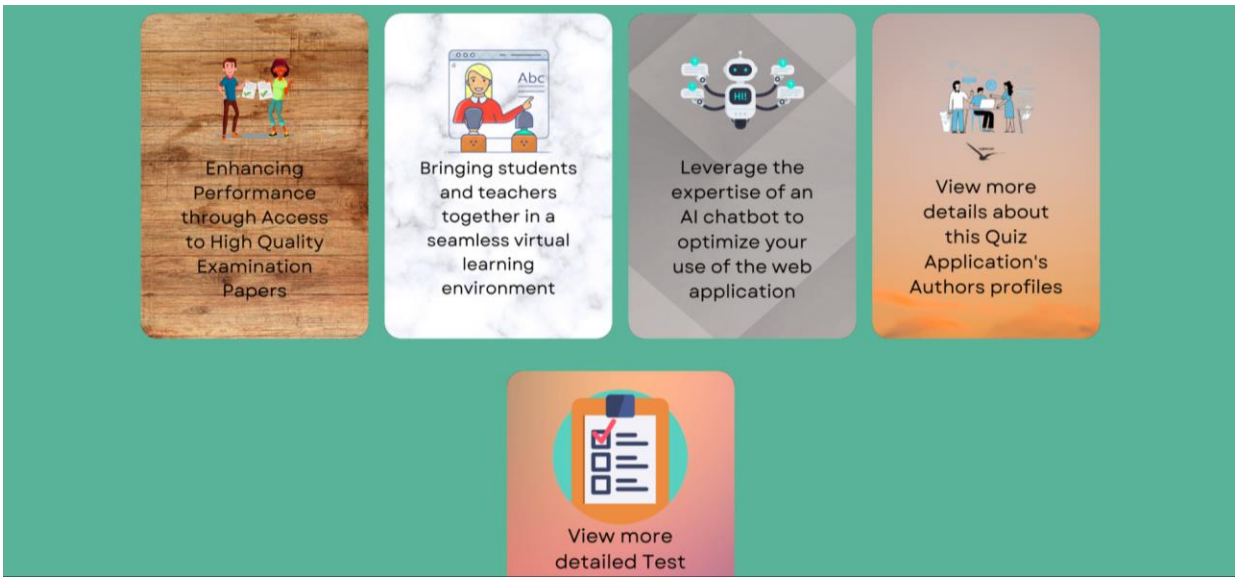


Figure 6.7: Learnverse Web - Home Page

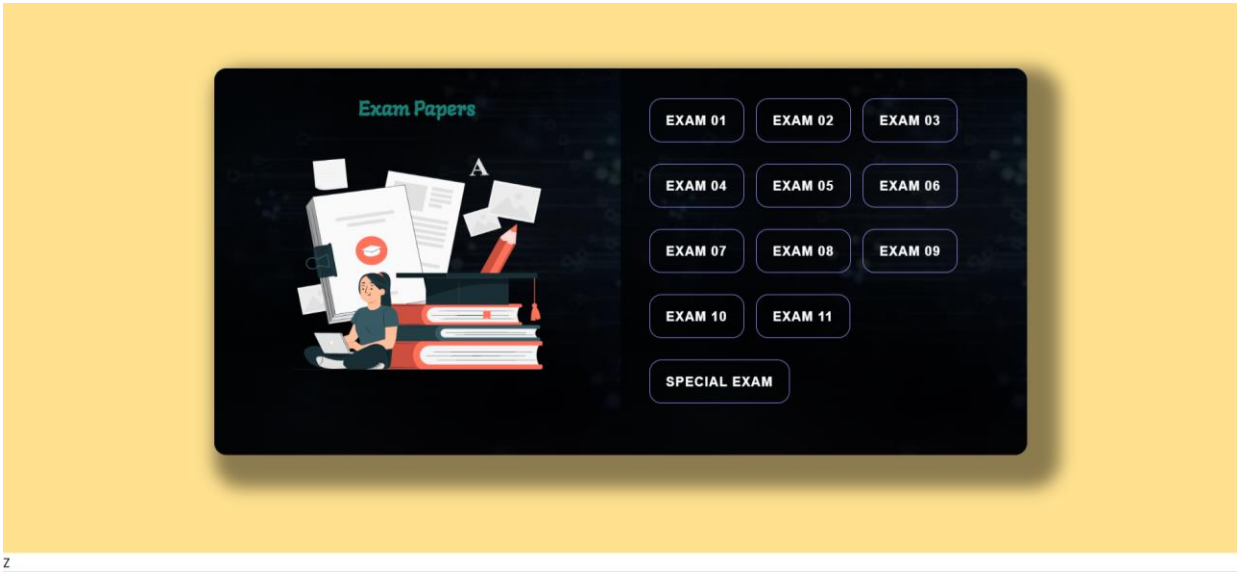
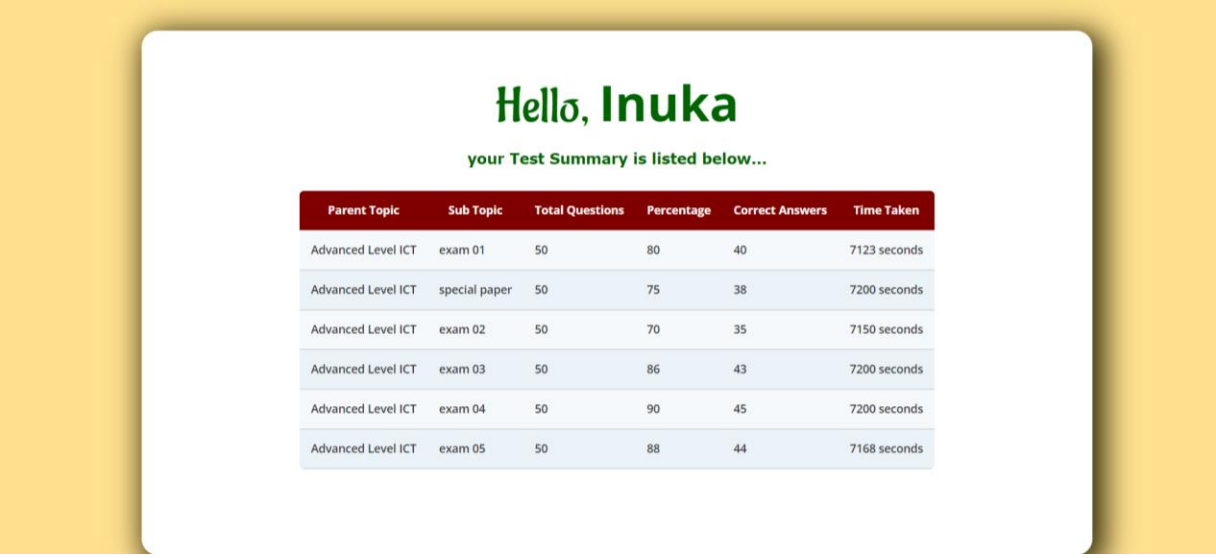


Figure 6.8: Learnverse Web - Exam Paper Selection



Parent Topic	Sub Topic	Total Questions	Percentage	Correct Answers	Time Taken
Advanced Level ICT	exam 01	50	80	40	7123 seconds
Advanced Level ICT	special paper	50	75	38	7200 seconds
Advanced Level ICT	exam 02	50	70	35	7150 seconds
Advanced Level ICT	exam 03	50	86	43	7200 seconds
Advanced Level ICT	exam 04	50	90	45	7200 seconds
Advanced Level ICT	exam 05	50	88	44	7168 seconds

Figure 6.9: Learnverse Web - Test Summary

Figure 6.10: Learnverse Web - Virtual Classroom

6.4.6 Process Flow Chart

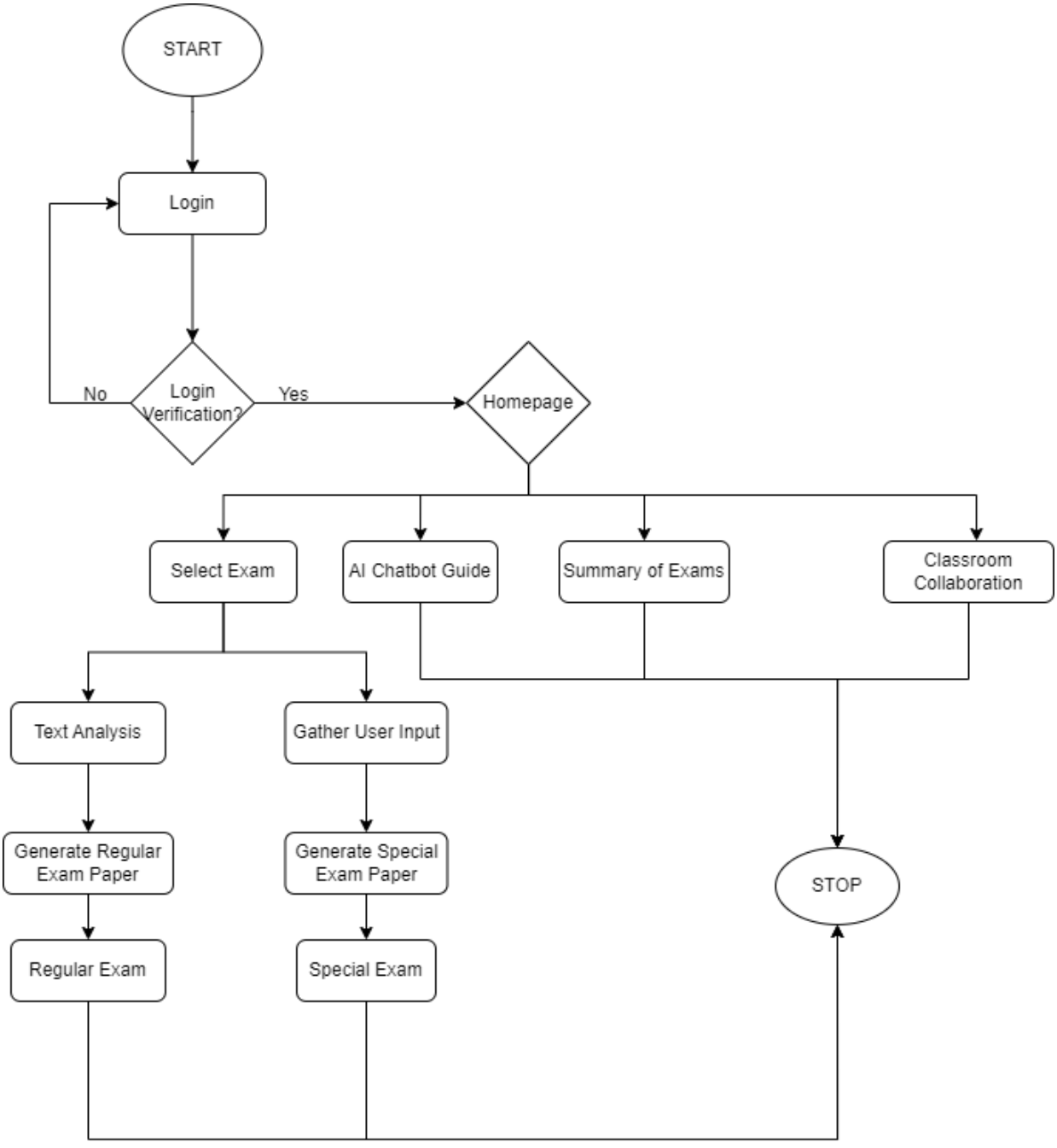


Figure 6.11: Process Flow Chart

6.5 Chapter Summary

As previously mentioned, this chapter has provided an overview of the various design components mentioned above. The component diagram, class diagram, sequence diagram, and UI/UX designs presented above provide a clear illustration of the system's intended design objectives.

CHAPTER 7: IMPLEMENTATION

7.1 Chapter Overview

This section will focus on examining the primary languages and tools that were employed in the creation of Learnverse. We will delve into the technology stack and explore the data selection methodologies that were utilized, as well as discuss the languages and frameworks that were employed throughout the project's development.

7.2 Technology Selection

7.2.1 Technology Stack

Figure 7.1: Technology Stack

We used several technologies to build the Learnverse web application. Jupyter was used for building the AI model, HTML, CSS, and JS were used for the front-end, Flask for the back-end, and Firebase and SQLite were used for databases. RASA was used for implementing the chatbot.

7.2.2 Data Selection

One of the critical steps in building robust AI models is selecting the appropriate dataset.To ensure that our AI model is trained with the most relevant and useful data, we conducted a thorough analysis of literature and other relevant projects. However, after an extensive search, we were unable to find any suitable datasets that fit our project's specific requirements. As a result, we

decided to create our own dataset that would be used in training our model. This dataset was carefully curated to meet the unique needs of our project and to ensure that our model is trained with the most relevant data available. We believe that this approach will result in a more accurate and effective AI model that will produce the best results possible for our users.

Domain	Dataset	Description
Exam Paper Generation from Student Performance	Standardized Test Assessment Dataset	The dataset consists of 1000+ records extracted from past papers and exam records of students in different subjects. It includes columns for related lessons, number of incorrect answers in a particular lesson, and the predicted number of incorrect answers in future exams. This dataset was created by our team to train an AI model for educational purposes. Link to the dataset: https://drive.google.com/file/d/1KekGcpc99ktDz3c_V8UEW7aYeHsuYRfA/view?usp=sharing

Table 7.1: Datasets

7.2.3 Selection Of Development Framework

7.2.3.1 Frontend

Our web application was built using a range of frontend technologies to deliver a robust and engaging user experience. Specifically, we utilized HTML to structure the content of our web pages, CSS to style the pages and create an attractive visual layout, and JavaScript to create dynamic and interactive features for the application. In addition to these technologies, we leveraged the jQuery framework to streamline development and enhance user interactivity. By incorporating jQuery, we were able to take advantage of pre-built functions and features, making it easier to manipulate the HTML DOM, handle events, create animations, and more. The combination of these frontend technologies allowed us to develop a user-friendly and intuitive web application that meets the needs of our users.

7.2.3.2 Backend

In this context, Flask is used to host the AI models and create an API for both the web frontend and the backend. An API allows two different systems to communicate with each other. In this case, the Flask API acts as a bridge between the web frontend and the backend (where the AI models are hosted). By using Flask, the AI model pipelines can be easily integrated into the system. Flask is known for being flexible and easy to develop, which means that developers can quickly

create web applications without the need for complex configurations or setup. This makes it an ideal choice for hosting AI models and creating APIs that can be used by other systems.

7.2.4 Programming Language

The main programming language used in the development of the 'Learnverse' web application is python assisted with javascript, html and css. Here flask-a python framework is used for the integration of the main components of the application. Reason behind using flask is the scalability of the framework where it can be used to build and integrate a web application efficiently.

Python is also used in building and training the AI models of the application, the fact that python allows the use of many libraries and frameworks that supports data science projects is the reason for using it for the following component.

For the development of the chatbot python is used as the main programming language assisted by Rasa framework. The major reason for choosing Rasa is that it is an open-source framework which is designed specially to build and train more sophisticated chatbots using natural language understanding (NLU) and dialogue management (DM) capabilities.

7.2.5 Libraries

We utilized multiple libraries to implement the system's core functionalities and summarized in a table below.

Libraries	**Version**
Web Application	
Flask	2.2.2
Flask-SQLAlchemy	3.0.2
importlib.resources	5.1.0
Rasa Core	0.8.6
Rasa NLU	0.11.5
Rasa SDK	3.4.0
Jinja2	2.11.2

Werkzeug	1.0.1
AI Models	
pandas	1.1.5
numpy	1.21.6
Scikit Learn	1.0.2
Seaborn	0.12.2
Matplotlib	3.5.3
NLTK	3.6.7
Jupyter	1.0.0

Table 7.2: Libraries

7.2.6 IDE

PyCharm- Since the overall application is based on python the developers have used PyCharm as the main IDE for development. This has allowed the developers to code the project contributing in one GIT repository by working on different branches at ease. Other than that PyCharm has allowed the developers to version the packages they have used in the application in their virtual environment.

Jupyter Notebook- was used in building and tanning the AI models since it allows the developers to run the code in sections so that debugging becomes much easier.

7.2.7 Summary Of Technology Selection (Tabular Format)

Component	**Tool/Technology**	**Version**
Programming Language	Python	3.7.6
	Javascript	-
IDE	PyCharm	2022.2.4
	Jupyter Notebook	1.0.0

Table 7.3: Technology Summarization

7.3 Implementation of Core Functionalities

7.3.1 Exam Paper Generation from Student Performance

7.3.1.1 Regular Paper Generation

The primary objective of this component is to use predictions to estimate the number of questions a student may get wrong in a particular lesson/lessons and create exam papers based on those predictions.

Pseudo code:

```
BEGIN

IMPORT Numpy, Pandas, Matplotlib, Seaborn, Scikit-learn, Statsmodels
SET df to pd.read_csv("table_to_train_the_model.csv")
PRE-PROCESS the dataset:
        REMOVE rows with missing values
        REMOVE punctuations and extra white spaces
        CONVERT letters in the "Related Lesson" column to lowercase:
                df['Related Lesson'] ← df["Related Lesson"].str.lower()
        CORRECT spelling errors in the "Related Lesson" column using a spellchecker library:
                function correct_spelling(text):
                   SET corrected_text to list
                   misspelled_text ← spell.unknown(text.split())
                   for word in text.split():
                      if word in misspelled_text then,
                         corrected_text.append(spell.correction(word))
                      else:
                         corrected_text.append(word)
                      end if
                   end for
                   return " ".join(filter(None,corrected_text))
                df['Related Lesson'] ← df['Related Lesson'].apply(lambda x: correct_spelling(x))

SET X to df[ [ "RelatedLesson","no_of_occurance" ] ]
SET y to df[ [ "no_of_occurance_future"] ]
SPLIT the dataset to test and train:
        X_train, X_test, y_train, y_test ← train_test_split(X, y, test_size = 0.2, random_state =
0)
CREATE dummy columns for the categorical columns:
```

```
        X_train ← pd.get_dummies(X_train,
                columns = ["RelatedLesson"],
                drop_first = True)

        X_test ← pd.get_dummies(X_test,
                columns = ["RelatedLesson"],
                drop_first = True)
```

SCALING the features:

```
        CALL the function StandardScaler , substitute the result for standardScaler
        CALL the method standardScaler.fit(X_train)
        X_train ← standardScaler.transform(X_train)
        X_test ← standardScaler.transform(X_test)
```

TRAIN the model:

```
        CALL the function LinearRegression , substitute the result for linearRegression
        CALL the method linearRegression.fit(X_train, y_train)
        y_pred ← linearRegression.predict(X_test)
```

EVALUATE the model:

```
        SET score to r2_score(y_test, y_pred)
        SET error to mean_squared_error(y_test,y_pred)
        PRINT "The accuracy of the model is " , score
        PRINT "The Mean Absolute Error of our model is", error
```

Function useModel(lessonName, noOfQuestionsAnsweredIncorrectly)

```
        SET df1 ← pd.read_csv('table_to_use_in_the_model_for_prediction.csv')
        df1.loc[len(df1.index)] ← [lessonName,noOfQuestionsAnsweredIncorrectly]
        SET indexNum ← len(df1.index)-1
        CREATE dummy columns for the categorical columns:
                df1 ← pd.get_dummies(df1, columns = ["RelatedLesson"], drop_first = True)
        df1 ← standardScaler.transform(df1)
        return numpy.round(linearRegression.predict(df1)[indexNum])
```

CREATE a FLASK endpoint that use the useModel function:

```
        Function get_questions_for_the_paper(listOfIncorrectQuestions):
        # listOfIncorrectQuestions is a variable that stores questions which was answered
        incorrectly by the student in previous papers
          SET predictionResult to list
```

```
        for i ← 0 to len(listOfIncorrectQuestions):
            lessonName = listOfIncorrectQuestions[ i ].lessonName
            noOfIncorrectQuestions = listOfIncorrectQuestions[ i ].noOfIncorrectQuestions
            Prediction = useModel(lessonName ,noOfIncorrectQuestions  )
            predictionResult.append(Prediction)
        END for
        SET listOfQuestions to list
        listOfQuestions ← FETCH questions from the database based on the predictionResult
        return listOfQuestions
```

When the user selects an exam paper, FLASK API endpoint will get called and the questions returned will get displayed.

END

7.3.1.2 Special Paper Generation

The purpose of the code is to create a chatbot interface that enables users to provide a list of lessons from which they want to receive questions. The chatbot then sends an AJAX request to a server to retrieve the exam paper containing the requested questions and displays it to the user. This functionality can be useful for students who want to quickly access exam questions from specific lessons.

Pseudo code:

```
BEGIN
DISPLAY("Enter one or two lesson numbers: ")
SET papers ← INPUT()

CONVERT user input to lesson text:
   function getLessonText(papers)
    SPLIT the user input into an array of numbers:
        SET numbers ← papers.split(/[ ,]+/).map(Number);

    CREATE an empty list to store the text:
        SET lessonTextList to list

    ITERATE through the array of numbers and add the respective text to the list:
        numbers.forEach(number => {
```

```
            switch(number) {
              case 1:
                lessonTextList.push("introduction to computer"); break;
              case 2:
                lessonTextList.push("concept of it"); break;
              case 3:
                lessonTextList.push("data representation"); break;
              case 4:
                lessonTextList.push("data communication and networking"); break;
              case 5:
                lessonTextList.push("database management"); break;

               REPEAT until case 14 with corresponding lesson names

              default:
                break;
            }
    });
CREATE a FLASK endpoint:
        function get_questions_for_specialPaper():
                SET listOfLessons ← lessonTextList
                Result ← jsonify(FETCH questions from DB based on listOfLessons)
                return Result

SEND AJAX request:
        MAKE an AJAX request to the get_questions_for_specialPaper endpoint
                if function(response) is SUCCESS then
                        # response is an object that contains list of questions for the special
paper
                        localStorage.setItem('listOfQuestions',JSON.stringify(response))
                        GENERATE the special paper from the response
                end if

DISPLAY user input:
   function showUserMessage(message, datetime):
      renderMessageToScreen({
        SET text← message,
        SET time← datetime,
        SET message_side← 'right',
      });
```

```
    showUserMessage(papers)
DISPLAY bot message:
   function showBotMessage(message, datetime):
        setTimeout(function() {
           renderMessageToScreen({
                SET text← message,
                SET message_side← 'left',
           });
        showBotMessage("Your paper has been generated successfully and is now available
        for viewing. You can access it by using the URL provided below.
        http://127.0.0.1:5000/specialPaper ");
END
```

7.3.2 Exam Result Prediction from Test Summary

The result prediction component is used to verify student grades according to previous exam scores.

Pseudo code:

Predicting the grade from past exam Score

```
BEGIN
exam_scores = []
onAuthStateChanged(user):
IF user is not None:
FOR doc in Firestore collection with user's uid:
ADD percentage value from doc to exam_scores
PRINT "Number of percentages:", length of exam_scores, "\nPercentages:", exam_scores
CALL addScore()
FUNCTION addScore():
IF exam_scores:
CALL calculateAverage()
FUNCTION calculateAverage():
avg_score = round(sum(exam_scores) / len(exam_scores), 2) if exam_scores else 0
PRINT "Average Score:", avg_score CALL predictResult(avg_score)
FUNCTION predictResult(avg_score):
result = "A+" if avg_score >= 90 else "A" if avg_score >= 75 else "B" if avg_score >= 65 else
"C" if avg_score >= 55 else "D" if avg_score >= 40 else "E" if avg_score >= 35 else "F"
PRINT "Predicted Result:", result
END
```

7.3.3 Virtual Classroom Implementation

The Virtual Classroom is a component in the Learnverse application which allows students and teachers to interact with each other and aid the students in developing their academic skills prior to the exams.

Sign Up to the Virtual Classroom.

```
Begin
function vc_signup_as_teacher():
    if the HTTP request method is 'POST':
        retrieve the submitted form data

        username = the submitted username
        email = the submitted email
        password = the submitted password
        confirm_password = the submitted confirm password

        is_teacher = set is_teacher flag to True
        is_student = set is_student flag to False
        is_active = set is_active flag to False
        is_superuser = set is_superuser flag to False
        is_staff = set is_staff flag to False

        if password is equal to confirm_password:
            create a new User object
            set the attributes of the User object
            register the new User object
            register the new teacher using the username
            return the login page

        else:
            return "Passwords do not match."
    else:
        return the teacher signup page


function create_user(username, email, password, confirm_password, is_student,
is_teacher, is_active, is_superuser, is_staff):
    create a new User object
    set the attributes of the User object
```

```
    return the User object

function register_user(user):
    add the user to the database

function register_teacher(username):
    add the teacher to the database
```

Log In to the page

```
function vc_login():
    if the HTTP request method is 'POST':

        retrieve the submitted form data
        username = the submitted username
        password = the submitted password

        retrieve the user from the database by the username
        if the user exists and the password matches the hashed password in the database:
            log the user as active
            if the user is a student:
                retrieve the student id
                retrieve the list of classrooms the student is enrolled in
                for each classroom, retrieve the classroom details and add to a list of Student_rooms
                close the database connection
                return the student dashboard template with the list of classrooms
            else:
                retrieve the teacher id
                retrieve the list of classrooms the teacher is teaching
                close the database connection
                return the teacher dashboard template with the list of classrooms
        else:
            return "Invalid username or password."
    else:
        return the login page
```

Creating new class (Teacher)

```
function create_class():
    if the HTTP request method is 'POST':

        retrieve the submitted form data
        name = the submitted name
        unit = the submitted unit
        details = the submitted detail

        generate a random code for the classroom
        create a new Classroom object with the retrieved data
        initialize the classroom in the database

        retrieve the current user's ID and the list of classrooms they are teaching
        create a database connection and cursor
        execute a SELECT query to retrieve the classrooms taught by the user
        fetch all the rows and store them in a variable
        close the database connection
        return the teacher dashboard template with the list of classrooms

    else:
        return the create classroom form template
```

Viewing the classroom(Teacher)

```
function view_class(id):
    set classroom_id to id

    create a database connection and cursor
    execute a SELECT query to retrieve the classroom with the given ID
    fetch all the rows and store them in a variable
    close the database connection

    retrieve the current user's ID
```

```
        retrieve the posts for the given classroom ID
```

Join Classroom(Student)

```
function join_class():
    create a global variable named room_id

    if request method is POST:
        retrieve the code submitted through the form
        retrieve the current user
        check if the code submitted matches the code for any classroom

        if the code is valid:
            create a database connection and cursor
            execute a SELECT query to retrieve the classroom with the given code
            fetch all the rows and store them in a variable
            close the database connection

            for each row retrieved:
                store the corresponding room ID in the room_id variable
            retrieve the posts for the given classroom ID
            return the template for the single classroom view with the retrieved data

        else:
            display a flash message saying that the code is invalid

    return the template for the student dashboard
```

Logging out

```
function vc_logout():
    call models.Log_deactive()
    Set is_active = false

    return render_template('register/login.html')
```

7.3.4 AI Chatbot Guide

Running the bot

```
BEGIN
  RUN the trained bot model
  WHILE the bot is running
    GET the user_input
    SET intent,entities <- NLU_model(user_input)
    SET response <- dialogue_management(intent,entities)
    SET response2user<- response_generation(response)
    DISPLAY the response2user to the user
END
```

NLU model – intent recognition and entity extraction

```
BEGIN

  FUNCTION NLU_model(user_input):
    run intent_recognition(user_input)
    run entity_recognition(user_input)
    RETURN intent,entities

  FUNCTION intent_recognition(user_input):
    PROCESS the user_input
    recognize the intent
    RETURN intent

  FUNCTION entity_extraction(user_input):
    check for entities.
    WHILE there are no entities:
      IF there is an entity:
        extract the entity
        add the entity to list entities
      ELSE
        continue:
    RETURN entities

END
```

Dialogue management

```
BEGIN

  FUNCTION dialogue_management(intent,entities):
    IMPORT predefined dialogue management rules
    check for the matching dialogue management rules
    SELECT the suitable response
    Return response

END
```

Response Generation

```
BEGIN

 FUNCTION response_generation(response):
  generate a suitable response to send to the user
  RETURN response_to_the_user

END
```

7.4 Chapter Summary

In this chapter, we provided an overview of the technology stack that was utilized in the development of Learnverse. We also presented pseudocode examples of the primary functionalities of the system, which helped to provide a general understanding of how the system operates.

CHAPTER 8: TESTING

8.1 Chapter Overview

This chapter is focused on testing the product to ensure that it functions correctly and meets the expected requirements. The chapter starts by explaining the testing objectives and goals, which will provide a clear understanding of what needs to be achieved during the testing phase. The testing is carried out on each feature of the product, one by one, after they have been implemented. Finally, the chapter concludes by presenting the results of the testing, which will give an overall view of the success of the testing phase and whether the product meets the required standards.

8.2 Objectives and Goals of Testing

The aim of testing is to ensure whether the implemented system meets all the functionalities and requirements. The following are the main functionalities that have to be tested in order to achieve the best results.

- Testing the quality and performance of the code implemented.
- Testing for bugs and errors which were undetected during the development.
- Testing whether the system has satisfied all the functional and non-functional requirements.

8.3 Testing Criteria

The following are the testing criteria used to ensure the robustness and the reliability of the system.

- Functionality: This helps to test whether the system performs all the functions it is designed to do correctly and reliably.
- Security: This checks if the project is secure and protected from unauthorized access.
- Performance: This is to check whether the system is fast and responsive depending on the scalability.
- Maintainability: Checks whether the project is easy to maintain, with clear and organized code and documentation.

8.4 Module Evaluation

8.4.1 Evaluation Metrics:

- **R2 Score:**

$$R\hat{}2\ Score\ =\ 1-\ \frac{SSres}{SStot}$$

Equation 1: R2 Score

  - **R^2 Score =** proportion of the total variation in the dependent variable that can be explained by the independent variables (measures how well the regression model fits the data)
  - **SSres** = sum of squares of the residuals (the difference between the predicted and actual values)
  - **SStot** = total sum of squares (the difference between the actual values and the mean of the dependent variable)

- **Mean Absolute Error:**

$$\mathrm{MAE}\ =\ \frac{1}{\mathrm{n}}\times\sum\ |\ \mathrm{yi}-\mathrm{xi}\ |$$

Equation 2: Mean Absolute Error

  - **Mean Absolute Error (MAE) =** average absolute difference between the predicted and actual values (provides a measure of how far the predicted values are, on average, from the actual values)
  - **n** = number of observations or data points
  - **yi** = predicted value for the ith observation
  - **xi** = actual value for the ith observation
  - **Σ** = summation symbol indicating to sum over all the observations

- **Mean Squared Error:**

$$\mathrm{MSE}\ =\ \frac{1}{\mathrm{n}}\times\sum\ (\mathrm{yi}-\mathrm{xi})^2$$

Equation 3: Mean Square Error

  - **Mean Squared Error (MSE) =** average squared difference between the predicted and actual values (provides a measure of the average squared distance between the predicted and actual values)
  - **n** = number of observations or data points
  - **yi** = predicted value for the ith observation

- **xi** = actual value for the ith observation
- **Σ** = summation symbol indicating to sum over all the observations

8.4.2 Student Performance Prediction for The Exam Paper Generation

- **Checking if the model is overfitted or under fitted using the learning curve:**

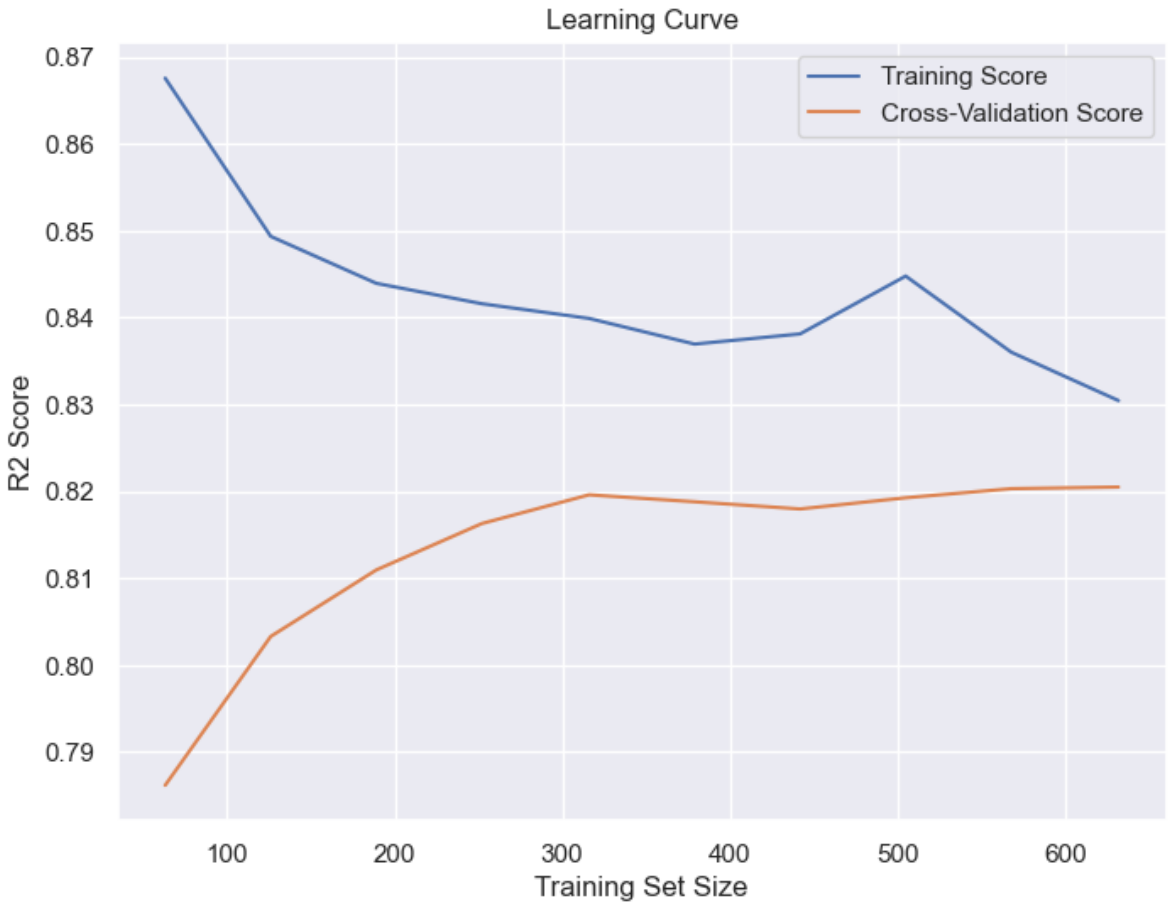


Figure 8.1: Learning Curve

- **Conclusion:** This model has a training score and cross-validation score that are both high and close together, and the gap between the two scores are minimal. Therefore, this model is an ideal model.

Test Proportion - 20% of the Data
R^2 Score - 0.762
Mean Absolute Error - 2.087
Mean Squared Error - 7.638

8.4.3 AI Chat bot

- **Rasa Core model test report**

  Correct: 35 / 35
  F1-Score: 1.000
  Precision: 1.000
  Accuracy: 1.000
  In-data fraction: 0
  Failed test stories: 0

- **Rasa NLU model test report**

  - **Intent confusion matrix**
  - The vertical axis depicts the true table, while the horizontal axis shows the predicted table.
  - The true table shows the original data that are in the training data, and for the predicted table is the data that are predicted by the model.

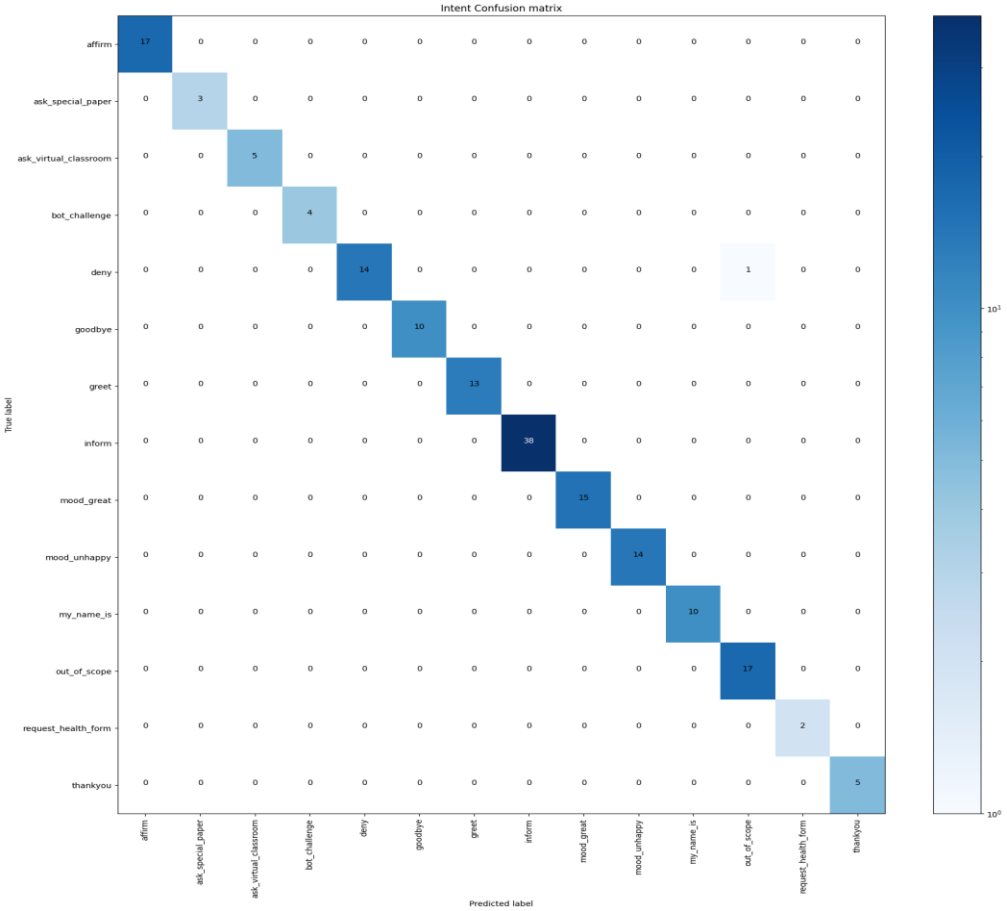


Figure 8.2: Intent Confusion Matrix

- **Story confusion matrix**
  This is the story confusion matrix, which is similar to the intent confusion matrix. The difference between the two is, here the story is tested, not the contest. The vertical and horizontal axis shows the true table and the predicted table respectively.

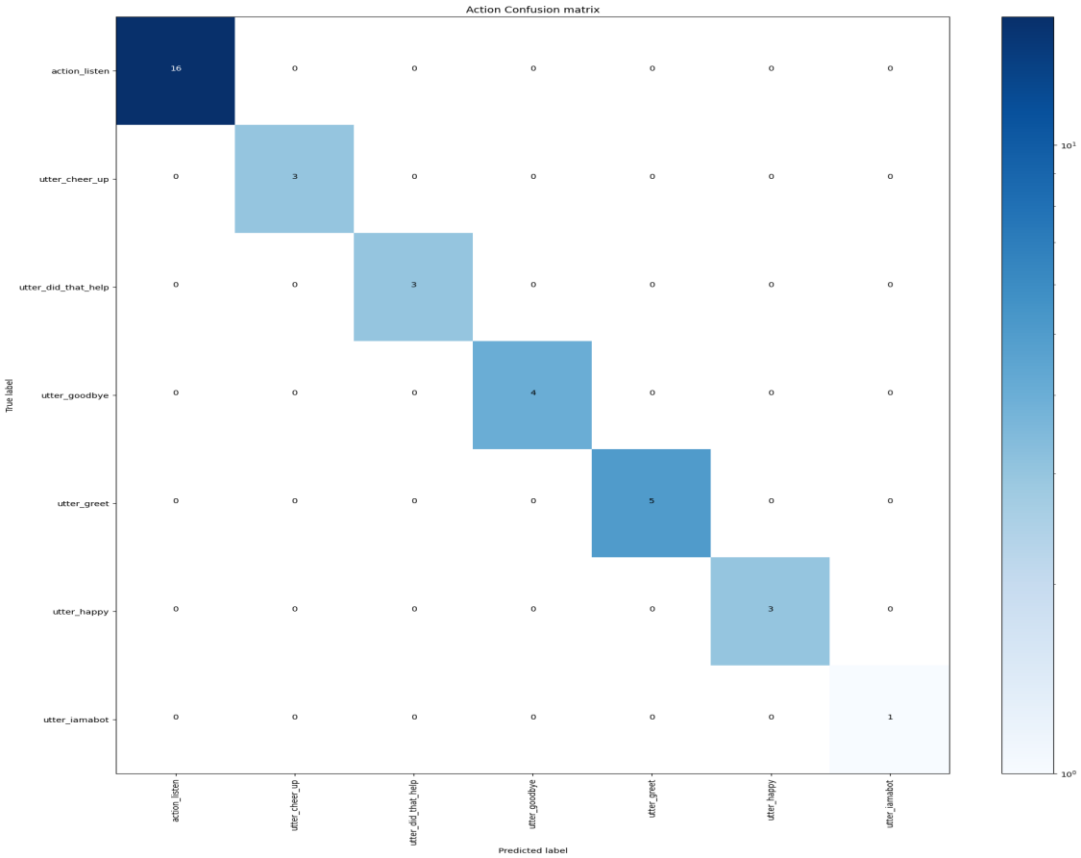


Figure 8.3: Story Confusion Matrix

- **Intent report**

Intent	**Result**			
	Precision	**Recall**	**F1-score**	**Support**
goodbye	1.0	1.0	1.0	10
affirm	1.0	1.0	1.0	38
out_of_scope	0.944	1.0	0.9714	17
mood_great	1.0	1.0	1.0	15

greet	1.0	1.0	1.0	13
mood_unhappy	1.0	1.0	1.0	14
ask_virtual_classroom	1.0	1.0	1.0	5
thankyou	1.0	1.0	1.0	5
my_name_is	1.0	1.0	1.0	10
deny	1.0	0.933	0.9655	15
bot_challenge	1.0	1.0	1.0	4
ask_special_paper	1.0	1.0	1.0	3

Table 8.1: Intent report for each intent

Accuracy	0.9940476190476191			
	precision	**recall**	**f1-score**	**support**
macro avg	0.9960	0.9952	0.9954	168
weighted avg	0.9944	0.9940	0.9940	168
micro avg	0.9940	0.9940	0.9940	168

Table 8.2: Intent Report of The Intents

- **Intent errors**
  The sentence “don’t like that” is intended to deny but predicted as out_of_scope. This will have an impact on the confidence value of the intent prediction by giving an answer that is not inlined with, which is intended by the user.

Figure 8.4: Intent_errors json file

8.5 Benchmarking

Benchmarking is the process of comparing a product to similar products offered by top-performing companies to evaluate its performance and identify areas for improvement. There are two types of benchmarking: competitive benchmarking, which compares our product with those of leading organizations to see how well it performs, and technical benchmarking, which evaluates the capabilities of our product by comparing it to similar products of top-performing companies.

System Component	**Human Level & State-of-the-art-performance**	**Comparison of Learnverse with other similar products**
Student Performance Prediction from Text	–	Our model has been developed using a proprietary dataset created by our team, which draws information from multiple sources, including past papers and student records. As a result, our dataset is unique to us, and therefore, our model cannot be directly compared to other models for benchmarking purposes.
Virtual Classroom Collaboration	–	Learnverse Virtual classroom has been developed as a side functionality as a platform for students and teachers to communicate. Here, a facility to maintain a Q&A collaboration chat and a space for sharing essential academic documents between students is provided which is mostly similar compared to other virtual classrooms.
AI Chat bot	–	Our AI chatbot is built by training using the possible dialogues between a student and a virtual assistant bot in an educational application. This bot helps the students by answering and guiding them in the application, which is similar to other AI chatbots or virtual assistants..

Table 8.3: Benchmarking

8.6 Functional Testing

Below are the results of the black box testing that was conducted

Test Case	Description	Input	Expected result	Actual result	Status
1	Checking whether user can enter details to sign up	Username, Email, Password	The user has successfully completed the account creation process.	The user has successfully completed the account creation process.	Passed
2	Checking whether user can enter the account details to login	Email, Password	The user has successfully logged in to his account.	The user has successfully logged in to his account.	Passed
3	Checking whether user can do the regular exam papers	Clicking the “exam paper” button	User can do the exam papers.	User can do the exam papers.	Passed
4	Testing if the user can send the names of the lessons to the special chatbot and receive a response.	Text	User should get an URL that gives access to the special paper	User gets an URL that gives access to the special paper	Passed
5	Testing if the user can try the special paper.	Text input via special chatbot	User should be able to do the special paper	User can do the special paper	Passed
6	Testing if user can check the results of exam papers he has done so far	Clicking the “Test Summary” button	User should be able to check the exam paper results	User can check the exam paper results	Passed
7	Checking whether the user can input credentials for VC signup	Username, Email, Password, Confirm password	Users are able to Create a Teacher/Student account and redirect to the login page.	Users are able to Create a Teacher/Student account and redirect to the login page.	Passed

8	Checking whether the user is able to login to the VC Dashboard	Username, Password	User redirected to Teacher/Student Dashboard.	User redirected to Teacher/Student Dashboard.	Passed
9	Testing if teachers can create new class	Class name, unit, description	Display created class in teacher dashboard	Display created class in teacher dashboard	Passed
10	Testing if users can chat in the classroom stream	User message	Display users' messages in the chat box in the related class.	Display users' messages in the chat box.	Passed
11	Testing if teachers can upload files	File name, File	Display file with the url.	Display file with the url.	Passed
12	Testing if students can join the Classroom	Class Code	Check code and redirect to the Classroom.	Redirect to the Classroom.	Passed
13	Testing if the student can ask about the virtual classroom	Text	Give a brief description about virtual classroom.	Give a brief description about virtual classroom.	Passed
14	Testing if the student get correct information about the special paper	Text	Provide a short summary about the special paper.	Provide a short summary about the special paper.	Passed
15	Testing if the bot identifies a request out of its scope.	Text	Inform the user that the asked question is out of scope.	Inform the user that the asked question is out of scope.	Passed

Table 8.4: Functional Testing

Functional test pass rate = 15/15 Therefore 100% pass.

8.7 Module and Integration Testing

Integration testing methods include Big Bang, Top-Down, Bottom-Up, Sandwich/Hybrid and Continuous Integration Testing. For our Learnverse project, we can use Continuous Integration Testing, which continuously integrates all modules and detects issues early. We first tested each component individually, then integrated and tested again to ensure correct functionality.

8.8 Non-functional Testing

8.8.1 Accuracy and Performance Testing

The testing was performed using a computer that had the following specifications:

Processor	i7 - 8550U @ 1.80GHz
RAM	8GB DDR4
GPU	AMD Radeon 530 8GB

Table 8.5: Computer Specifications

Student Performance Prediction for The Exam Paper Generation

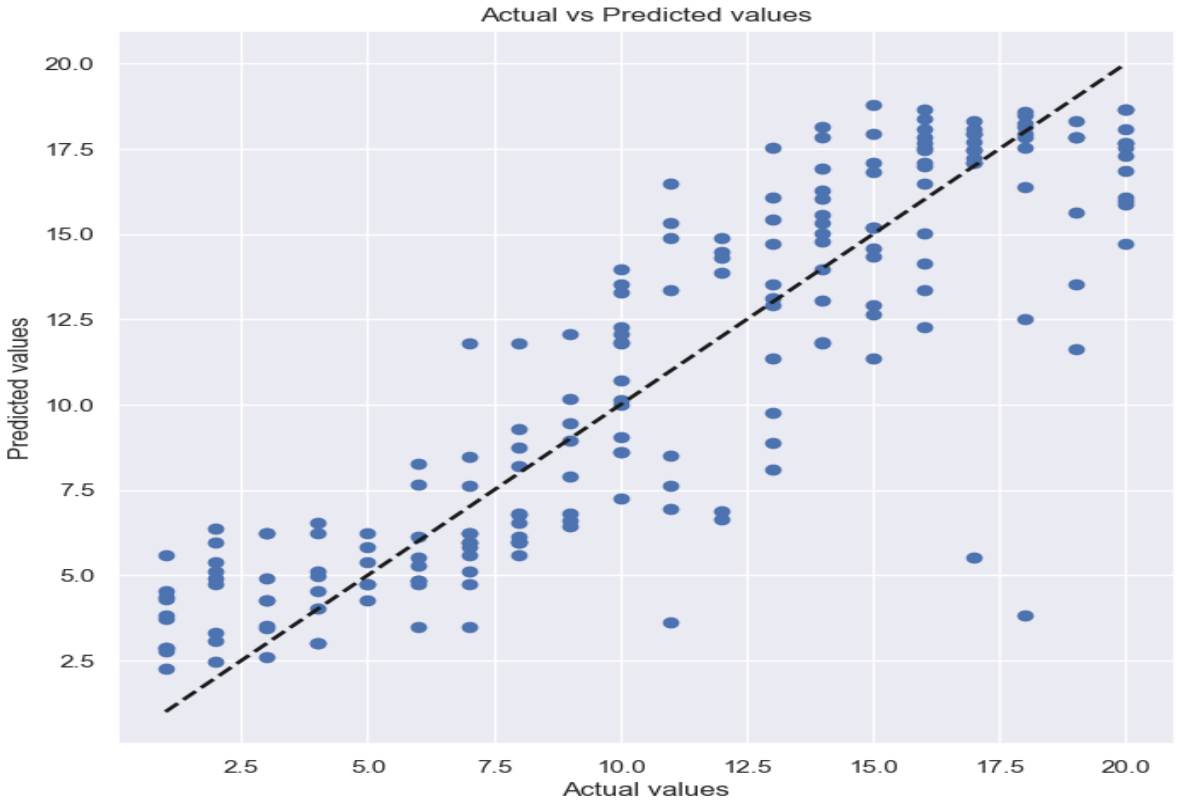


Figure 8.5: Scatter plot

- **Conclusion:** The scatter plot indicates that the model's predictions closely match the actual values, implying that the model is accurate.

- **Test accuracy (R2 Score)** - 76.2%

8.8.2 Security Testing

The first view of the system would be the login page for the users. Here the user must provide the valid username and password in order to login to the system, or else he/she shall not be able to use the system and an error message will be displayed. In the event of a new user, they are able to sign up to the system as a new user.

Below is an image of the login page.

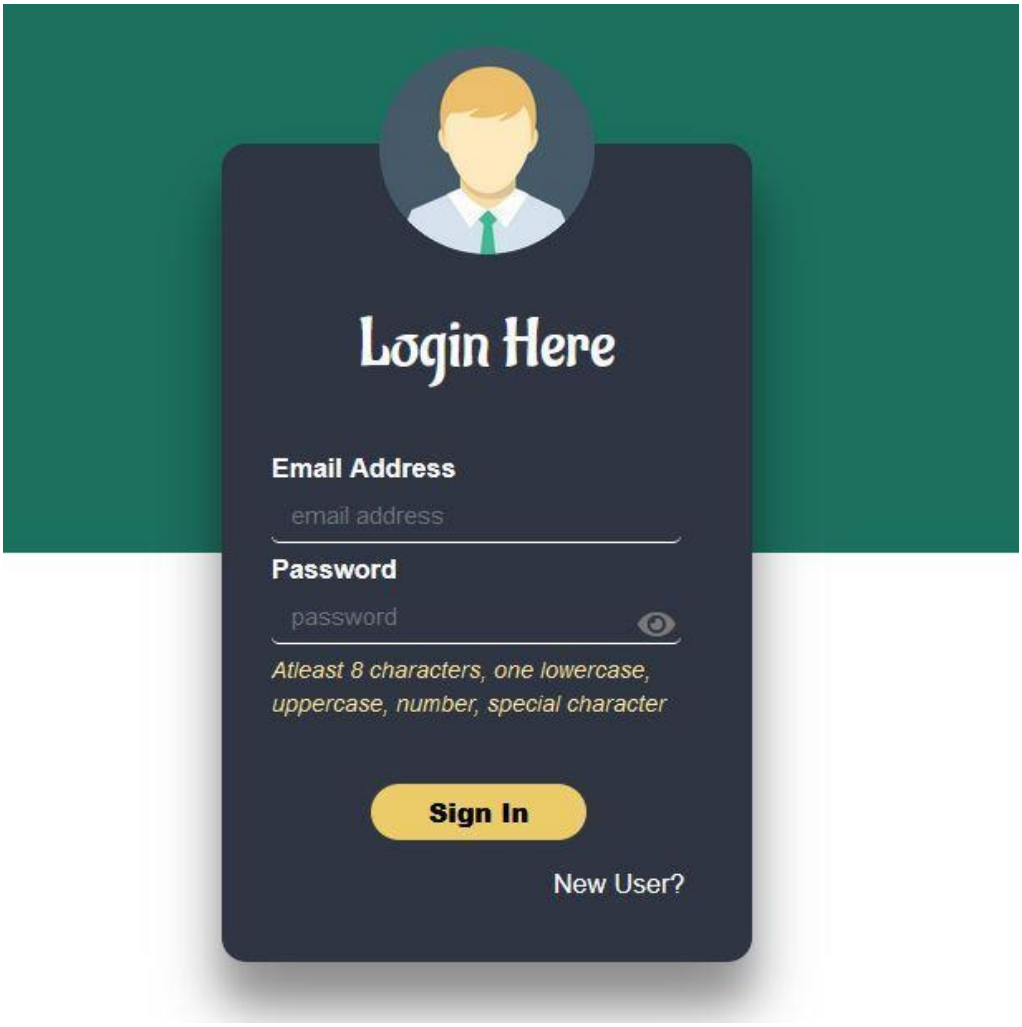


Figure 8.6: Login page

8.9 Limitations

During the testing process, certain limitations were discovered and have been documented below:-

1. The dataset used to train the model was small and created by the team. As such, the accuracy of the data in the dataset cannot be guaranteed, which may affect the reliability and generalizability of the model's predictions.
2. To test the app, an internet connection is required because some features use databases stored in the cloud.
3. Some features take longer to execute because they require a lot of processing power and GPU.
4. The AI chatbot is trained using dialogues which can be asked by a student. Since the training data set is limited, this can lead to lower performance in solving students' issues.
5. The user is limited to create only one Teacher/Student account for the virtual classroom, as it will issue confusions in the system database.

8.10 Chapter Summary

This chapter presents various testing methods that are used to assess different aspects of the application. The testing process involves a comprehensive evaluation of all the application's features, and the importance of testing the system thoroughly is tested. The objectives of the tests are clearly defined, and the chapter also covers both the Functional and Non-functional Requirements of the application. The limitations of the testing process are also discussed in the chapter's conclusion.

CHAPTER 9: EVALUATION

9.1 Chapter Overview

This chapter presents the evaluation of the model and the system in different categories and perspectives of the technical and domain experts. Self-evaluation of the authors' also included. Evaluation methods, the approaches taken, and the relevant evaluation criteria are discussed in this chapter.

9.2 Evaluation Methodology and Approach

The system has features to generate past papers, grade prediction, AI chatbot and a virtual classroom. The models used, and the system can be evaluated by reaching out to experts in education and ICT related fields to get feedback and information about these categories.

- Model performance
- Usability of the system
- User-friendliness of the system

9.3 Evaluation Criteria

The criteria that have been addressed by the evaluators are as follows.

1. The overall concept of the project
2. Scope of the project
3. System Design, Architecture, and Implementation
4. Solution and prototype
5. User interface and user application experience

9.4 Self-Evaluation

Criteria	Author's Evaluation
Project Concept	Advanced level examination is among the most competitive exams, to support students to jump this hurdle Learnverse provides the facilities to be better in the subject. With help of personalized exam generation to Chatbot guide, Learnverse provides four major facilities that students can use to get better in their subject.
Scope of the project	Accurate Exam papers according to the users previous exams can be generated with completion of more exams.
System Design, Architecture, and	The Architecture and design of Learnverse is

Implementation	implemented with a user-friendly interface, although minor changes could be done to improve it.
Solution and Prototype	The Prototype is a simple web application filled with all the main functionalities so that it is accessible to any users.

Table 9.1: Self-evaluation

9.5 Selection of Evaluators

Evaluators are chosen based on two types of expertise:

1. Domain expertise in the educational sector
2. Technical expertise in web application development

Evaluators who are selected from the above-mentioned categories are as follows,

Group	Affiliation	Reason
Domain Experts	Mr. Gisina Vithanage (A/L ICT Educator)	Mr. Gisina Vithanage is a Network engineer with years of experience as a tuition master in Advanced Level ICT.
Technical Experts	Mr. Kiruthiharan Basker (Software Developer)	Mr. Kiruthiharan Basker is employed as a software developer at Sysco Labs, where he has been creating computer applications for several years.

Table 9.2: Selected evaluators

9.6 Evaluation Results

9.6.1 Overall Concept

Question	
What do you think about the overall project?	
Person	Feedback
Mr. Kiruthiharan Basker	“The project's got some pretty neat features, like creating exam papers based on student's

	performance, generating custom papers, and setting up a way for students to easily reach out to their teachers. All in all, it's looking pretty good from where I stand.”
Mr. Gisina Withanage	“The goal of the overall project is clear and there are some good features developed for the support in progressing through exams.”

Table 9.3: Overall Concept

Evaluation Summary
Evaluators are satisfied with the overall project.

9.6.2 Scope of the System

Question	
What do you think about the scope of the project?	
Person	Feedback
Mr. Kiruthiharan Basker	“The project's scope is impressive, mainly because of its unique features like generating exam papers based on a student's performance.”
Mr. Gisina Withanage	"This project can be very helpful for A/L students. This app has many useful features that could help them prepare for their exams. The project has a lot of potential and could be a great tool to improve exam preparation."

Table 9.4: Scope of the System

Evaluation Summary
The evaluators have expressed satisfaction with both the project's scope and the system's capabilities.

9.6.3 Design, Architecture and Implementation

Question	
What do you think about the design, architecture, and implementation of the project?	
Person	Feedback
Mr. Kiruthiharan Basker	“The design is decent, but the user interface (UI) could use some consistency. It'd be great if you could standardize the UI across all components because right now, there are varying styles.”
Mr. Gisina Withanage	“The Design is good but you could do more to make the interface more user friendly. There are some issues when going back to home pages, other than that the design is good.”

Table 9.5: Design, architecture and implementation

Evaluation Summary
Although the evaluators have pointed out some design problems, they are pleased with the project's overall design.

9.6.4 Solution and Prototype

Question	
What do you think about the solution and prototype of the project?	
Person	Feedback
Mr. Kiruthiharan Basker	“The solution is both innovative and creative, which is impressive.”
Mr. Gisina Withanage	"I am satisfied with the solution provided and the outcome of the application."

Table 9.6: Solution and prototype

Evaluation Summary
The evaluators are satisfied with the system's solution, which is considered innovative.

9.7 Limitations

Person	Feedback/Suggestions
Mr. Kiruthiharan Basker	“The system's overall performance is satisfactory, but it'd be great if you could speed up the paper generation time after a student completes a previous paper. Alternatively, you could also add indicators like spinners or progress bars to keep users informed that a paper is being generated.” “You could have utilized the same frontend component for the general AI bot, special AI bot, and student-teacher chat platform, as they all serve as messaging platforms. The only difference would be in the backend calls.”
Mr. Gisina Withanage	"To make the project better, you could add more subjects to the app and target students who are preparing for O/L exams too. This would make the app more useful and help more students."

Table 9.7: Limitations

9.8 Evaluation on Functional Requirements

Requirement ID	Requirement and Description	Evaluation	Priority
FR01	**User Requirements**		
FR01.01	**Login and Access**: Users should be able to access their account by entering their username and password to use all the features of the system.	Implemented	Critical
FR01.02	**Exam papers**: Users should be able to take exam papers that are generated based on their performance.	Implemented	Critical
FR01.03	**Customization**: Users should be able to input the specific lessons they want to focus on, and the system should generate exam papers with questions related to those lessons.	Implemented	Critical

FR01.04	**Results**: Users should be able to view the summary of the results of the exam papers they have completed, as well as predicted results based on their performance.	Implemented	Critical
FR01.05	**Chatbot**: Users should be able to communicate with an AI chatbot that guides them through the web application system.	Implemented	Critical
FR01.06	**Teacher-Student Communication**: Teachers should be able to communicate and share resources with students via the system.	Implemented	Critical
FR02	**Business Requirements**		
FR02.01	**Efficiency**: The system should perform efficiently and quickly, allowing users to complete exam papers within a reasonable time frame.	Implemented	Critical
FR02.02	**Scalability**: The system should be able to handle a high volume of traffic without experiencing any performance issues.	Not Implemented	Important
FR02.03	**Anti-Cheating Measures**: The system should be able to detect and prevent cheating during exams.	Not Implemented	Important
FR03	**System Requirements**		
FR03.01	**Databases**: The system should have one or multiple databases to store users' personal information, exam results, and question bank. The database should be able to handle a large amount of data and provide efficient querying capabilities.	Implemented	Critical
FR03.02	**Interface**: The system should have an intuitive and user-friendly interface for students to take exams and for teachers to communicate with students. The interface should be accessible from different devices and platforms, such as desktops and laptops.	Implemented	Important
FR03.03	**AI Algorithm**: The system should have an algorithm (AI machine learning model) that can generate exam papers based on student performance. This algorithm should be	Implemented	Critical

	accurate, reliable, and scalable and should take into account factors such as the student's performance history.		
FR03.04	**Security**: The system should have robust security features to protect user data and prevent unauthorized access. This may include features such as encryption, secure login, and role-based access control.	Not Implemented	Important

Table 9.8: Functional Requirements Evaluation

9.9 Evaluation on Non-Functional Requirements

Requirement ID	Requirement and Description	Evaluation	Priority
NFR01	**Website**		
NRF01.01	**Usability**: The user must be able to use all the functionalities implemented in the system.	Implemented	Important
NRF01.02	**Accessibility**: The web app should be able to be accessed by any device (should be responsive).	Not Implemented	Important
NRF02	**UI/UX**		
NRF02.01	The Interface should be user friendly	Implemented	Critical
NRF02.02	User Signup/Login operations should be simple	Implemented	Desirable
NRF03	**Performance**		
NRF03.01	Exam Paper generation model should perform with better inference speed.	Not Implemented	Important

Table 9.9: Non-Functional Requirements Evaluation

9.10 Chapter Summary

In this chapter, the evaluation of the system is based on different criteria by the domain experts and the authors. The discussion with experts were stated in the evaluation criteria in different categories, and then the author's evaluation criteria is mentioned. To sum up, the functional and non-functional requirements are discussed in the chapter.

CHAPTER 10: CONCLUSION

10.1 Chapter Overview

In this chapter, an overview of the Learnverse project will be presented. It will start with a discussion of the project's aims and objectives, followed by an account of the team's learning experiences and challenges encountered during the project. The future improvements that can be made to the project will also be discussed, along with the limitations of the current work. Ethical considerations will also be addressed before concluding with a summary of individual contributions to the project.

10.2 Achievements of project aims & objectives

10.2.1 Project Aim

Considering how students perform in model papers, this recommended system will detect students' weak competencies, generate new model papers with more questions relevant to areas where students are weak, and predict student results based on past scores. Also, AI chatbots will be used to gather information about subjects that students need to improve on and generate unique papers that only contain questions about those specific subjects.

10.2.2 Completion of objective of the project

Description	Status
Literature Review	
Evaluation of existing word and system	Completed
Software Requirements and Specification	
Product specification overview, requirements, and stakeholder analysis.	Completed
Design	
Design web applications.	Completed
Development	
Developed a working web prototype according to the design and requirements.	Completed
Testing	

Description	Status
Literature Review	
Evaluation of existing word and system	Completed
Software Requirements and Specification	
Product specification overview, requirements, and stakeholder analysis.	Completed
Test the model, the Web application, and the backend.	Completed

Table 10.1: Completion Status

10.3 Utilization of knowledge from the course

Module	Description
Data Science Group Project(CM 2603)	• Project management methodologies, quality assurance standards and methodologies related to innovation and marketing for software products. • Research methods, modeling, and reflections on legal, ethical, professional, and social issues.
Machine Learning(CM2604)	• Introduction to machine learning algorithms were done • Taught how to develop and evaluate machine learning models
Web Technology(CM1605)	• Developing the frontend of an interactive website using HTML, JavaScript, and CSS.
Database Systems(CM1603)	• Creating, updating and maintaining a database.
Programming Fundamentals(CM1601)	• Version control was introduced • Introduction to programming and basics were taught • Best practices of coding and design is introduced
Object-Oriented Development(CM2601)	• Version controlling was used • Connecting Databases were taught

Table 10.2: Knowledge Utilization from Course

10.4 Use of existing skills

Existing skills formed the foundation for the project's development and were crucial in its successful and timely implementation.

10.4.1 Machine Learning

Our understanding of the foundation of machine learning was acquired through a combination of LinkedIn learning courses and tutorials on YouTube. Additionally, we gained valuable insights into how machine learning models work through various repositories on GitHub. Armed with this knowledge, we were able to develop effective AI models using Jupyter Notebook.

10.4.2 Web Development – Frontend

The frontend of the application was developed using HTML, CSS, and JavaScript, which were learned during the web development module in the first year of our degree program. These front-end technologies were instrumental in creating an attractive and user-friendly interface for the application.

10.5 Use of new skills

The team was able to acquire new skills and improve upon their existing skills while working on the project.

10.5.1 Machine Learning

Through the project, we gained valuable knowledge on various aspects of machine learning. This included learning new techniques for pre-processing and feature engineering before model training, as well as exploring new methods for data visualization and plotting during exploratory data analysis. Additionally, we learned how to deploy an AI model into an application by implementing a function that executes the model when called.

10.5.2 Web Development – Backend

During the project, the backend was developed using FLASK API, which was a new technology for the team. To learn FLASK, the team referred to other projects and utilized online tutorials on platforms such as YouTube. The team was able to effectively call functions using "GET" and "POST" methods for various operations. Furthermore, the team utilized JQuery to retrieve and manipulate data as necessary.

10.5.3 Version Control

Leveraging version control through GitHub for a large-scale project provided numerous benefits and expedited the development process. This enabled the team to work in a more structured and organized fashion.

10.5.4 Conversational AI

Designing and implementing conversational flows were done by getting a sound knowledge of user intent recognition, intent classification, entity recognition, entity extraction, and context management, and dialogue management. Creating custom actions and integrations was another sub part in the gained skill, Finally evaluating and improving performance with the help of the analysing metrics is done to better performance with a better accuracy.

10.6 Achievement of learning outcomes

10.6.1 Skills developed through collaborating within a team on a software development project

- The team used Git and GitHub for version control during the project, which promoted organization and effective collaboration.
- To enhance time management skills, the team created a weekly plan that aligned with the overall project delivery plan. This enabled the team to effectively allocate time and resources to the project's various tasks and objectives.
- Weekly virtual meetings conducted via Zoom and official communication through WhatsApp facilitated seamless collaboration and ensured clear and consistent communication among team members.

10.6.2 Analysis of the User-Centered Design Process and its Impact on Legal, Ethical, Professional, and Social Issues in Data Science Applications

- Conducted a thorough analysis of existing research and literature by creating a Literature Review and SRS document before developing the application.
- Developed the product design and features with a business-centric approach aimed at generating revenue.
- A web application was created with compatibility for multiple platforms.
- Utilized cutting-edge and robust AI models for the entire system.
- Obtained permission from relevant parties and authors before making datasets/data.
- Ensured anonymity of all data used and did not violate any ethical boundaries.

10.7 Problems and challenges faced

Problems/ Challenges	Solution/ Workarounds
No datasets to leverage the machine learning model	As there were no relevant datasets available for our project, we had to create our own dataset by collecting data from various sources, such as educational institutes and schools.
Limitations of the required knowledge sources.	In implementing some components, relevant techniques and knowledge needed for the specific versions of software products, the approaches were not available on the internet. Using trial and error method, self learning and using mixed approaches were used to overcome this problem.
Time management	Since the system had several components, they had to be developed in a short time frame. Using version controlling, team productivity helped to finish the workload on time.

Table 10.3: Problems and challenges faced

10.8 Future enhancement

In order to enhance the quality of the application, several improvements can be made. The website can be reformatted by including indicators such as spinners and progress bars where necessary, and navigation bars can be added to make the UI more attractive. It would be ideal if the web application could use a single messaging platform for regular and special AI chatbots, as well as a student-teacher chat platform with different back-end calls. This will improve the performance and quality of the application.

Improving security is also a major enhancement. The data handled should be encrypted, and data regulations need to be followed. Two-factor authentication can be incorporated into the application to increase security.

10.9 Achievements of the contribution to the body of knowledge

The project's progress has made several valuable additions to the knowledge base. Learnverse is a comprehensive education platform that benefits both students and educators by improving the efficiency and effectiveness of educational systems and enhancing the overall user experience.

10.10 Individual contribution

The team members made significant contributions in the development and creation of the thesis and the working application. Here is a summary of each member's individual contributions.

Team Member	Contribution
Inuka Rodrigo	Main role - AI Engineer ● AI Model for Student Performance Prediction from Text ● AI Backend and API form Flask ● Exam Paper Generation with the use of the AI model ● Frontend and backend of the Exam Papers page ● Frontend of the special AI chatbot ● Backend for the customized exam paper generation
Lisara Gajaweera	Main role- Chatbot Developer ● Backend of the special chatbot ● Backend of the general chatbot ● Frontend of the general chatbot
Haneek Ahamed	Main role - Software Developer ● Backend for the Test Summary ● Frontend for the Test Summary ● Frontend for the predicting grade ● Frontend for the Authors profile
Sanjula Maneth	Main role - Software Developer ● Backend of the Student and Teacher Dashboard. ● Frontend of the Student and Teacher Dashboard. ● Frontend and backend of the Virtual Classroom. ● Front-end and backend of the virtual classroom user login.

Table 10.4: Individual Contribution

10.11 Chapter Summary

The chapter presents a summary of the project, which includes the development of an application for Generating MCQ, Predicting Result, Virtual Classroom, and Chat Bot. The team gained significant experience and exposure in the fields of Data Science and Web Development. The project has the potential to be expanded into a successful application for students. The chapter also discusses the challenges faced during the project, future enhancements, and ethical concerns. Overall, it provides an overview of the project's aims, goals, and individual contributions.

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APPENDIX PART 2 – OTHER RELEVANT DETAILS

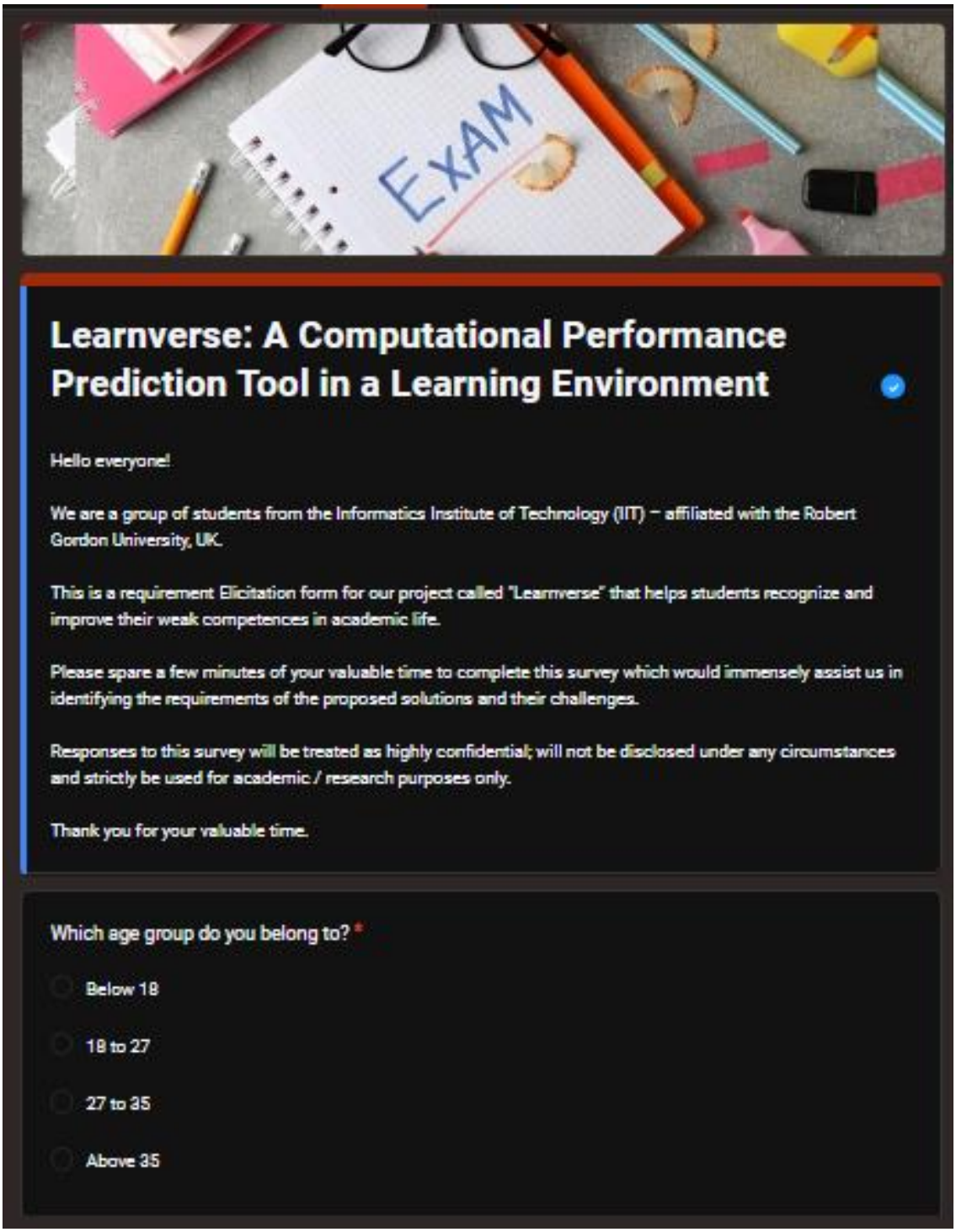

Figure 11.1: Survey form for Students

Find the survey form from here