UNIVERSITY OF WESTMINSTER

Title: Physics Education Platform
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Date: April 2022
Course: BSc Computer Systems Engineering

# Abstract

Students' perceptions and attitudes toward general science, especially physics, increasingly get negative as they progress through school. Even though there has been a drastic increase in the number of physics students in high school in the past decade, students' conceptual understanding of various areas in physics remains deficient; the typical stereotype is that physics is one of the hardest science subjects. The situation is seen worse when it comes to females—students who have a more negative attitude toward the subject result from being stereotyped. Although the number of female students is now almost equal to that of male students, women do not get the same attention in physics; the behavior of their male peers affects their performance as it does the behavior of some teachers.

The study's primary goal was to develop a Physics Education Platform that would help students supplement what they are taught in class. The system consists of learning materials that will assist students in reviewing their class and conducting a test to help them know their level of understanding. The platform's main aim was to create an equitable, friendly, and motivating learning platform for all A-level physics students.

## Acknowledgment

I take this chance to express my sincere gratitude to the people who have been indirectly and directly involved during the development of the Physics Education Platform. Their versatile know-how in java applications and research has eased my struggle during the building of the project. I pay special thanks to my supervisor, **Mohammed Al-Janabi**, who has given me comprehensive guidance. I have used these contributions in every step of the development of the project.

# Contents

# 1.0 Introduction

## 1.1 Background of study

Education provides an avenue of learning and training in various schools; it enhances skills and knowledge. The main goal of education is to empower a pupil or student to excel exemplary in each area and positively impact their environment [1]. Unfortunately, the result of the education process has failed to maintain high standards of excellence among learners. Reasons associated with poor performance in education are mainly associated with education policies in admission and enrollment and perception of specific courses such as physics, teaching approach, and lack of comprehensive supplementary learning materials alternative to books and regular classes [2].

The rate of enrollment in physics course is declining drastically, the number of A level student who chooses physics at the university level is getting lower every passing day, this should be a cause of concern in our educational approach, and something needs to be done about it [3]. Traditionally adolescents start their study of physics in secondary school. Of all the sciences in school, such as biology and chemistry, physics is considered the most demanding and the most challenging subject by most students.

A subject such as biology needs more memorization of various facts; there is a lot to understand and explain; however, students still find it manageable and score well in biology. There are almost no numerical problems, graphs, or calculations to be solved, especially at the secondary school level. In chemistry, memorization makes it seem more accessible to students; one must understand electron structure and chemical equations formulas; however, many students still find chemistry manageable and easy to understand [4].

Physics is not loved by many students because:

a) The subject is more demanding.

b) Every topic involves thinking at various levels.

c) There is a traditional negative perception of physics, and thus perception has been passed through generations in school [5]. Numerous studies have shown that students' misconceptions about physics are not addressed in the right way.

d) Experiments must be conducted, and results compared with theoretical values.

e) There are graphs and calculations in physics; there are many formulas to learn.

f) Physics’ practical aspects include laboratory physics and awareness of concepts such as zero error, sensitivity, accuracy, and most minor count.

g) There is a need to remember physics laws and definitions.

h) Physics uses geometry, algebra, and calculus, and students must be good in these areas.

i) Students find it hard to relate to various topics in physics because they are abstract; these topics include atomic physics and quantum mechanics [6].

j) Physics is taught faster compared to social sciences and languages

k) The foundation of interpreting and drawing graphs is, in most cases, weak.

l) Physics is the most institution is not taught the way it should be taught. This is not the student's fault; however, students suffer.

## 1.2 Problem statement

In various ways, teaching physics has its own set of difficulties. Physics is an area many views as complex, and perhaps this is true. The subject needs sound reasoning and understanding of concepts that many students find hard to clearly understand [3]. In addition, it needs students to develop strong mathematical and analytical skills. To help students with their difficulties in physics, it is necessary to clearly understand the factors resulting in their challenges [7].

A study conducted at Rhodes University in 2017 focused its research on the first-year student as the study focus group. Various interviews were conducted with physics lecturers to have a deeper understanding and perspective as to why they thought many students struggled with physics. Based on focus groups and interviews, a framework of various issues was established; a corresponding survey was also performed in the first-year class.

These factors were divided into three categories: cognitive, subject, and practical.

**A. <u>Subject domain</u>**

i. **Mathematics**- Many interviewed academics complained about the poor foundation in mathematics. An example of the identified issue was that students could not solve variables in a complicated mathematical equation. In addition, students felt they don't clearly understand fundamental math concepts, for example, functions. Trigonometry equations are not clearly understood; students view them as just buttons in a calculator without getting to know what they exactly mean. Moreover, students lack general confidence in mathematical abilities.

ii. **Teaching**- all interviewees agreed that how physics is taught affects the general perception of the subject. Factors identified include the pace of teaching the subject by various teachers and different approaches undertaken.

iii. **Under-preparedness**- Many lectures recognized that a lot of students were not prepared for university. This means an underlying problem in high school is dragged into the university. A lot of concepts are not well addressed in the previous levels, resulting in many challenges in higher learning.

**B. <u>The cognitive domain</u>**

i. **Compartmentalisation**- Students tend to compartmentalize their knowledge of physics. Various Physics lecturers suggested that physics becomes more straightforward when students view things in the big picture instead of compartmentalizing their knowledge.

ii. **Language**- Students find it difficult to read independently because various books use big words that students don't understand, hence killing their reading morale. On the other hand, lecturers and teachers use big words during their class, making it challenging for students to understand. Most of the students that raised this point do not use English as their first language.

iii. **Understanding** - it was established that most students tend to learn the formula and memorize concepts instead of understanding them. Time was recognized as the main contributor; students said they didn't have enough time for various concepts to sink in.

iv. **Problem-solving** - students tend to identify the procedure to follow rather than solving the actual problem at hand. Problem-solving was a factor that had a significant amount of attention from various literature.

v. **Expectations**-various academics had the general perception of what learning physics would be like. These expectations were based on the exciting physics side they learned in the media. The natural side of physics might not precisely resemble what is portrayed in the 'exciting physics,' which can primarily affect student performance.

vi. **Misconceptions**- there is the notion that has been passed from generation to generation in school that physics is complex. This perception affects students' attitude toward physics, suggesting that the subject is too complex, and they can't understand its concepts.

**C. The affective domain**

i. **Emotions** - physics and teachers said that if students don't have the right kind of support, they may find the subject to be lonely. Students lose motivation when they take too much time solving a single problem.

ii. **Genders**- it was identified that there is stereotyping regarding physics. Boys make fun of girls who decide to do physics, making it challenging for them.

iii. **Fear and anxiety**- Students fear bad marks more than not. Students at all levels, whether university or high school, worry about failing in the subject. When they finish a physics course, they might not remember essential topics learned.

The findings of this literature review were directly used to create a learning education platform that is equitable and motivating to all A-level students. Techniques applied included giving students the freedom to choose and promoting a sense of responsibility, encouraging positive male adolescent behavior, creating a collaborative and entertaining learning platform, promoting an equitable learning environment for all students, and connecting the curriculum to the real world.

To address the problem encountered in physics, I developed a Physics Education Platform that supplements students' learning in the classroom. This is aimed to help students have a different point of view during their learning process. The system consists of study material in videos, text, and images. To make reading easier and change the negative perceptions of topics in physics, the platform employs visual graphics. As the name suggests, visual representations help students connect new ideas, practice critical thinking, and grasp new concepts. According to research, the human brain processes visual information faster than text; it is easier to remember something I saw than something I read. Therefore, this principle is applied to the platform to make learning easy.

## 1.3 Aim and Objectives

1. To provide learning materials to physics students.
2. To offer a more interactive learning environment to physics students making it more practical and exciting.
3. To provide assessments and quizzes.
4. To support teaching students fundamental and practical topics in Physics.

# 2.0 Main Body

## 2.1 Planning and Design

The Waterfall methodology was used to plan, design, and develop the system- it provided a framework used to plan, structure, and control all the processes during the development of the Physics Education Platform. The methodology provided a rigid structure which means all requirements were well defined before beginning the development of the system.

1. **Requirement** - through a series of research, a gap was identified, poor attitude and perception toward physics. Then a proposal was written down to document and show why the Physics Education Platform was needed. A poster was also written down to present the proposal.
2. **Design-**A technical solution was developed for the identified problems; everything was designed based on the system requirements; it is including layouts, scenarios, and data models. A logical design of the system was designed then a physical design was created.
3. **Implementation-**After completion of design, the system was developed using java Language and JavaFX aided by the spring boot framework.
4. **Testing-**Unit Testing was used to test Physics Education Platform modules such as login, signup, lessons, and assessment.

## 2.2 Choices of software or programming language -why java?

The java language and JavaFX was the program of choice, aided by the spring boot framework. The reason for using java and JavaFX was because the target platform was a desktop, java is ideal for this, and the fact that it easily pairs with the spring boot framework is natively written in java. It made developing the program easier than initially perceived.

### 2.3 Software organization

### 2.3.1 System flowchart

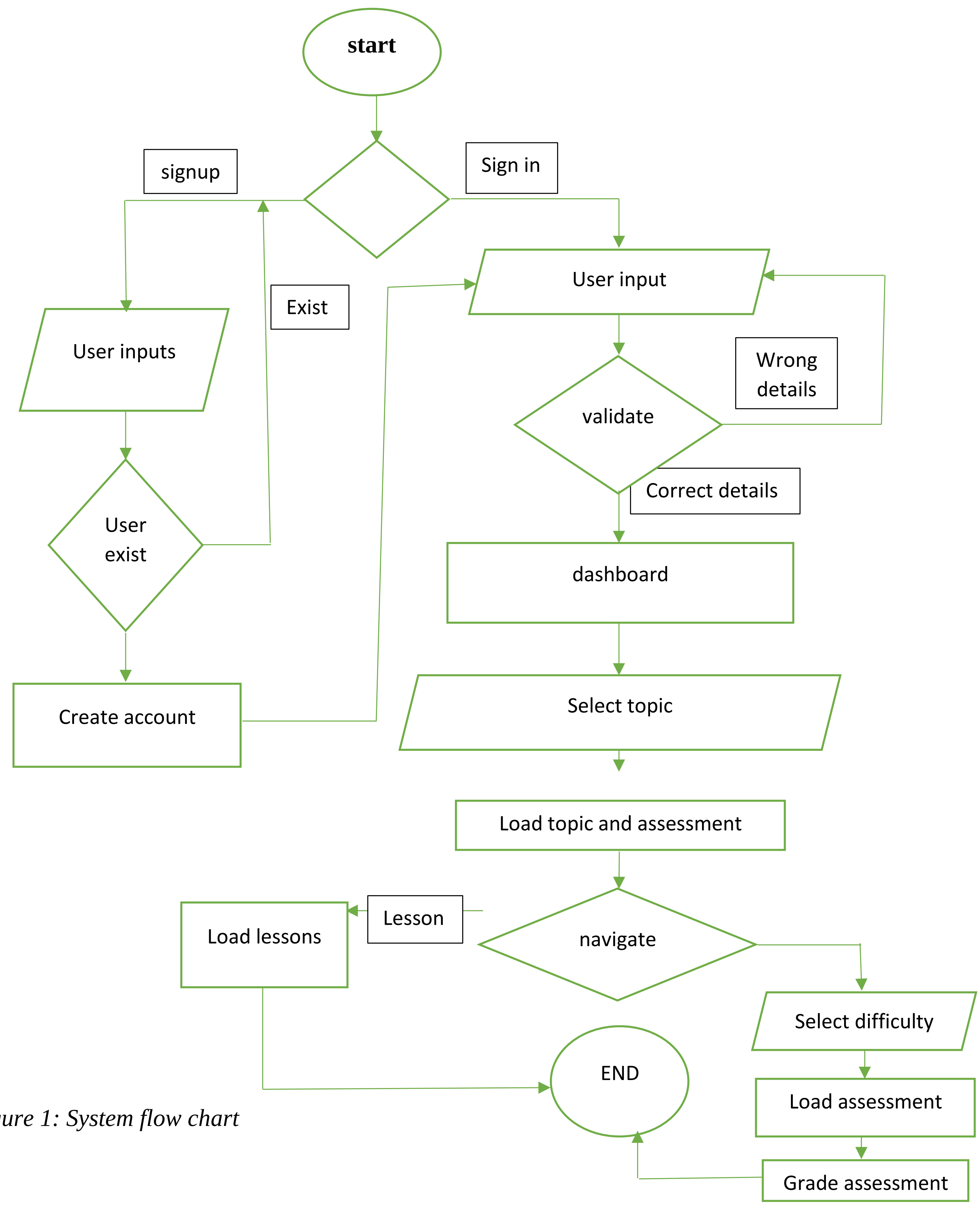



*Figure 1: System flow chart*

### 2.3.2 Graphical user interface

The system is built on the MVC design pattern where I have models which represent the database objects, views that are fxml-based windows that the user interacts with, and a controller which binds the view to the logic. A spring boot component service further backs the controller. The service manipulates the data and interacts with the database through a repository that extends the spring JPA repository. JPA (Java Persistence API) abstracts most of the database-related tasks, allowing most focus on developing the business logic.

JavaFX and Spring Boot Framework power all the above. The need for the spring framework is majorly to provide rapid development of the database logic, security for password encryption, and creation of the POJOs.

The first screen the user interacts with on start-up is the login, as shown below in **Figure 2:**

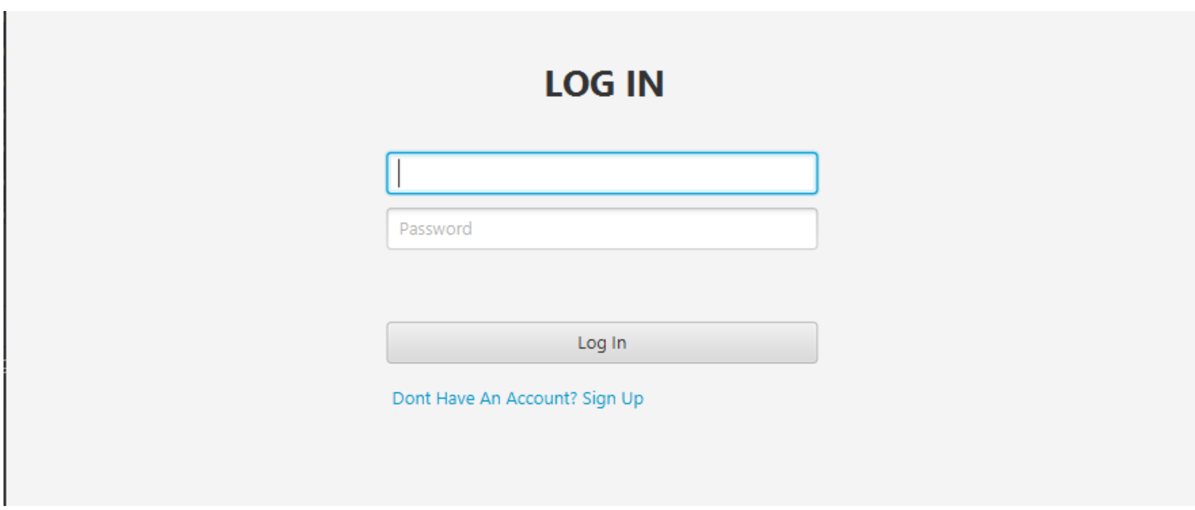



*Figure 2: login*

If the user doesn't have an account, they can create one by clicking on the "don't have an account? Sign up " link, which leads to the next screen shown below in **Figure 3:**

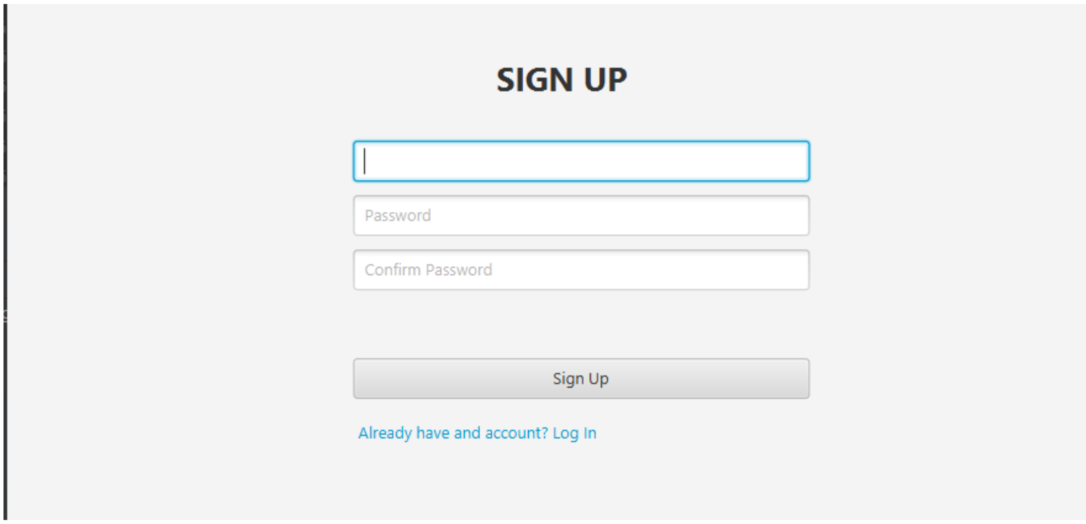



*Figure 3: sign up*

Once logged in, the dashboard is the following screen the user interacts with. The dashboard has main options, i.e., The major education topics covered by the platform:

1. Astronomy
2. Electricity
3. Laws Of Physics
4. Mechanics

This screen is shown below in **Figure 4:**

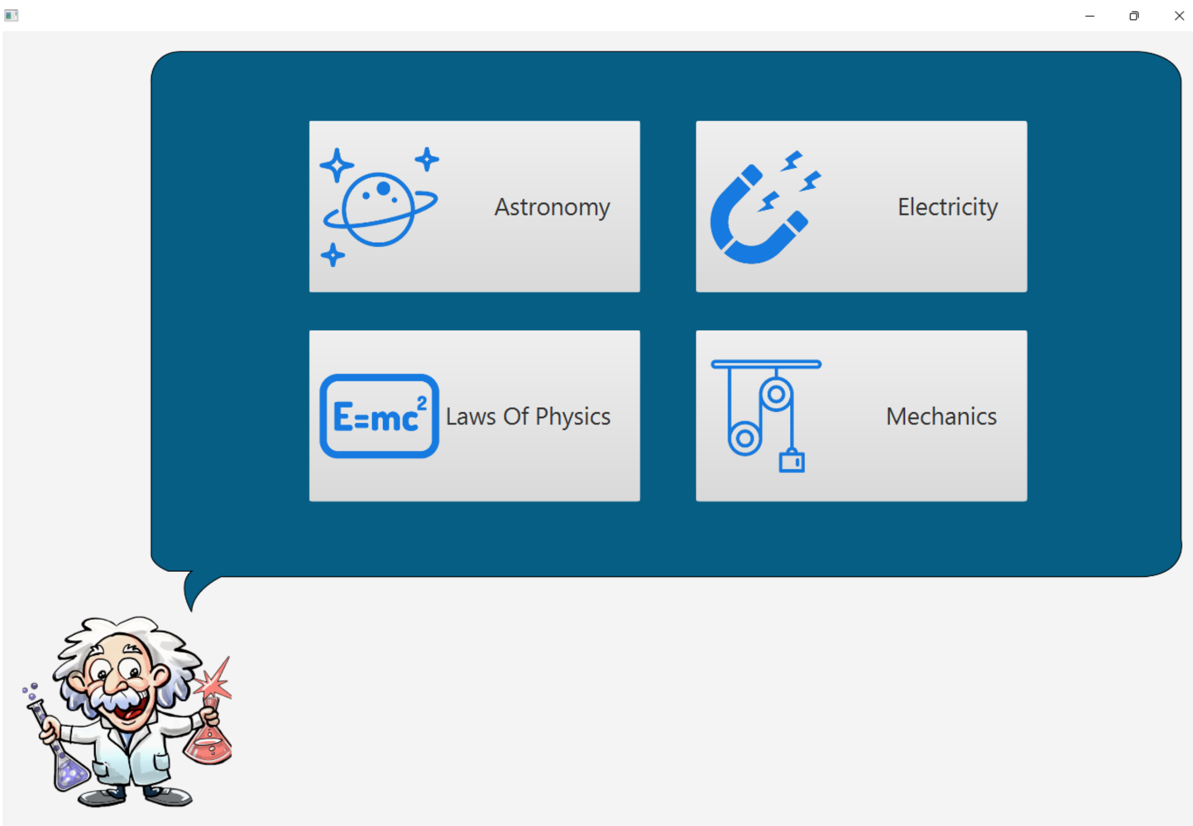



*Figure 4: Dashboard*

On selecting an option, the following screen is an area to learn and assess oneself against the chosen topic of study. **Figure 5** below shows a lesson about electricity

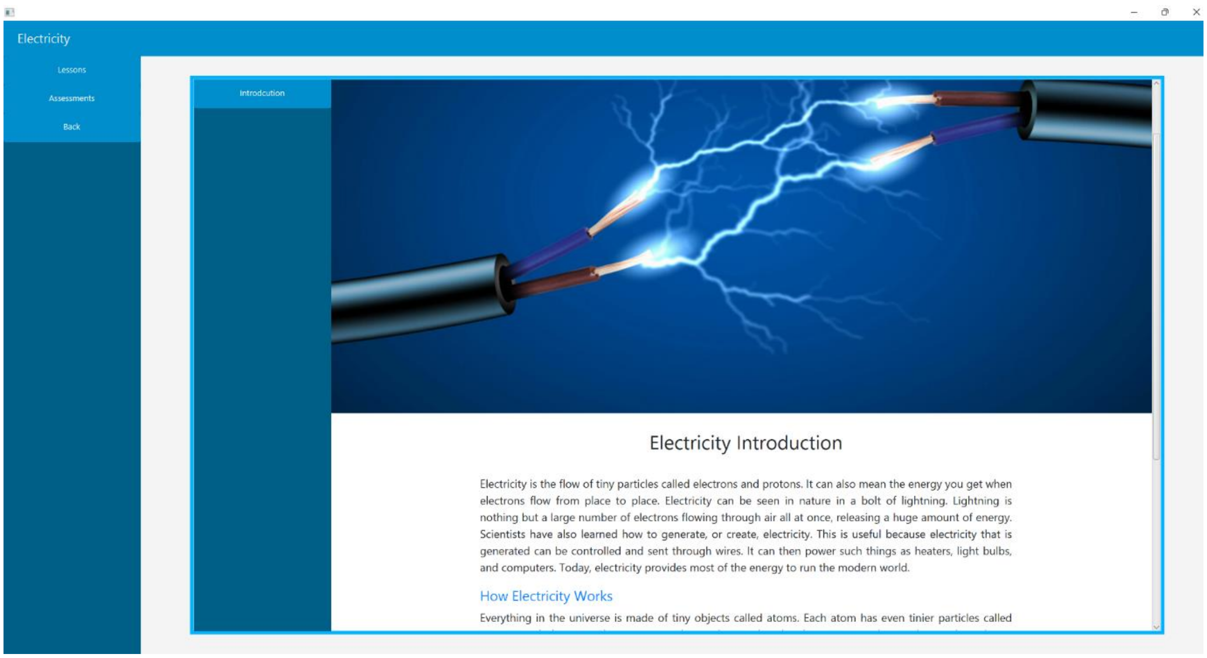



*Figure 5: lesson 1*

Also below is **Figure 6,** showing an astronomy lesson.

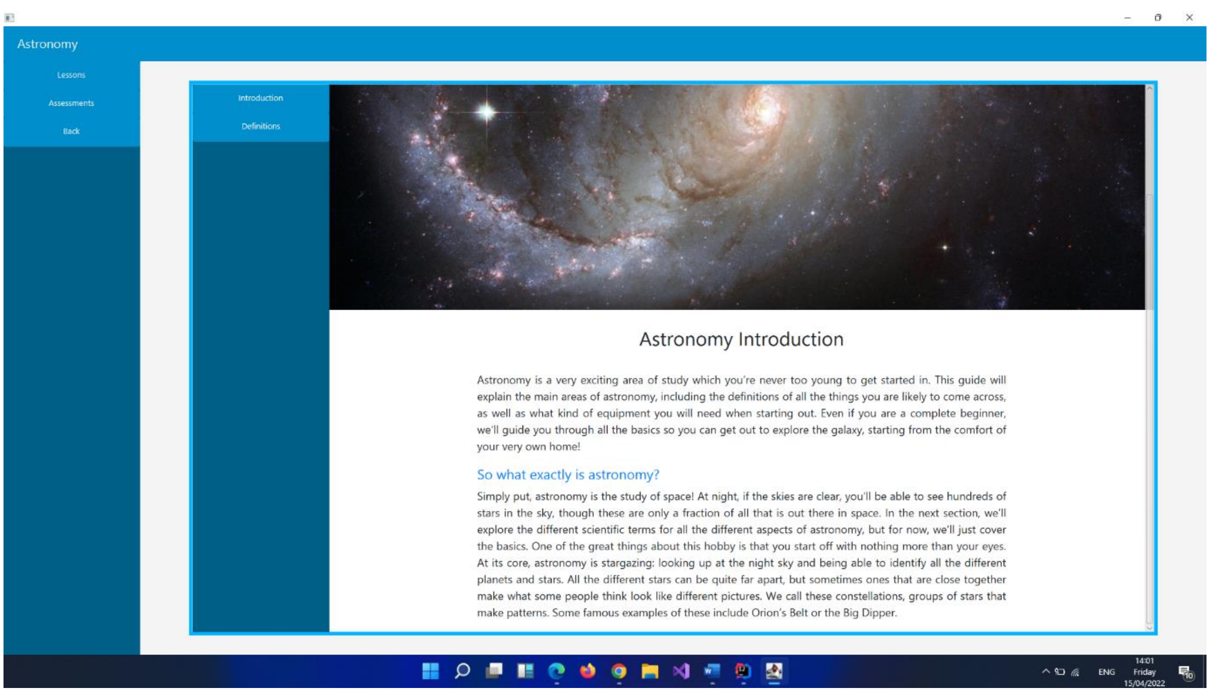
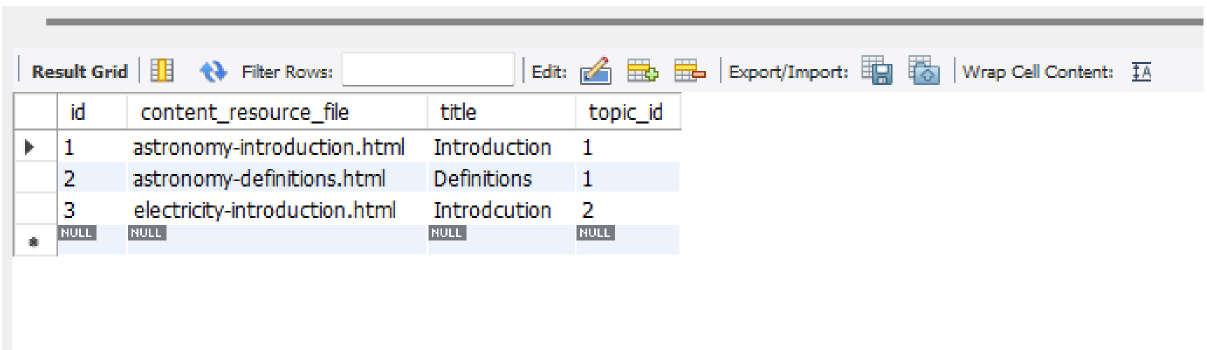



*Figure 6: lesson 2*

The lessons displayed are HTML-based. Rendering lessons as web content allows easy creation of the content and adding features that will make it interactive. Creating the same using plain java or JavaFX would not be labour intensive. The set up in the lessons table where the admin creates a record for a lesson. The record has a topic ID and a foreign key, and the HTML file name is shown below in **Figure 7:**





| id | content_resource_file | title | topic_id |
|---|---|---|---|
| 1 | astronomy-introduction.html | Introduction | 1 |
| 2 | astronomy-definitions.html | Definitions | 1 |
| 3 | electricity-introduction.html | Introdcution | 2 |
| NULL | NULL | NULL | NULL |

*Figure 7: lesson table*

The created files are stored in the application's resources folder, as shown below. This has a disadvantage since when you add a new page, the application must be restarted to pick up the changes in the resource directory shown below in **Figure 8:**

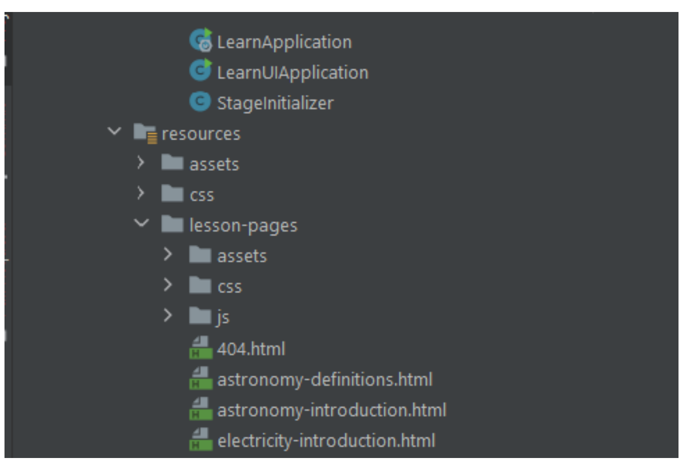




*Figure 8: folder*

Once all this is set up, the system is ready to deliver an exquisite learning experience.

The assessments are also a significant part of every topic. The user clicks on the assessment tab and is prompted to select an assessment level, as shown below in **Figure 9:**

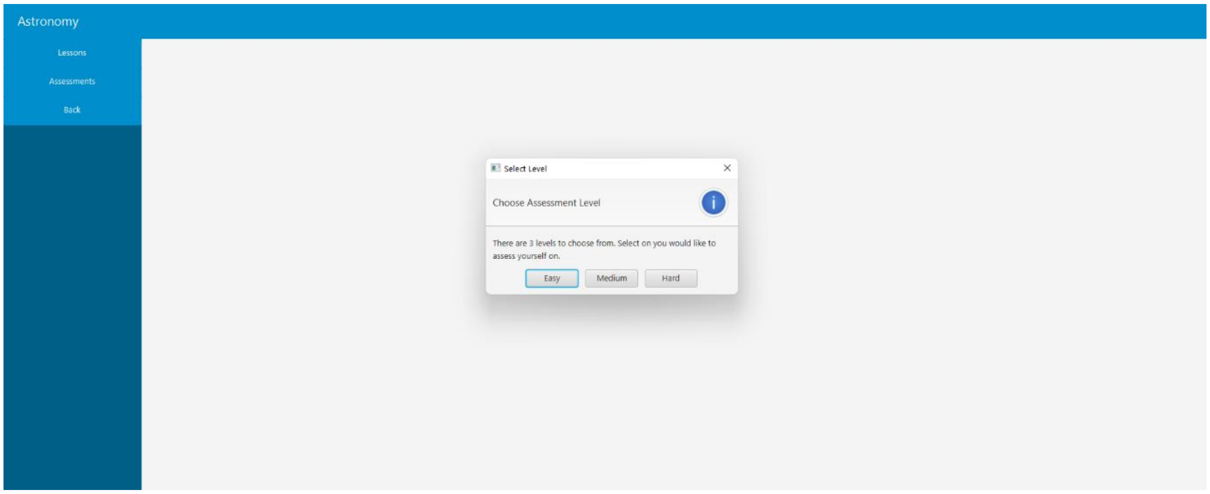



*Figure 9: assessment level*

Once a choice is selected, the user can proceed to undertake an assessment. A sample assessment is shown below in **Figure 10:**

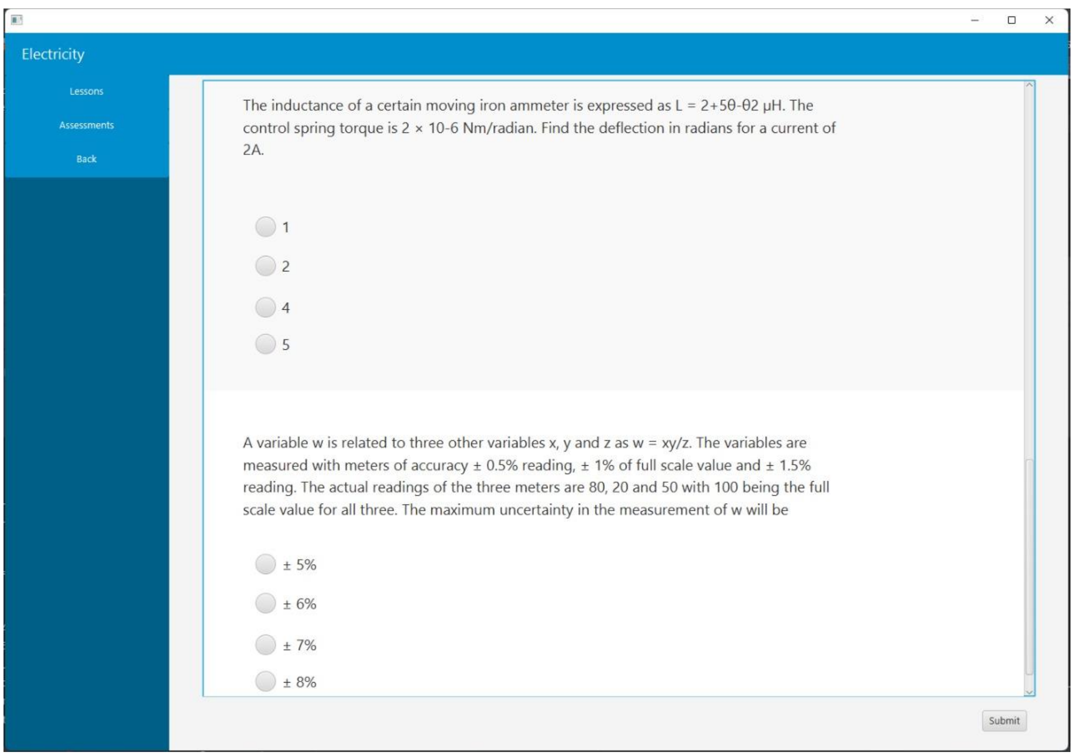



*Figure 10: sample assessment*

The assessments are also loaded from the database based on the current topic and assessment level. The figure below, **Figure 11** shows the table associated table with sample data. We have difficulty with the question, the associated topic, the question, the choices, and the answer index. The choices MUST always be four options delimited by a comma. The answer index is the value of the zero-based position index of the string when separated by the commas. E.g., as shown in **Figure 11**,as seen in row one, the answer index is 1, meaning the correct answer is Venus.

Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

| id | answer_index | choices | difficulty | question | topic_id |
|---|---|---|---|---|---|
| 1 | 1 | Mars,Venus,Mercury,Pluto | EASY | Which is the second planet from the sun? | 1 |
| 2 | 1 | Jupiter,Mars,Neptune,Uranus | EASY | Phobos and Deimos are moons of which planet in our solar system? | 1 |
| 3 | 3 | Venus,Earth,Mars,Jupiter | EASY | What is the fifth planet from the sun? | 1 |
| 4 | 2 | Lupus,Aquila,The plough,The most ploughed | EASY | In astronomy, ‘The Big Dipper’ is another name for which constellation? | 1 |
| 5 | 0 | Jupiter,Saturn,Earth,Mercury | EASY | Which is the fastest rotating planet in our solar system? | 1 |
| 6 | 1 | 33%,50%,75%,98% | EASY | The efficiency of a transformer is usually of the order of? | 2 |
| 7 | 0 | Very High,Low,Medium,As Low as possible | EASY | The internal impedance of an accurate voltmeter should be | 2 |
| 8 | 2 | electronic tubes or transistors,non-linear elements,All the above,powdered ... | EASY | Ohm’s law cannot be applied to the circuits consisting of | 2 |
| 9 | 1 | random movements of electrons in a conductor,movement of free electro... | EASY | An electric current is the? | 2 |
| NULL | NULL | NULL | NULL | NULL | NULL |

*Figure 11: answers*

### 2.3.2 Coding

Security Configurations

```
package com.sc.learn.models;

import lombok.Data;

import javax.persistence.*;

@Entity
@Data
public class Lesson {

    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;

    private String title;

    private String contentResourceFile;

    @Column(name = "topic_id")
    private Long topicId;

    @ManyToOne()
    @JoinColumn(name = "topic_id", referencedColumnName = "id",updatable =
false,insertable = false)
    private Topic topic;

}
```

*Figure 12: security configuration code*

Service Sample (Lessons Service)

```
package com.sc.learn.service.impl;

import com.sc.learn.models.Lesson;
import com.sc.learn.repository.LessonRepository;
import com.sc.learn.service.LessonService;
import org.springframework.stereotype.Service;

import java.util.List;

@Service
public class LessonServiceImpl implements LessonService {

    private final LessonRepository lessonRepository;

    public LessonServiceImpl(LessonRepository lessonRepository) {
        this.lessonRepository = lessonRepository;
    }

    @Override
    public List<Lesson> getLessonsByTopicId(Long Id) {
        return lessonRepository.findByTopicId(Id);
    }
}
```

*Figure 13: service code*

Repository Sample (Questions Repository) – Interacts with the database via JPA

```
package com.sc.learn.repository;

import com.sc.learn.enums.Difficulty;
import com.sc.learn.models.Questions;
import org.springframework.data.jpa.repository.JpaRepository;

import java.util.List;

public interface QuestionsRepository extends JpaRepository<Questions,Long>
{

    List<Questions> findByTopic(Long topicId);

    List<Questions> findByTopicIdAndDifficulty(Long topicId, Difficulty
difficulty);

}
```

*Figure 14: questions repository*

Main Class

```
package com.sc.learn;

import javafx.application.Application;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class LearnApplication {

    public static void main(String[] args) {
        Application.launch(LearnUIApplication.class,args);
    }

}
```

*Figure 15: main class*

LearnUIApplication – Enables Javafx to leverage the features of spring boot.

```
package com.sc.learn;

import javafx.application.Application;
import javafx.application.Platform;
import javafx.stage.Stage;
import org.springframework.boot.builder.SpringApplicationBuilder;
import org.springframework.context.ApplicationEvent;
import org.springframework.context.ConfigurableApplicationContext;

public class LearnUIApplication extends Application {

    //Get the spring application context
    private ConfigurableApplicationContext applicationContext;

    @Override
    public void init() {
        applicationContext = new
SpringApplicationBuilder(LearnApplication.class).run();
    }

    @Override
    public void start(Stage stage) {
        applicationContext.publishEvent(new StageReadyEvent(stage)
    }

    //Tear down
    @Override
    public void stop() {
        applicationContext.close();
        Platform.exit();
    }

    static class StageReadyEvent extends ApplicationEvent {
        public StageReadyEvent(Stage stage) {
            super(stage);
        }

        public Stage getStage() {
            return ((Stage) getSource());
        }
    }
}
```

*Figure 16: learnUIapplication*

Stage Initializer – Initializes the application stage.

```
package com.sc.learn;


import javafx.fxml.FXMLLoader;
import javafx.scene.Parent;
import javafx.scene.Scene;
import javafx.stage.Stage;
import org.springframework.beans.factory.annotation.Value;
import org.springframework.context.ApplicationContext;
import org.springframework.context.ApplicationListener;
import org.springframework.core.io.Resource;
import org.springframework.stereotype.Component;

import java.io.IOException;

import static com.sc.learn.LearnUIApplication.*;

@Component
public class StageInitializer implements
ApplicationListener<StageReadyEvent> {

    @Value("classpath:/login.fxml")
    private Resource fxmlResource;

    private final ApplicationContext applicationContext;

    public StageInitializer(ApplicationContext applicationContext) {
        this.applicationContext = applicationContext;
    }

    @Override
    public void onApplicationEvent(StageReadyEvent event) {
        try {
            FXMLLoader loader = new FXMLLoader(fxmlResource.getURL());
            loader.setControllerFactory(applicationContext::getBean);

            Parent parent = loader.load();
            Stage stage = event.getStage();
            stage.setScene(new Scene(parent));
            stage.show();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

*Figure 17: stage initializer*

## 2.4 Testing

In my project, I used unit testing (a software development process used to test the smallest testable components in a project) to determine whether the system was working as required as per the initial requirements. Unit tests using JUnit. Unit testing is a suitable method since it addresses the fundamental building blocks that result in the entire application. Junit, a java testing library, is ideal for doing this. The use of unit testing is shown below in **Figure 18 & 19:**

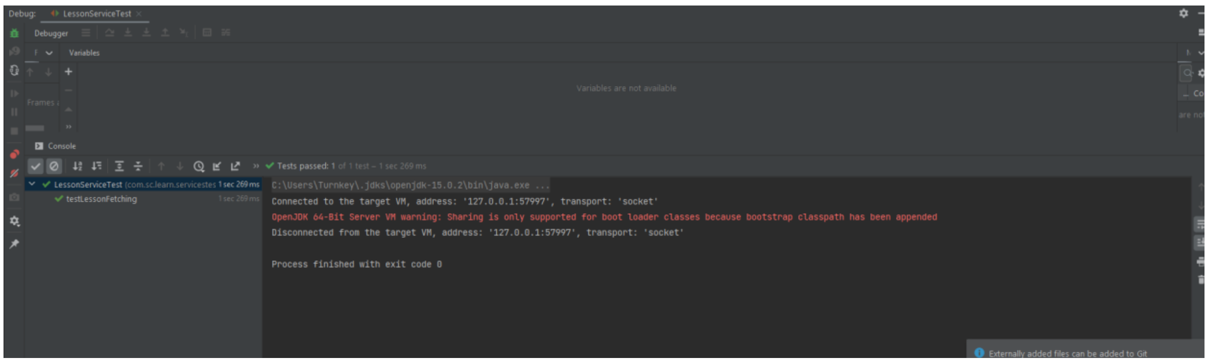



*Figure 18: test1*

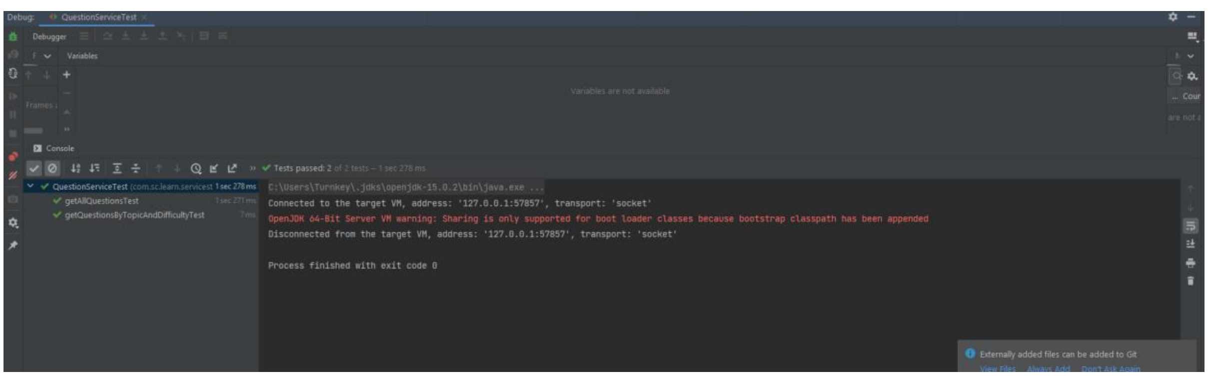



*Figure 19: test2*

These units include

1. **Sign-up and login areas** - I tested using different passwords and usernames to determine whether the system was using the proper authentication criteria. In addition, data filtering was tested, for instance, the use of only emails in the 'email' text boxes.
2. **Dashboard**- in the dashboard, the design was analysed to check whether the system displayed menu items in the right way.
3. **Assessment section**- the assessment area was tested to check whether the grading criteria were correct.
4. **Lessons** - the lesson section was also tested to check whether the design was satisfactory and user friendly.

## 2.5 Problems encountered during development and their solutions

The major problem was integrating spring boot with JavaFX to get the best of both worlds and rendering the lesson, using a WebView to generate HTML contents that serve as a platform to make the learning process more user-friendly and immersive. After a series of research, I finally managed to integrate spring boot with JavaFX and rendered lessons in the system using web view.

## 3. Workplan

### 3.1 Ghantt chart

| Activities\Dates | November 2021 | December 2021 | January 2022 | February 2022 | March 2022 | April 2022 |
|---|---|---|---|---|---|---|
| Research of the problem | | | | | | |
| Creating a poster | | | | | | |
| Proposal writing | | | | | | |
| System Design | | | | | | |
| System Implementation | | | | | | |
| Testing | | | | | | |
| Report writing | | | | | | |

*Figure 20: Gantt chart*

### 3.2 Milestoned workplan

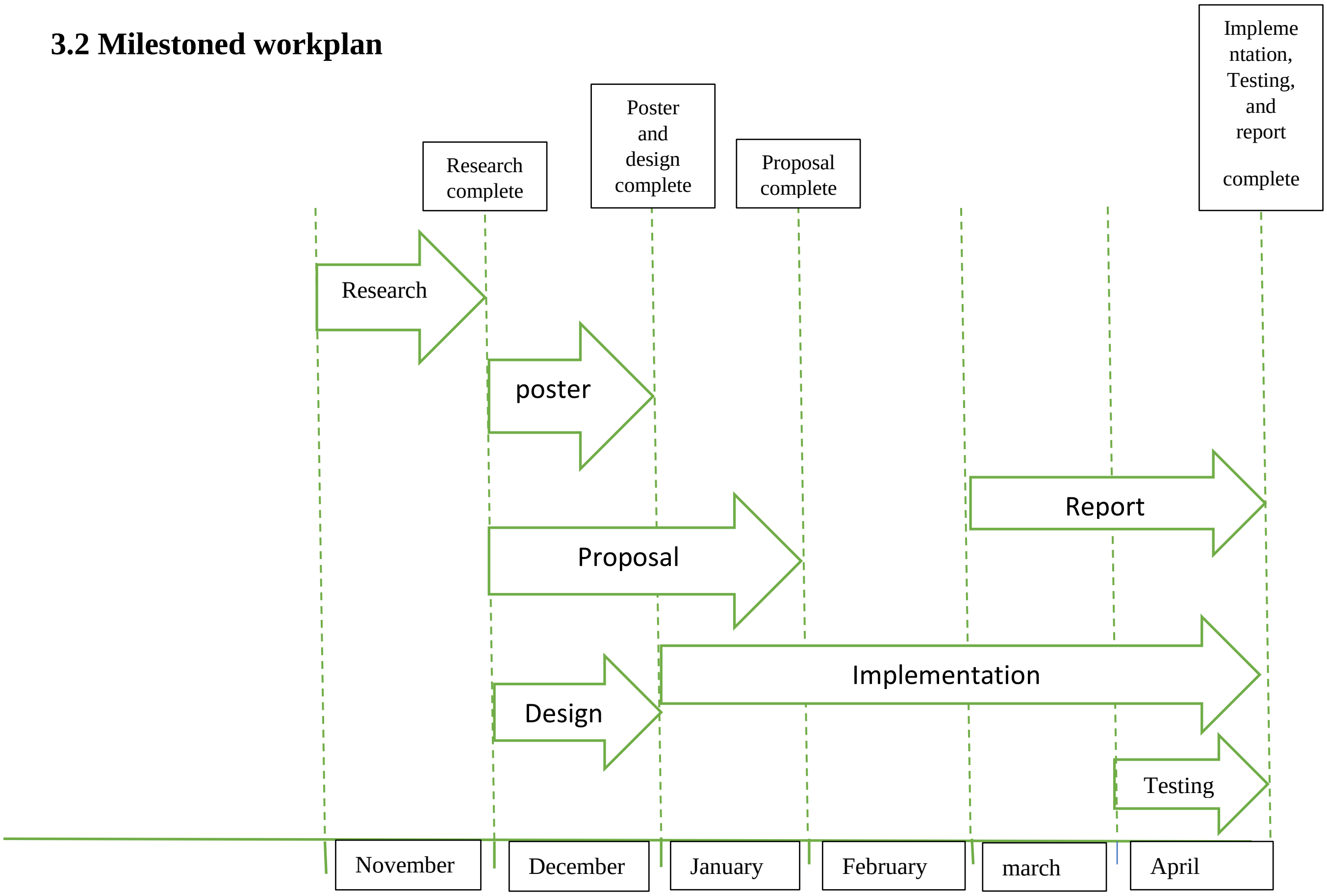



*Figure 21: milestoned workplan*

### 3.3 Work Breakdown Structure (WBS)

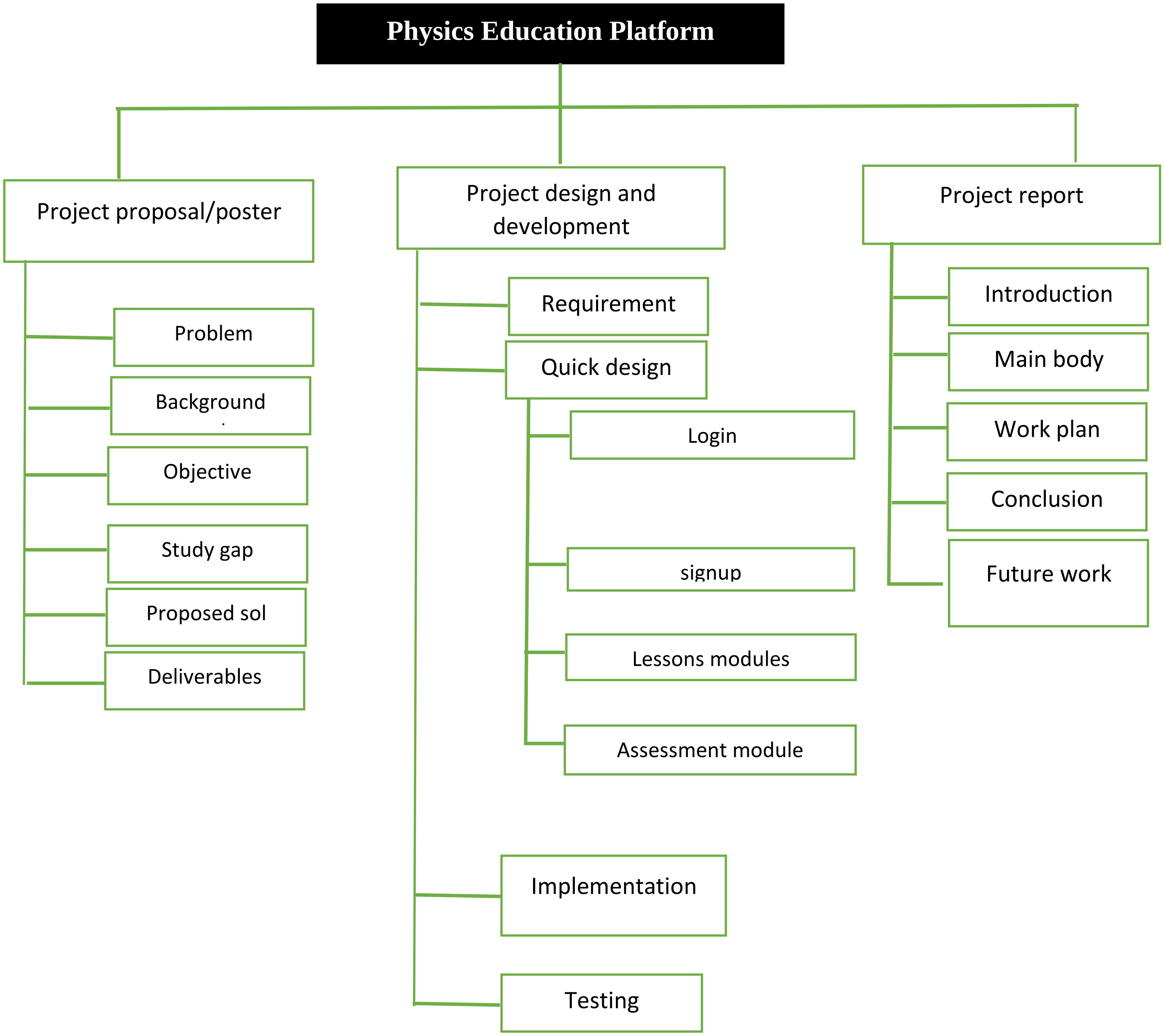



*Figure 22: wbs*

### 3.4 Benefits of Physics Education Platform

i. The system will provide supplementary learning materials to physics students.

ii. The platform will offer a more practical, more interactive learning environment and hence exciting.

iii. Assessments and quizzes will help students practice and know their understanding of a given topic

iv. The system will ensure equitable learning regardless of gender or background of origin; everybody can access the system for free.

### 3.5 Limitations of Physics Education Platform

i. The system is focused only on physics courses which limit other students in other course from learning from it.

ii. The system is an offline desktop application which means it will be difficult to access it online from anywhere.

### 3.6 Ethical and legal considerations

Physics Education Platform is an original idea built and developed from scratch; any attempt to copy its contents or materials is illegal. As far as any physical or mental harm it may cause to students, there are no causes for concern.

### 3.7 What worked or didn't work?

During the development of the Physics Education Platform, I encountered various problems that I have already mentioned in chapter 2.5. it was mainly just cooperating the database with the java coding to work together to create the system as per the initial requirements and plan.

However, all those challenges did not deter the system from fully implementing all the requirements. Therefore, creating a functioning system in the end.

## 4. Conclusion

The physics education platform will enhance physics learning in school and develop a positive attitude towards the subject. It will provide supplementary learning materials and methods; hence students can understand the fundamental concepts of physics. The practical aspects of the platform will enhance a more profound understanding of the subject. Quizzes and assessments will help cement what has already been learned in class.

The system was able to fulfil all the stated aims and objectives that was stated in the project specification form submitted before the beginning of the project. According to the project specification form the aim of the project was to develop a software tool that supported teaching students fundamental and practical topics in physics. I believe that I have met that aim and have created a software that teaches students physics. The primary goals were to develop problem solving exercises with different difficulties, develop assessments on the topics, decide the main topics that will be taught, develop, and implement a software tool that will embed the problem-solving exercises and assessments, add labelled diagrams and to devise a strategy to test the tool. I feel that I have followed the project specification form from the beginning of the project and used it as a path to clearly outline the order in the tasks I need to complete the project, I feel that because of this the primary goals stated were met at the end with the Physics Education Program that I have developed.

## 5.0 Suggestions for Further Work

Physics Education Platform is a desktop application; I suggest in the future that the system be a web-based application to enhance accessibility by students all over the world. Students do not only face difficulties in physics. Therefore, the future system should incorporate other courses and subjects as well. I also suggest tackling the secondary goals that were stated in the project specification form at the beginning of the project development phase. Adding worked examples, step by step answers to students mistakes and video demos to enhance the interactions between the students and the program further.

# References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# Appendix

Project specification form:

## PROJECT SPECIFICATION FORM

**Project Title:** Developing a Physics software tool for secondary school students

**Student Name:** Aaish Bakhtiar Year: 2021/22

**Supervisor(s):** Dr Mohammed Al-Janabi

**AIMS and DESCRIPTION**

The aim of the project is to develop a software tool to support teaching students fundamental and practical topics in Physics. The program will offer users a wide range of topics with different levels of difficulty. It will be user-friendly and where appropriate produce labelled diagrams to enhance the understanding of difficult concepts.

**PRIMARY GOALS**

1. Research, investigate educational websites and other online resources that teach Physics and Applied Mathematics. Research and critically compare the advantages and limitations of these tools.
2. Develop problem solving exercises with different levels of difficulty from Mechanics and Electricity. These will be developed and presented to make them more engaging and fun to use. Problems will be devised on space and healthy-living applications.
3. Develop different types of assessments and quizzes from Mechanics, Electricity and Applied Mathematics that will help monitor student progress.
4. Decide the topics, features, functions, and the overall layout of this tool at the system-level.
5. Develop and implement a software tool that will embed these problem-solving exercises and assessments to support the teaching of Physics to secondary school students.
6. Develop this teaching tool further to enable it to produce labelled diagrams to improve the understanding of difficult topics.
7. Devise a strategy to comprehensively test this teaching tool.

**SECONDARY GOALS**

1. Develop this teaching tool further to incorporate worked examples in Physics that will involve multiple steps to obtain the final answers.
2. Develop recorded demos and embed them in this teaching tool to enhance its user-friendliness.
3. Incorporate different levels of challenge to cater for students with different academic abilities.

**RESOURCES NEEDED**

Programming – Java, Physics and Applied Mathematics

**HEALTH and SAFETY ASSESSMENT**

Low Risk, No special requirements or precautions.

**ETHICAL ISSUES**

None

Supervisor(s) Signature: Mohammed Al-Janabi Student's Signature: Aaish Bakhtiar

Date: 13th October 2021 Date: 13/09/2021

**LearnApplicationTests.java**

```
package com.sc.learn;

import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;

@SpringBootTest
class LearnApplicationTests {

    @Test
    void contextLoads() {
    }

}
```

**StageInitializer.java**

```
package com.sc.learn;


import javafx.fxml.FXMLLoader;
import javafx.scene.Parent;
import javafx.scene.Scene;
import javafx.stage.Stage;
import org.springframework.beans.factory.annotation.Value;
import org.springframework.context.ApplicationContext;
import org.springframework.context.ApplicationListener;
import org.springframework.core.io.Resource;
import org.springframework.stereotype.Component;

import java.io.IOException;

import static com.sc.learn.LearnUIApplication.*;

@Component
public class StageInitializer implements ApplicationListener<StageReadyEvent> {

    @Value("classpath:/dashboard.fxml")
    private Resource loginResource;
    private final ApplicationContext applicationContext;

    public StageInitializer(ApplicationContext applicationContext) {
        this.applicationContext = applicationContext;
    }

    @Override
    public void onApplicationEvent(StageReadyEvent event) {
        try {
            FXMLLoader loader = new FXMLLoader(loginResource.getURL());
            loader.setControllerFactory(applicationContext::getBean);

            Parent parent = loader.load();
```

```
            Stage stage = event.getStage();
            stage.setScene(new Scene(parent));
            stage.show();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

**LearnUIApplication.java**

```
package com.sc.learn;

import javafx.application.Application;
import javafx.application.Platform;
import javafx.stage.Stage;
import org.springframework.boot.builder.SpringApplicationBuilder;
import org.springframework.context.ApplicationEvent;
import org.springframework.context.ConfigurableApplicationContext;

public class LearnUIApplication extends Application {
    private ConfigurableApplicationContext applicationContext;

    @Override
    public void init() {
        applicationContext = new SpringApplicationBuilder(LearnApplication.class).run();
    }

    @Override
    public void start(Stage stage) {
        applicationContext.publishEvent(new StageReadyEvent(stage));
    }

    @Override
    public void stop() {
        applicationContext.close();
        Platform.exit();
    }

    static class StageReadyEvent extends ApplicationEvent {
        public StageReadyEvent(Stage stage) {
            super(stage);
        }

        public Stage getStage() {
            return ((Stage) getSource());
        }
    }
}
```

**LearnApplication.java**

```
package com.sc.learn;

import javafx.application.Application;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class LearnApplication {

    public static void main(String[] args) {
        Application.launch(LearnUIApplication.class,args);
    }

}
```