**“AITor” - EDUCATION PLATFORM – A PERSONALIZED STUDENT PERFORMANCE ANALYZER AND RECOMMENDATION SYSTEM**

2022-017

Project Proposal Report

Hirimuthugoda UJ– IT19138114

(Liyanage M.L.A.P., Thammita D.H.M.M.P., Liyanage N.L.T.N)

B.Sc. (Hons) in Information Technology specializing in Software Engineering

Department of Software Engineering

Sri Lanka Institute of Information Technology

Sri Lanka

January 2022

# DECLARATION

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

A picture containing computer, dark, domestic cat, night sky

Description automatically generated

IT19138114 - Hirimuthugoda UJ

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

..................................

Signature of the supervisor Date

# ABSTRACT

E-learning has shown rapid growth in the last decades. With the competition, it has focused on teaching and measuring student performance in different and more efficient ways. But when it comes to evaluating the student, it’s all about measuring the student's technical knowledge or subject related performance. But stepping out to the industry, having good technical knowledge is not enough for a successful career. There are some personal skills that everyone needs to have. Specially in the computer science field, different careers required different skill sets including some personal skills.

Every modern e-learning platform will give a detailed report about how the student performed for a specific module or module content in the assessments. Mostly it will be based on obtained marks by the student for an assessment. But there is no way to identify student personal skills like logical thinking, problem solving, analytical skills. Some of e-learning platforms offer report for those skills but just based on earned score. Since obtained mark is not the only factor to measure the student performance, we can’t guarantee those details are accurate.

AITor is a web-based learning platform capable of identifying not only student module-based performance but also student personal skills in a more accurate manner. While the platform is having the usual assessment workflow, it will monitor student personal/cognitive skills with different factors. As an outcome, students will have a detailed report based on both module-based performance and the personal skills level. Also, student performance will be analyzed along with the given learning materials and the system will help the student to refer most suitable learning materials.

TABLE OF CONTENTS

[DECLARATION ii](#_Toc95508371)

[ABSTRACT iii](#_Toc95508372)

[LIST OF FIGURES iv](#_Toc95508373)

[LIST OF TABLES v](#_Toc95508374)

[1 INTRODUCTION 1](#_Toc95508375)

[1.1 Background and Literature survey 1](#_Toc95508376)

[1.2 Research Gap 6](#_Toc95508377)

[1.3 Research Problem 7](#_Toc95508378)

[2 OBJECTIVES 9](#_Toc95508379)

[2.1 Main objectives 9](#_Toc95508380)

[2.2 Specific objectives 9](#_Toc95508381)

[3 Requirements 10](#_Toc95508382)

[3.1 Functional requirements 10](#_Toc95508383)

[3.2 Non functional requirements 10](#_Toc95508384)

[3.3 User requirements 10](#_Toc95508385)

[4 Methodology 11](#_Toc95508386)

[4.1 Steps 11](#_Toc95508387)

[ Assessment preparation 11](#_Toc95508388)

[ Question tagging 11](#_Toc95508389)

[o Concept 11](#_Toc95508390)

[o Difficulty level 11](#_Toc95508391)

[o Personal skills 12](#_Toc95508392)

[ Assessment conducting 12](#_Toc95508393)

[ Performance factors capturing 12](#_Toc95508394)

[ Answer evaluation 12](#_Toc95508395)

[ Subject based performance analysis and personal skill identification 12](#_Toc95508396)

[4.2 Implementation 13](#_Toc95508397)

[4.2.1 Assessment platform development 13](#_Toc95508398)

[4.2.2 Algorithms 14](#_Toc95508399)

[4.2.3 Database Handling 14](#_Toc95508400)

[4.3 Deployment 14](#_Toc95508401)

[5 Gantt chart 14](#_Toc95508402)

[6 Budget 15](#_Toc95508403)

[7 References 15](#_Toc95508404)

# LIST OF FIGURES

[Figure 1.1 - Summary of responses for student awareness of their personal skills 7](#_Toc95061079)

[Figure 1.2 - Summary of responses for student's opinion on capability of existing learning platforms to understand their personal skills. 7](#_Toc95061080)

[Figure 1.3 - Summary of responses for student's awareness of industry demand for personal skills 8](#_Toc95061081)

[Figure 1.4 - Summary of responses for student’s understanding of personal skills 12](#_Toc95061082)

[Figure 1.5 - Demand for personal skills in Software development by F. Ahmed, L. F. Capretz, and P. Campbell 12](#_Toc95061083)

[Figure 3.1 - System diagram of student performance analyze module 16](#_Toc95061084)

# LIST OF TABLES

[Table 1.1‑1 . Comparison of former researches 11](#_Toc95489747)

[Table 5‑1- cloud budget justification 19](#_Toc95489748)

# INTRODUCTION

## Background and Literature survey

Within covid-19 pandemic period, many research have been conducted focusing on online learning. Since in a e-learning platform each student has an individual learning space, it’s easy to monitor each student individually comparing to traditional classroom learning system. With this advantage, it’s possible to gather and analyze student performance data and prepare a student specific report easily. Number of research are conducted focusing on how to conduct assessment, evaluate them, analyze those data, and give a detailed report in more efficient way.

A survey has been conducted to collect data about student awareness of personal skills. 47 students were involved to the survey representing all the academic years.

Soft skills or personal skills are most important as same as technical skills in the industry. Since proposed system is focusing on computer science field, it is important to identify what are the personal skills required in the industry for computer science.

Chart, pie chart

Description automatically generatedFigure 1.1 - Summary of responses for student awareness of their personal skills

According to the figure 1.1, more than 50% of student don’t have a good understanding about their personal skills and around 40% of students have moderate awareness of their personal skills.

Chart, pie chart

Description automatically generatedFigure 1.2 - Summary of responses for student's opinion on capability of existing learning platforms to understand their personal skills.

Figure 1.2 shows around 60% of student won’t get any help from existing learning platforms to understand their personal skills.

Chart, pie chart

Description automatically generated Figure 1.3 - Summary of responses for student's awareness of industry demand for personal skills

Figure 1.3 illustrate the majority of student doesn’t have a good understanding of the demand for personal skills in the industry.

Faheem Ahmed and Luiz Fernand have conducted research to evaluate the demand for soft skills in software development. They have analyzed 500 advertisements for IT positions to identify required soft skills. They were able to categorize those skills along with the position and the skill demand level. Following soft skills were arranged along with the career position and the skill demand level as high, medium, and low.

* Communication skills
* Interpersonal skills
* Analytical skills
* Problem solving skills
* Team player
* Organization skills
* Fast learner
* Ability to work independently
* Innovative
* Open and adaptive to change

[1]

When analyzing student performance in different perspectives, a proper classification is required for learning materials, module content as well as for the assessments also.

Ayush sharma have proposed a system to recommend learning materials based on content tagging concept and student learning style. Research proposes a recommendation engine that consider content hierarchical map structure called knowledge map, resembling the prerequisites of educational concepts and detects the learning style and pattern of the student to recommend content type. This research was based on Felder-Silverman learning style classification which is most popular model for classification of learning styles. To identify the student learning style, they suggest deploying a model to predicts the student learning style on continuous evaluation as the most appropriate method.

This learning style recognition model based on several parameters.

* Type of learning material Interpersonal Skills - Verbal and nonverbal skills
* Access to examples: In relation to the total number of available examples, how many of them has the student accessed to.
* Answer changes: Percentage of answer changes of the exam before student hands it over
* Exercises: In relation to the total number of available exercises, how many exercises has the student accessed to.
* Exam delivery time: Relation between the student’s exam delivery time and the units’ time
* Exam revision: Percentage of time spent by the student checking the correctness of the exam
* Chat/forum access
* Accessing previously learnt lessons to recall: Need to detect if that lesson was related to the current lesson or not
* Ratio of document length to the time spent on a page
* Ratio of images area to document length and scroll distance
* Student's demographic details

Under tagging, Questions were tagged by several attributes. Principle based, Procedural based, Facts likewise.

Knowledge structure also tagged with identified attributes such as Basic Knowledge, Procedural Knowledge and Conceptual Knowledge.

Learning material tagged as reading materials, Scenario based, collaborative method likewise. Those tagged materials again tagged by sub attributes.

For the predictive model, they suggest using any machine learning technique, complex if-else condition, or associative inferring. [2]

Karishma khan and Janhavi patil have come up with the intelligent student performance analysis system using e-learning platform. Research was based on MCQ answer evaluation and identification of facts that affect student performance. They were considered several parameters during this research.

* The order of questions
* difficulty level of the question
* answer key (correct choice)
* time spent by a student on each question and every section
* order in which the student attempted the questions
* correctness of the chosen answer
* average time spent by all the students who attempted the test on a question,
* Marks obtained

They have analyzed how student performed in the exams along with the difficulty level of the answer and spent time on the question. As the outcome, system highlight what are the concept or learning areas student should take more effort. SEMMA model is used in the data mining process. [3]

Priscila da silva and Ana paula proposed a system to content analysis of assessment exams. The main purpose of the system is identification of student performance based on the domain knowledge represented in the exam. According to them, this data can be used by data mining algorithms to predict the student outcome in the exams based on their performance during the course. A prototype has been implemented to classify and analyze the data from computer science students.

System is structured into three phases.

1. Identification/Cataloging

Identification of exam questions will be done according to the pre identified themes. This classification can be done manually or text mining techniques.

1. Group by theme

Under phase 2, Student’s result will be collected for each exam question, and questions will be group by the theme and the score earned by the student in that theme.

1. Analysis and result

Since the data is already grouped, descriptive and inferential statics are used to analyze the data. Several inferential statistics tests have been done to determine the correlation between themes and groups. How the students fare in the different themes and hoe themes relate to each other can be analyzed in the proposed system. Additionally, analyzed data have been used to predict the student outcome. Assuming exam test results reflect the academic result, this system allow to predict the exam outcome based on student performance. [4]

Ameya karnad and Sharat yadappanavar have conducted research on evaluation and validation of problem solving and thinking skills based on academic performance. Different course modules were considered, and a weightage score have been allocated to each module. Students were clustered with k means clustering algorithms based on their performance.[5]

Implementing a proper online examination platform is another challenging task in a e-learning platform. Huiping and Ruowu have designed and implemented an online exam system based on data mining techniques. System is divided in to two sub systems, teacher management subsystem and student test subsystem. Under teacher management subsystem, it has divided in to five subcomponents.

* System management
* Exam questions bank management
* Exam paper generating management
* Marking management
* Test management

Student test subsystem contains online exam component which is responsible for conducting exams.[6]

Huang darong and Huang huimin have proposed a online exam system based on S2SH (Struts2 + Spring + Hibernate). Proposed online exam system contains with seven sub modules.

* Management of test questions
* Management of exam
* Management of grade
* Management of examinee
* Management of system
* Query of grade
* Online examining [7]

Yongcheng and Chongqing have conducted research on online exam system based on MVC framework.

System contains with 8 core modules.

* System maintenance
* Data backup
* Inquiry statistics
* Paper inspection management
* Exam management
* Paper inspection teacher management
* Examinee management
* Test bank management

[8]

When looking at above former research on online exam platforms, it can identify common core modules of an online exam system.

* System manage module

Responsible for handling administrative functions. Handling users and user based functions will be performed here.

* Question management module

Making question, storing, and updating functions will be performed in this module.

* Paper evaluation module

Once assessment is conducted, students answers will be evaluated through this module.

* Examinee management module.

All the actions, functions related to the examinee will be performed through this module.

Previous studies have shown, labeling and categorization is more helpful to analyze data in different aspects easily [2]. Also, when determining student personal skill level, Karishma khan and Janhavi patil’s study have showed Multiple choice answers are the most suitable and easiest way to collect and analyze the data in the evaluation process. Any way there are some skill parameters we can’t collect through the MCQ questions. So, in that case we have to go with descriptive answers which can be evaluated by lectures.

## Research Gap

When analyzing the previous research conducted on student performance analysis in e-learning platforms, most of them have focused on only evaluating students’ technical skills in a more accurate way. Some of them have considered some different factors like students’ confidence while answering, time management. But those data are not used for analyzing student personal skills.[2][3]

AITor - proposed e-learning platform is focusing on monitoring how the student behaves during the assessment, analyzing the student's personal skill levels, and optimizing the learning material recommendation through analyzing the learning progress.

Following table shows a tabularize format of comparing of AItor with previously conducted researches.

|  |  |  |  |
| --- | --- | --- | --- |
| **Research** | **Analyze student personal skill level** | **Additionally Considered factors in evaluations** | **Evaluate technical skills** |
| **Research A** [2] | No | Time   Confident level   Difficulty level  | Yes |
| **Research B**  [3] | No | Time   Confident level   Difficulty level  | Yes |
| **Research B**  [9] | No | Time   Confident level   Difficulty level  | Yes |
| **AITor** | Yes | Time   Confident level   Difficulty level  | Yes |

Table 1.1‑1 . Comparison of former researches

## Research Problem

When someone steps into the industry or job market, personal skills/soft skills are mandatory requirements in every field. Those required skills can vary from field to field, but those skills are considered important as same as the technical skills. Since this research is focusing on computer science students, there are a number of identified personal skills related to this field. [1]

But existing e-learning platforms have lack of ability to identify those personal skills of a student, or those platforms are not considered for analyzing student personal skills. According to the figure 1.2, majority of student don’t have any experience in understanding of their personal skills in existing learning platforms.

Chart, pie chart

Description automatically generatedFigure 1.4 - Summary of responses for student’s understanding of personal skills

According to the figure 1.4, although majority of student have an understanding about what are the personal skills, considerable amount of student doesn’t have an idea about what are the personal skills.

Graphical user interface, application, table, Excel

Description automatically generated

Figure 1.5 - Demand for personal skills in Software development by F. Ahmed, L. F. Capretz, and P. Campbell

But in fact, as previously mentioned, those skills are highly required in every position in the industry. Before moving into the industry, when they are choosing their degree path, students need to have a clear understanding of themselves. There are some fields in the IT industry that required higher problem solving, critical thinking, and analytical skills. There are some job opportunities that required creativity more than problem-solving skills. So, while both academic and career decisions personal skills have a direct impact, it’s important to get a clear understanding of personal skills as same as technical skills.

Figure 1.3 shows most of the students have a lack knowledge of personal skills demanded in the industry. Analyzing survey data shows students who studying in academic years 1,2 have a poor understanding of personal skills and their importance. This situation can lead them to make wrong choices in selecting their academic learning path. So, it’s a clear requirement to make a way for students to understand and improve their personal skills.

Another problem going to address from this research part is learning materials are not optimized according to student learning style. Traditional classroom learning styles and current e-learning platforms provide the same kind of learning materials for each student. But none of them are considered about how it can affect for the student studies. Every student has a different learning style and in traditional classroom learning style, it’s true that learning materials are not possible to optimize for each student. But when it comes to the e-learning platforms, every student has a separate learning space and since every student’s performance can be analyzed individually, learning materials can be provided according to the student’s learning style by analyzing student performance along with the provided learning martial type. But current e-learning platforms don’t have this kind of feature to support the student and teach efficiently.

# OBJECTIVES

## Main objectives

One of the main objectives of this research part is to analyze the student's personal skills same as the technical skills and give students a better understanding of their capabilities. As the final outcome, students will have a clear understanding of which skills are going to make them stand out. In this research, it’s going to focus on selected personal skills which can be measurable through assessments.

Ex:

* Analytical skills
* Problem solving skills
* Fast learning
* Creative thinking

## Specific objectives

To achieve the above main objectives, the specific objectives that needed to be attained is as follows,

1. Implement a student assessment platform to capture factors that consider in performance evaluation process.

In student performance evaluation process, system will consider several factors needed to capture during the assessments.

* Time consumed for individual questions
* Confident of answering
* Correctness of the answer

# Requirements

## Functional requirements

* Conduct assessments for completed module areas

Assessment preparation and conduct them to evaluate the student knowledge.

* Collect student confidence of answering, answering speed and content covering speed.

The web examination platform should be capable of capturing above parameters while student attending to the exam.

* Identify student personal skills

System should be able to identify the student personal skills by analyzing exam result along with the skill tags and the captured additional parameters.

* Evaluate assessments

Conducted assessment need to be marked and collect the examination outcome for the further analyze.

## Non functional requirements

* Accuracy

The outcome of this module is going to be impact on student’s future career or academic life, they need to me very accurate.

* Usability

Student assessment module contains with an online exam platform. This platform needed to be very user friendly and need to have high availability since student are attending to exams online.

* Privacy

Privacy is a highly considered here since student performance profile is very private to them.

* Reliability

Since all the examinations are conducted online, reliability is highly concern in this module.

## User requirements

* Tutor can Prepare and conduct assessments for completed module areas.

Question tagging will be used here.

* Student can attend to assessments. All the assessment will be timed assessments.
* Student and Tutor can see student’s performance report.

# Methodology

## Steps

Student performance evaluation and personal skill identification will be breakdown in to several steps.

1. Assessment preparation
2. Question tagging
3. Assessment conducting
4. Performance factor capturing
5. Answer evaluation
6. Subject based performance analysis and personal skill level determination

### Assessment preparation

Tutor or lecturer will prepare the assessment through the platform. They can based on a specific subject area or for an entire module. Assessment platform will implement in the web application to prepare and conduct the assessments.

### Question tagging

According to the research conducted by A. Sharma, they were followed a question tagging approach under several categories to analyze the data in different aspects. [2].

Since this research also going to analyze student performance in different aspects by considering several factors, question tagging approach will be used here. While preparing the assessments, tutor or lecturer can tag each and every question under different categories.

### Concept

Question will be tagged according to the learning concept it based on. There can be one or multiple tags under this category

### Difficulty level

Lecturer will be able to tag the question considering effort level required for the specific question. It will be decided by the lecturer. (Later, analyzing student’s performance, system will be able to decide the difficulty level itself). Difficulty level will be tagged as High, Medium, Low.

### Personal skills

As mentioned earlier, analyze of personal skills of the student is a one of main objective of this research. By conducting assessment there are some personal skills that can be measure.

Ex:

* Analytical skills
* Problem solving skills
* Critical thinking

Preparing assessments lecturer can tag question with required personal skills for the question. There can be multiple tags under this category.

## Assessment conducting

Prepared assessments will be conducted through the assessment platform and student will attend them through the web application.

## Performance factors capturing

When this platform is purpose to give an accurate performance analysis there are some factors need to consider. Student answering speed and answering confidence will be captured during the assessments.

## Answer evaluation

Once an assessment is conducted, answers will be evaluated through the evaluator module. MCQ questions will be evaluated through the system and descriptive answers will be evaluated by the lecturer.

## Subject based performance analysis and personal skill identification

Analyzing evaluated answers and captured performance factors, student subject-based performance level and the personal skill level will be calculated. Score will be allocated for the student performance and the personal skill level based on captured additional performance analysis factors. Student learning speed will also be considered as a performance factor.

## Implementation

Diagram

Description automatically generated

Figure 3.1 - System diagram of student performance analyze module

The implementation phase complies with the development of the functionalities below,

* Assessment preparation
* Assessment conducting
* Student behavior capturing during the assessment (answering speed and answering confidence)
* Answer evaluation and calculate score
* Subject based performance level determination
* Student’s personal skills identification

### Assessment platform development

Assessment platform will be implemented with Vue JS. Assessment preparing, conducting will be performed through the assessment platform.

### Algorithms

* Decision tree algorithm for analysis student subject based and personal skill level
* K means clustering algorithm for clustering students based on performance level

### Database Handling

Data related to student performance analysis will have structured manner. So, SQL database is the most preferred solution for data handling. MySQL will be used for the storing data for this component.

## Deployment

Amazon Web Service (AWS) will be used to deploy the proposed application and components will be containerized with the docker techniques.

# Gantt chart

Chart

Description automatically generated

# Budget

|  |  |  |  |
| --- | --- | --- | --- |
| **Service** | **Monthly** | **First 12 months total** | **Currency** |
| **AWS Fargate** | 36.04 | 432.48 | USD |
| **S3 Standard** | 1.16 | 13.92 | USD |
| **Data Transfer** | 0 | 0 | USD |
| **Amazon Simple Queue Service (SQS)** | 0 | 0 | USD |
| **Amazon Elastic Container Registry** | 0.5 | 6 | USD |
| **Amazon EC2** | 43.87 | 526.44 | USD |
| **Amazon Keyspace** | 2 | 64 | USD |
| **Other** | 20 | 240 | USD |
|  |  |  |  |
| **Cost** | 103.57 | 1282.84 | USD |
|  |  |  |  |

Table 5‑1- cloud budget justification

# References

[1] F. Ahmed, L. F. Capretz, and P. Campbell, “Evaluating the Demand for Soft Skills in Software Development,” *IT Prof.*, vol. 14, no. 1, pp. 44–49, Jan. 2012, doi: 10.1109/MITP.2012.7.

[2] A. Sharma, “A proposed e-learning system facilitating recommendation using content tagging and student learning styles,” in *2017 5th National Conference on E-Learning & E-Learning Technologies (ELELTECH)*, Hyderabad, India, Aug. 2017, pp. 1–6. doi: 10.1109/ELELTECH.2017.8074989.

[3] K. Khan, J. Patil, N. Shaikh, A. Thakur, and Z. Pirani, “Analysis of Intelligent System for Student’s Performance using E-learning Approach,” in *2018 International Conference on Smart Systems and Inventive Technology (ICSSIT)*, Tirunelveli, India, Dec. 2018, pp. 390–394. doi: 10.1109/ICSSIT.2018.8748328.

[4] P. da Silva Neves Lima, A. P. L. Ambrosio, I. M. Felix, J. D. Brancher, and D. J. Ferreira, “Content Analysis of Student Assessment Exams,” in *2018 IEEE Frontiers in Education Conference (FIE)*, San Jose, CA, USA, Oct. 2018, pp. 1–9. doi: 10.1109/FIE.2018.8659169.

[5] A. Karnad, S. Yadappanavar, and P. G. S. Hiremath, “Evaluation and validation of problem solving and thinking skills based on student academic performance,” in *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, Bangalore, May 2017, pp. 642–646. doi: 10.1109/RTEICT.2017.8256676.

[6] H. Wang and R. Zhong, “Design and Implementation of Online Exam System Based on Data Mining,” in *2011 International Conference on Internet Computing and Information Services*, Hong Kong, Sep. 2011, pp. 207–209. doi: 10.1109/ICICIS.2011.59.

[7] H. Darong and H. Huimin, “Realization and Research of Online Exam System Based on S2SH Framework,” in *2010 International Conference on Web Information Systems and Mining*, Sanya, China, Oct. 2010, pp. 396–399. doi: 10.1109/WISM.2010.11.

[8] B. Xu and Y. Liao, “The Online Exam System Research Based on the MVC Framework,” in *2021 IEEE 4th Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC)*, Chongqing, China, Jun. 2021, pp. 2179–2183. doi: 10.1109/IMCEC51613.2021.9482049.

[9] S. S. R. Abidi and A. Goh, “A Web-enabled Exam Preparation and Evaluation Service: providing real-time personalized tests for academic enhancement,” in *Proceedings IEEE International Conference on Advanced Learning Technologies*, Madison, WI, USA, 2001, pp. 441–442. doi: 10.1109/ICALT.2001.943971.