HIGHER EDUCATIONAL ESTABLISHMENT
OF THE UNION OF COOPERATIVE SOCIETIES OF UKRAINE
«POLTAVA UNIVERSITY OF ECONOMICS AND TRADE»

FOREIGN STUDENTS DEPARTMENT

THE DEPARTMENT OF MATHEMATICAL SIMULATION AND SOCIAL INFORMATICS

Allowed to defend

Head of the Department _____ O.O. Iemets
(signature, initials, surname)

«____»_____ 20 __ y

DIPLOMA THESIS
EXPLANATORY NOTE

on topic:
DEVELOPMENT OF AN ALGORITHM AND ITS SOFTWARE FOR THE SIMULATOR OF THE DISTANCE LEARNING COURSE "ALGEBRA AND GEOMETRY" ON THE TOPIC "A PLANE IN SPACE"

major 122 «Computer Sciences»

Student who prepared the thesis *Chagonda Nyasha Stanley* _____
(SNP) (signature, data)

Scientific supervisor _____ _____
(academic degree, academic status, SNP) (signature, data)

Poltava – 2021

ABSTRACT

Note: 42 p., 34 fig., 0 tables, 2 appendex (on 38 pages), 6 sources.

The object of development is creating software for the distance learning platform to assist students with Algebra and Geometry

The subject of development is creating an application for the distance learning course on the topic “A plane in space” in “Algebra and Geometry”.

The *aim* of the simulator is for the simulator to be used as training aid or even as a substitute to assist students with grasping the concepts of the mathematical discipline.

The following methods for the development have been used:

- The JavaFx environment
- The algorithmization for creating the distance learning course simulator
- Scene Builder for creating the user interface
- Algebra and Geometry methods

Keywords: SIMULATOR, ALGEBRA, GEOMETRY, PROGRAM, PLANE, SPACE, JAVA, FXML, APPLICATION.

CONTENT

LIST OF SYMBOLS, UNITS, ABBREVIATION AND TERMS

Symbols, units, abbreviations, terms	Explanation of symbols, units, abbreviations, terms
Simulator	a program enabling a computer to execute program
FXML	a scriptable, XML-based markup language for constructing Java object graphs
Algorithm	a process or set of rules to be followed in calculations or other problem-solving operations
Java	a high-level programming language

INTRODUCTION

Algebra and Geometry is a branch of mathematics, classically studying zeros of multivariate polynomials. The fundamental objects of study in algebraic geometry are algebraic varieties, which are manifestations of solutions of systems of polynomial equations.

In this work is a complete breakdown of the processes behind the creation of a training simulator for the topic, “Plane in space”. In the recent times education has taken a different form, it is not as necessary as it was before for students to physically attend classes. Nowadays a considerable amount of people participate in online classes. A simulator is an efficient and effective teaching aid, especially with distance learning.

Purpose of work is to create a simulator for the topic “Plane in space” to be used as training aid or even as a substitute to assist students with grasping the concepts of the educational discipline “Algebra and Geometry”.

To realize the aim of the work we have to implement the following tasks:

- study the corresponding lit and material from the dist course on algebra and geometry, to review the corresponding simulators
- to formulate corresponding problems and to work over theoretical question
- to create the algorithm of the work of the simulator
- to choose the language of programming taking into consideration possible implementation of it in the module platform
- to think over the structure and design of the simulator, to write the program according to the algorithm
- to check the correctness of the simulator's work

The object of development is creating software for the distance learning platform to assist students with Algebra and Geometry

The subject of development is creating an application for the distance learning course on the topic “A plane in space” in “Algebra and Geometry”.

The following methods for the development have been used:

- The JavaFx environment.
- The algorithmization for creating the distance learning course simulator.
- Scene Builder for creating the user interface.
- Algebra and Geometry methods .

The work consists of an introduction, the problem statement, information review of similar works, the theoretical part which includes the algorithmization of the topic of the work and the justification of the choice of software for the implementation of the task, the practical part which includes flowcharts. The description of the program and the run manual and a summary of the work.

The length of the explanatory note is 80 pages, of which 42 pages of the main text and 38 pages

1. PROBLEM STATEMENT

The main objective of the bachelors' work is to create a training simulator for the topic, "Plane in space", in order to increase students' access to relevant and practical information about the mathematical discipline and more importantly, to assist students to gain skills to solve problems within the mathematical discipline.

When designing the simulator it is required to include source theoretical material about the topic, create an algorithm and to write code based off of that algorithm and to make a clear, understandable user interface of the simulator.

The simulator must be capable of performing the role of a training system with little difficulty incurred and also automatically

The advantage of using simulator is that only relevant information about the subject is presented to the students and it is relatively easy and convenient to make any changes and to update the material.

The simulator must be easy to access and also easy to use. The simulator must include practical exercises that are relevant to the topic "Plane in space".

It is necessary to implement the following tasks

1. Write the equation of a plane passing through a point $M(3;4;5)$ perpendicular to the vector $\overrightarrow{MK}$ where $K(-2;1;3)$.

2. Write the equation of the plane passing through the point $M(1;2;5)$ and cuts off on axes *Ox* and *Oy* segments -3 and 4 accordingly.

3. Given the point $(8,3,3)$ on a plane and perpendicular line $\frac{x-1}{6}=\frac{y+3}{1}=\frac{z+8}{-8}$. Find the equation of the plane.

Before solving each problem in the simulator, it is necessary to formulate the necessary theoretical questions.

The simulator must also be user friendly by providing automated assistance to the user in the event of mistakes.

Before creating the simulator, it was necessary to conduct research to answer basic questions such as why a simulator is useful and to also review similar projects of this nature, and then followed by the creation of the algorithm and flowcharts for the simulator and last but not least, the user interface. Testing was conducted to ensure that the simulator was working as intended.

The resources used in this project are easily accessible, and the methods are easy to follow. The programming language used, Java programming language, is one of the most well-known and frequently used programming languages in the world. Java programming language was also used becsause it is easy to learn, therefore easy to write, compile and debug than other programming languages.

2. INFORMATION REVIEW

2.1. Review of works where the task similar to a theme of work is considered

The article [1] is a report on the topic of “Land and Doig Method”. The report justifies both the relevance and scope of the simulator. It highlights the processes necessary for creating a training simulator for the topic “Land and Doig” step by step.

Keywords – simulator, digital programming, land and doig method, PLP, PILP.

The article [2] is a report on examining mobile learning in a virtual school environment. The article references a case study of students in an Advanced Placement European History course, which used an app that works on mobile devices for four weeks to study. The results indicated students’ true perceptions of the mobile virtual learning and also highlight that students’ access to mobile devices limited the project implementation.

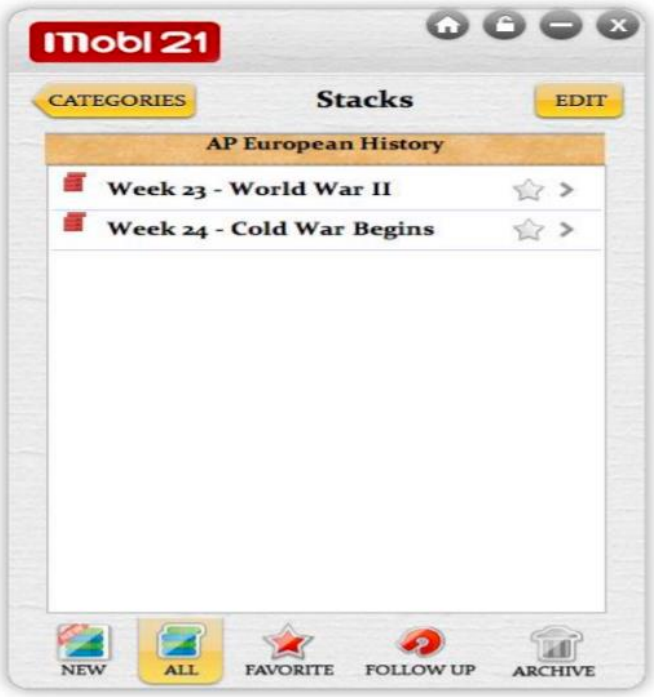


Fig 2.1 - Mobl21 mobile learning management system environment for AP European History

Keywords – mobile learning, virtual school environment.

The article [3] is a report on distance learning: promises, problems and possibilities. It highlights the history of distance learning, the promises of distance learning, the problems of distance learning, the quality of instruction that is given through distance learning simulators, the true cost and cost effectiveness of distance learning simulators and the misuse of technology where there is a possibility of not being able to utilize all its potential. The article also references the problems with equipment and how it would affect the effectiveness of distance learning, the attitudes towards distance learning as a major potential roadblock to effective distance learning, and also both the students' and instructor concerns

Keywords – distance learning, virtual school environment.

2.2. Positive Aspect of the reviewed works

i. Relevant creation of the simulator since no simulator on the subject "Land and Doig's Method" exists.[1]

ii. Abstract highlights history and definitions of distance learning.[3]

iii. Abstract highlights the capabilities of distance learning programs.[3]

iv. Abstract highlights the true cost of distance learning programs and also the cost effectiveness.[1][3]

v. The simulator will assist students on the topic "Land and Doig's Method" from the course "Methods of Optimization and Operations Research".[1]

vi. Minimizes cost of resources.[1]

vii. Preferable learning platform for students since they can access the simulator in their location of choice.[1]

viii. Students are receptive to learning in a virtual environment.[2]

ix. Students have increased access to mobile phones and computers hence increasing the success rate of a virtual learning environment.[2]

2.3. Defects in the development of the inspected works

i. The scope is limited, the program only shows one topic, “Land and Doig’s Method”.[1]

ii. There is no detailed information about the construction of the program, i.e. programming code and flowcharts.[1]

iii. In cases where students have limited access to mobile phones and computers the success rate of the project drops significantly.[2]

iv. The abstract deals with on theoretical material and offers no practical advice.[3]

2.4. Necessity and relevance of the topic of work.

The development of the distance learning course simulator is different because it focuses on a niche topic, “plane in space” in the subject “Algebra and Geometry”, which has been left unattended to by other developers.

The simulator is important due to the structure of the questions that help students to reinforce the concepts that they would have learnt in class and assists them in mastering the topic and gaining confidence in the subject.

3. THEORETICAL PART

3.1. Algorithmization of the problem on the topic of work

3.1.1. Algorithm for constructing the equation of the plane in space that passes through a given point perpendicular to the vector

Step 1. The user needs to select their preferred language, either English or Ukrainian.

Go to step 2.

Step 2. A question appears on the screen. The user needs to choose one of answer options, among which one is correct. If the user selects the correct answer, then go to step 3. If not, an “error message” that contains a hint on how to solve the question correctly appears on the screen.

What is the equation of the plane of the form $Ax + By + Cz + D = 0$?

a. canonical or equation of a plane passing through a given point;

b. general equation of a plane;

c. equation of a plane in the intercept form;

d. normal;

e. equation of a plane passing through three points

Error message: The equation of the form $Ax + By + Cz + D = 0$ is the general equation of the plane.

Go to step 3.

Step 3. A question appears on the screen. The user needs to choose one of answer options, among which one is correct. If the user selects the correct answer, then go to step 4. If not, an “error message” that contains a hint on how to solve the question correctly appears on the screen.

What is the equation of the plane of the form

$$A(x-x_0)+B(y-y_0)+C(z-z_0)=0\,?$$

a. canonical or equation of a plane passing through a given point.

b. general equation of a plane;

c. equation of a plane in the intercept form;

d. normal;

e. equation of a plane passing through three points

Error message: The equation of the form $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$ is the canonical or equation of a plane passing through a given point. Go to step 4.

Step 4. A question appears on the screen. The user needs to choose one of answer options, among which one is correct. If the user selects the correct answer, then go to step 5. If not, an "error message" that contains a hint on how to solve the question correctly appears on the screen.

What is the equation of the plane of the form

$$x\cos\alpha+y\cos\beta+z\cos\gamma-p=0\ ?$$

a. canonical or equation of a plane passing through a given point;

b. general equation of a plane;

c. equation of a plane in the intercept form;

d. normal;

e. equation of a plane passing through three points

Error message: The equation of the form $x\cos\alpha+y\cos\beta+z\cos\gamma-p=0$ is the nominal equation of the plane. Go to step 5.

Step 5. A question appears on the screen. The user needs to choose one of answer options, among which one is correct. If the user selects the correct answer, then go to step 6. If not, an "error message" that contains a hint on how to solve the question correctly appears on the screen.

What is the equation of the plane of the form $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$?

a. canonical or equation of a plane passing through a given point;

b. general equation of a plane;

c. equation of a plane in the intercept form;

d. normal;

e. equation of a plane passing through three points

Error message: The equation of the form $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ is equation of a plane in the intercept form. Go to step 6.

Step 6. A question appears on the screen. The user needs to choose one of answer options, among which one is correct. If the user selects the correct answer, then go to step 7. If not, an "error message" that contains a hint on how to solve the question correctly appears on the screen.

What is the equation of the plane of the form $\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 \end{vmatrix}=0$?

a. canonical or equation of a plane passing through a given point;

b. general equation of a plane;

c. equation of a plane in the intercept form;

d. normal;

e. equation of a plane passing through three points

Error message: The equation of the form $\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 \end{vmatrix}=0$ is equation of a plane passing through three points. Go to step 7.

Step 7. *The task condition appears on the screen, which must be available until it is solved.*

Write the equation of a plane passing through a point $M(3;4;5)$ perpendicular to the vector $\overrightarrow{MK}$ where $K(-2;1;3)$.

Next, the user is asked to answer several questions by selecting one of the suggested answers. If the correct choice is made, the transition to the next step is performed. Otherwise, an error message appears that contains the correct answer.

The canonical equation $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$.

A,B,C of the plane means

a. the coordinates of the points of intersection of the plane with the axes,
b. the coordinates of the point belonging to the plane,
c. the coordinates of the vector normal to the plane.

Error message: "In the canonical equation of a plane $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$ A,B,C are the coordinates of the vector normal to the plane."

Go to step 8.

Step 8. *On the question screen:*

A normal vector is a vector that:

1) lies on a given plane or on a plane parallel to it,
2) vector perpendicular to a given plane.

Error message: "A normal vector is a vector that is perpendicular to a given plane."

Go to step 9.

Step 9. *On the screen:*

In the canonical equation the plane $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$ x_0,y_0,z_0 means

1) The coordinates of the points of intersection of the plane with the axes,

2) The coordinates of the point belonging to the plane,

3) The coordinates of the vector normal to the plane.

Error message: "Is the canonical equation of a plane $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$, x_0, y_0, z_0 are the coordinates of the point that belongs to the plane."

Go to step 10.

Step 10. *On the task screen:*

Enter values in the cells. The coordinates of a point belonging to a given plane

$$x_0 = \square,\ y_0 = \square,\ z_0 = \square.$$

The check is performed after filling all the cells, and those cells in which an error is made, should be highlighted in a different colour (for example, red, and the same throughout the simulator). However, an error message appears:

"Under the condition of the problem M the point belongs to a given plane, its coordinates $(3;4;5)$, so the correct answer $x_0 = 3,\ y_0 = 4,\ z_0 = 5$.".

Go to step 11.

Step 11. *On the task screen:* The vector $\overrightarrow{MK}$ for a given plane is:

1) guide vector,
2) **vector of normal,**
3) a single vector.

Error message: "Under the condition of the problem, the plane passes perpendicular to the vector $\overrightarrow{MK}$, so the vector $\overrightarrow{MK}$ is a vector of normal for a given plane."

Go to step 12.

Step 12. *On the task screen:*

Fill cells: vector coordinates $\overrightarrow{MK} = (\square, \square, \square)$

The check is performed after filling all the cells, and those cells in which an error occurred, should be highlighted in a different colour. An error message appears at the same time:

"The points M and K under the condition of the problem have the coordinates $(3;4;5)$ and $(-2;1;3)$. To find the coordinates of a vector, you must subtract the coordinates of its beginning (point K) from the coordinates of the end of the vector (point M).".

The user is given the opportunity to correct the value. And in case of a repeated error, the message "Coordinates of the vector $\overrightarrow{MK} = (-2-3, 1-4, 3-5) = (-5, -3, -2)$ appears."

Go to step 13.

Step 13. *On the task screen:* Enter a value in the cells.

The equation of the plane passing through $M(3;4;5)$ the point perpendicular to the vector $\overrightarrow{MK} = (-5, -3, -2)$ will look like:

$$\square(x - \square) + \square(y - \square) + \square(z - \square) = 0.$$

After filling all the cells is checked. If all the cells are filled correctly, the equation appears on the screen

$$-5(x-3) - 3(y-4) - 2(z-5) = 0.$$

Otherwise, the cells with false values are highlighted in a different colour and the message appears: "In the canonical equation of a plane

$A(x-x_0)+B(y-y_0)+C(z-z_0)=0$, A,B,C are the coordinates of the vector normal to the plane, x_0,y_0,z_0 are the coordinates of the point that belongs to the plane."

The user is given the opportunity to correct the value. And if you make a mistake again, the message appears:

"The equation of the plane passing through the point $M(3;4;5)$ perpendicular to the vector $\overrightarrow{MK}=(-5,-3,-2)$ has the form: $-5(x-3)-3(y-4)-2(z-5)=0$".

Go to step 14.

Step 14. *On the task screen:*

Fill the cells. The general equation of the plane given by the equation $-5(x-3)-3(y-4)-2(z-5)=0$ has the form:

$$\square x+\square y+\square z+\square=0.$$

After filling all the cells is checked. If all the cells are filled correctly, the equation appears on the screen

$$-5x-3y-2z+37=0.$$

And the algorithm ends.

Otherwise, cells with false values are highlighted in a different colour and a message appears:

"Let's open the brackets in $-5(x-3)-3(y-4)-2(z-5)=0$.

Then $-5x+15-3y+12-2z+10=0\Rightarrow -5x-3y-2z+37=0$."

Step 14. *User is presented with a prompt message on the screen notifying them that the task is complete.*

3.1.2. Algorithm for constructing the equation of the plane in the intercept form

Task 2. Write the equation of the plane passing through the point $M(1;2;5)$ and cuts off on axes Ox and Oy segments -3 and 4 accordingly.

Step 1. What equation is used to solve this problem?

- $A(x-x_0)+B(y-y_0)+C(z-z_0)=0.$
- $x\cos\alpha+y\cos\beta+z\cos\gamma-p=0.$
- $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1.$
- $\begin{vmatrix} x-x_1 & y-y_1 & z-z_1 \\ x_2-x_1 & y_2-y_1 & z_2-z_1 \\ x_3-x_1 & y_3-y_1 & z_3-z_1 \end{vmatrix}=0.$

Error message: "The equation of a plane in the intercept form on axes is used. Namely $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$."

Step 2. Choose the right option.

- $a=-3, b=4, c$ is unknown.
- $b=-3, c=4, a$ is unknown.
- $c=-3, a=4, b$ is unknown.
- $b=-3, a=4, c$ is unknown.

Error message: "Under the condition of the problem $a=-3$, $b=4$ and c is unknown."

Step 3. Under the condition of the problem, the plane passes through a point $M(1;2;5)$. Therefore, the coordinates of this point satisfy the equation $\frac{x}{-3}+\frac{y}{4}+\frac{z}{c}=1$. Namely $\frac{\square}{-3}+\frac{\square}{4}+\frac{\square}{c}=1$ (enter the value in the cells).

Error message: "Under the condition of the problem $M(1;2;5)$ or $x=1, y=2, z=5$. So we have $\frac{1}{-3}+\frac{2}{4}+\frac{5}{c}=1$. "

Step 4. $\frac{1}{-3}+\frac{2}{4}+\frac{5}{c}=1$. Find $c=\square$

Error message: " $\Rightarrow \frac{5}{c}=1+\frac{1}{3}-\frac{2}{4} \Rightarrow \frac{5}{c}=\frac{12+4-6}{12} \Rightarrow \frac{5}{c}=\frac{10}{12} \Rightarrow c=\frac{5\cdot 12}{10}=6$. So, desired equation is $\frac{x}{-3}+\frac{y}{4}+\frac{z}{6}=1$."

Algorithm is finished.

3.1.3. Algorithm for constructing the equation of the plane in space that passes through a given point perpendicular to the line

Task 3. Given the point $(8,3,3)$ on a plane and perpendicular line $\frac{x-1}{6}=\frac{y+3}{1}=\frac{z+8}{-8}$. Find the equation of the plane.

Step 1. What is the formula for the equation of a plane:

a. $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$

b. $A(x-x_0)+B(y-y_0)+C(z-z_0)=1$

c. $Ax+By+Cz=0$

d. $Ax+By+Cz=1$

Error message: $A(x-x_0)+B(y-y_0)+C(z-z_0)=0$ is the equation of a plane, where x_1, y_1, and z, are any point on the plane.

Step 2. What is a normal to a plane?

a. A vector perpendicular to the plane

b. A vector parallel to the plane

c. A vector that is an inverse of the plane

Error message: A normal is a vector perpendicular to the plane

Step 3. Find normal a, b, c

a. $6,1,-8$

b. $6,1,8$

c. $0,1,2$

d. $8,1,6$

Error message: Normal a,b,c is 6,1,-8, because $\frac{x-1}{6}=\frac{y+3}{1}=\frac{z+8}{-8}$ is perpendicular to the plane and vector <6,1,8> is parallel to $\frac{x-1}{6}=\frac{y+3}{1}=\frac{z+8}{-8}$,,

Step 4. Given that $x_1=8$, $y_1=3$ and $z_1=3$, Find the solution for $6(x-8)+1(y-3)-8(z-3)=0.$

a. $6x+y+8z=27$
b. $6x+y-8z=27$
c. $6x+y-8z=0$
d. $6x+y-8z=1$

Error message: $6(x-8)+1(y-3)-8(z-3)=0\Rightarrow 6x-48+y-3-8z+24=0\Rightarrow$ $6x+y-8z=27.$

The algorithm is complete.

3.2. Algorithm Description

Algorithm.

Step 0. Start the program.

Step 1. Display language selection choice.

Step 2. User makes a choice.

Step 3. Display the first question and possible answers.

Step 4. User makes a choice.

Step 5. User clicks “next” button.

Step 6. If answer is correct move to step 7, if answer is wrong user is presented with a hint and move to step 4.

Step 7. Display next question and possible answers.

Step 8. End program.

3.3. Justification of the choice of software and programming language for the implementation of the task.

Java is simple and easy to learn, and it is designed to be easy to write, compile and also debug than other programming languages. The fact that Java is object-oriented means that it can be used to create modular programs and reusable code. Last but not least, Java is platform independent, which means it has the ability to move from one computer system to another, and run the same program on different systems.

4. PRACTICAL PART

4.1. Development of a flowchart to be programmed

Program start (Fig 4.1)

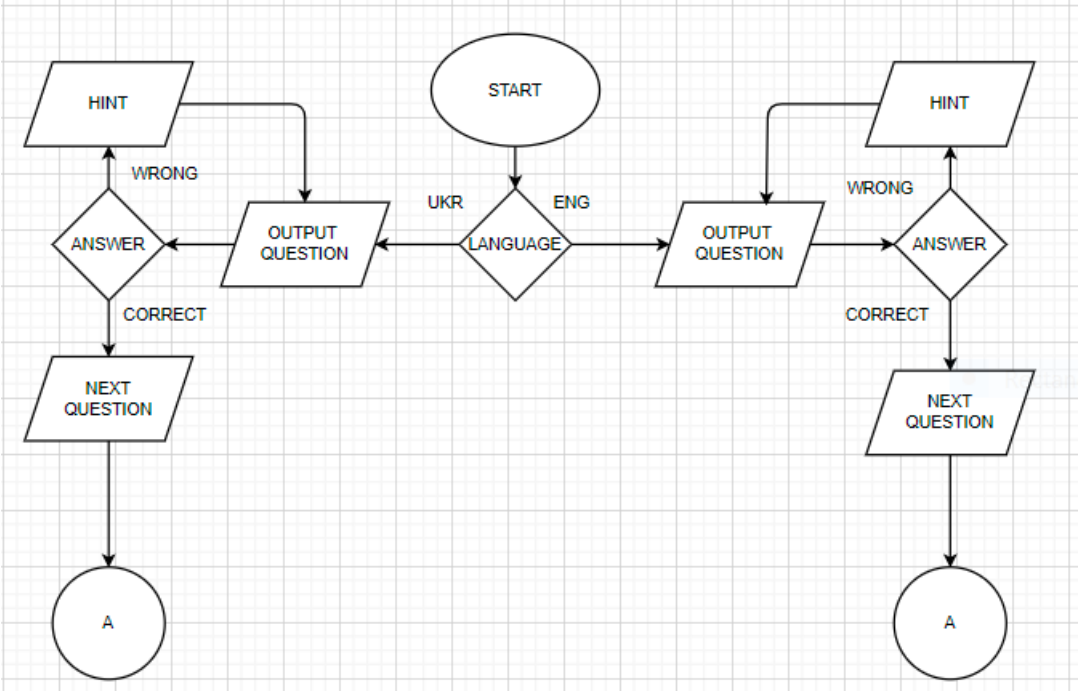


Fig 4.1 – Start

First question (Fig 4.2)

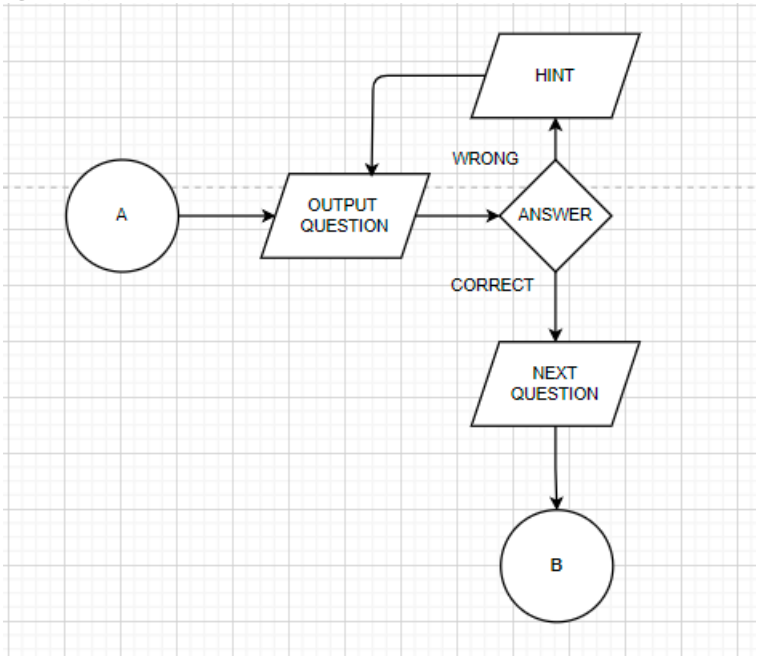


Fig 4.2 – Question 1

Next question and so on (Fig 4.3)

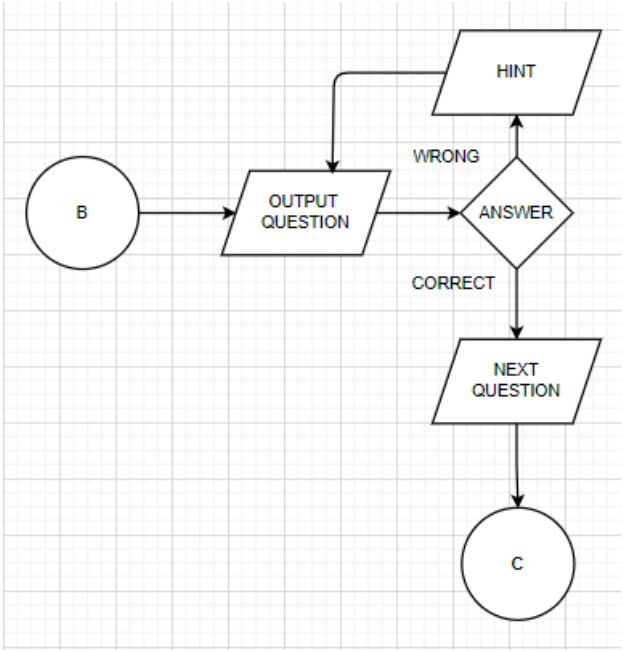


Fig 4.3 – Next Question

Last question and program end (Fig 4.4)

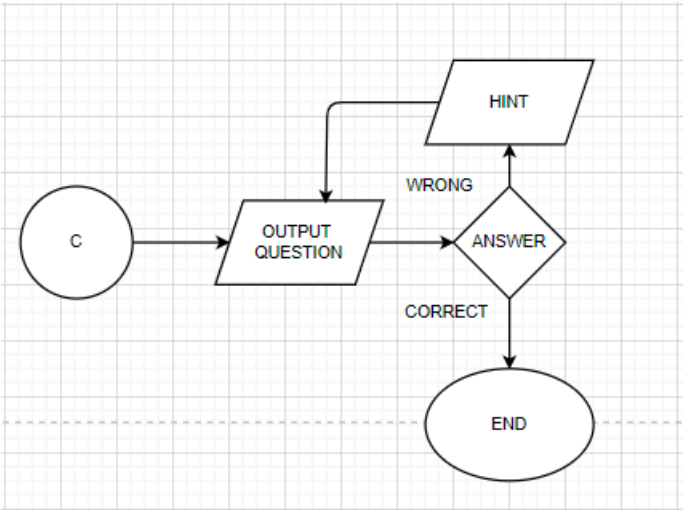


Fig 4.4 – Final Question

4.2. Run manual

The user is prompted to choose a language of their choice. (Fig 4.5)

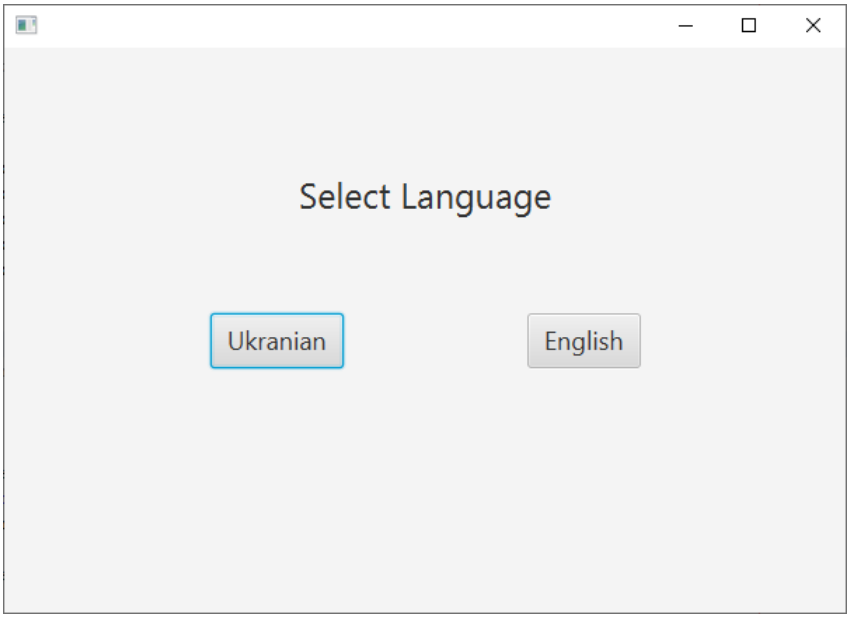


Fig 4.5 – Program start

The user is presented with a question and possible answers. (Fig 4.6)

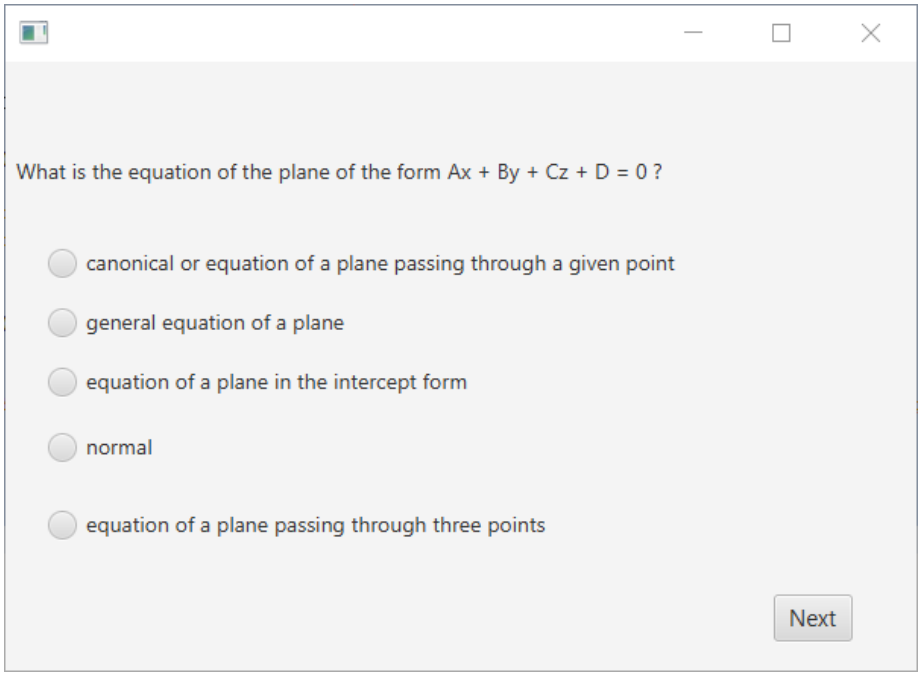


Fig 4.6 – Question 1

If the user makes an incorrect choice they are alerted and are given a hint.(Fig 4.7)

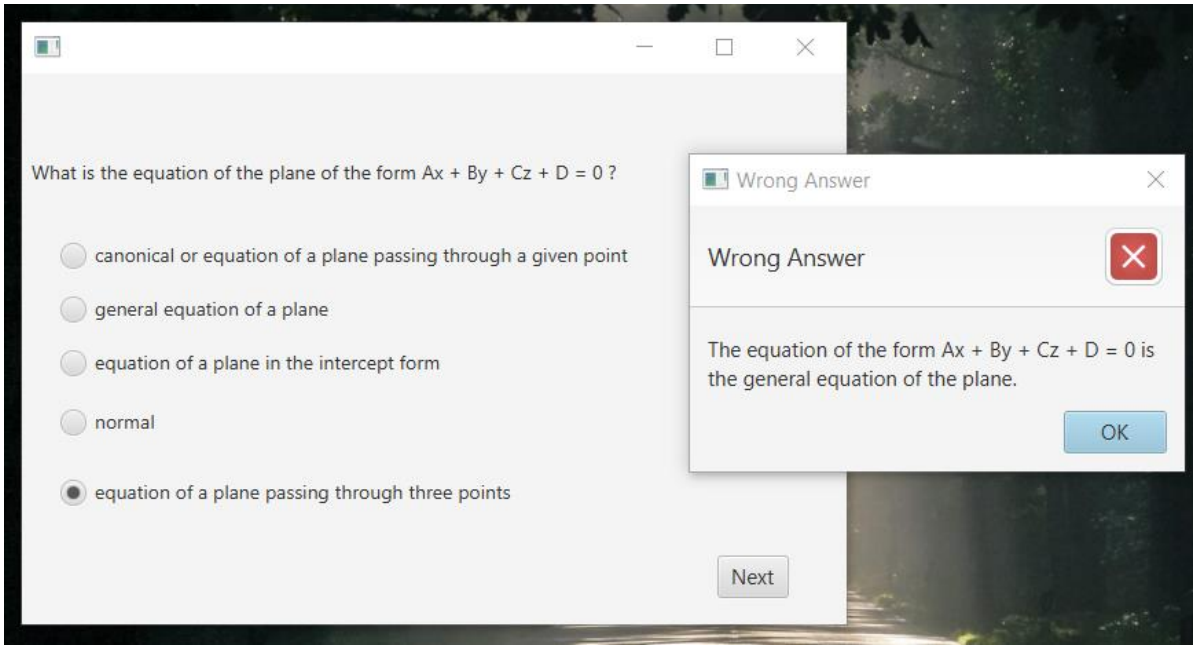


Fig 4.7 - Error

When the user makes a correct choice they are presented with a new question.(Fig 4.8)

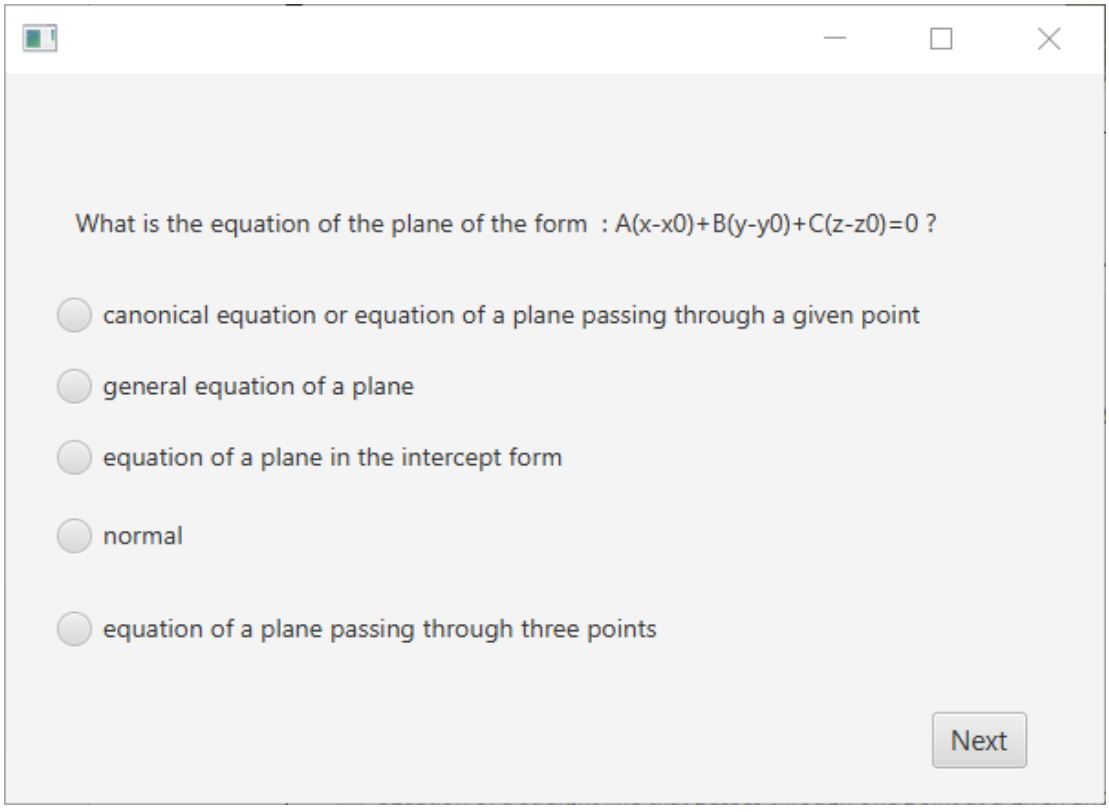


Fig 4.8 – New question

Question 9 Demonstrates a different type of question. The user should input the correct values of x0, y0 and z0 into the textbox. (Fig 4.9)

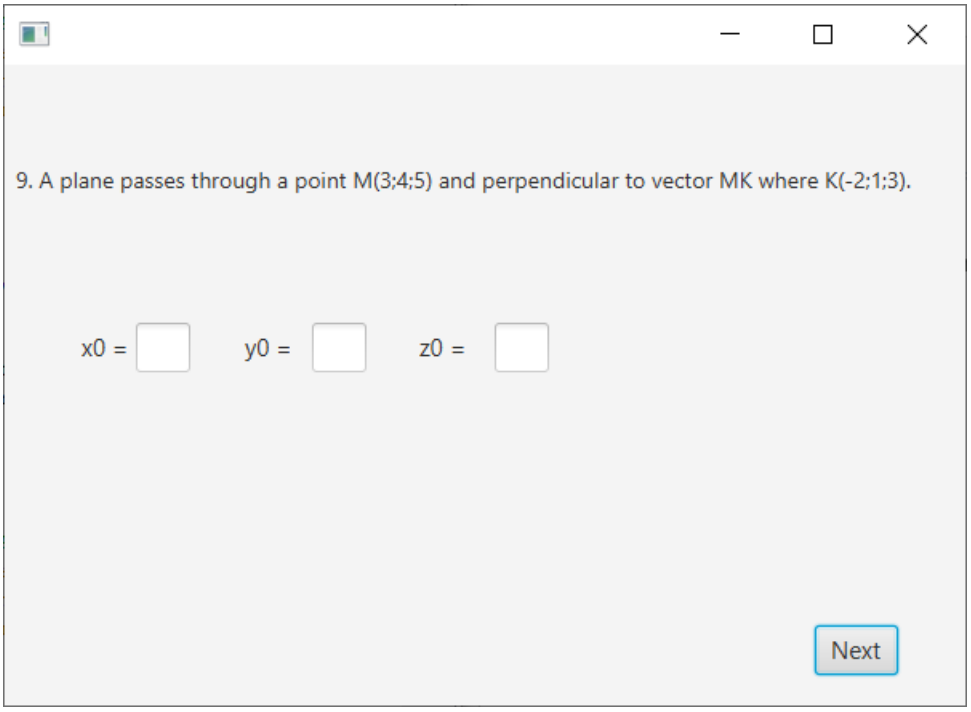


Fig 4.9 – Text input

In the event that the user inputs wrong values a prompt message appears on the screen (Fig 4.10)

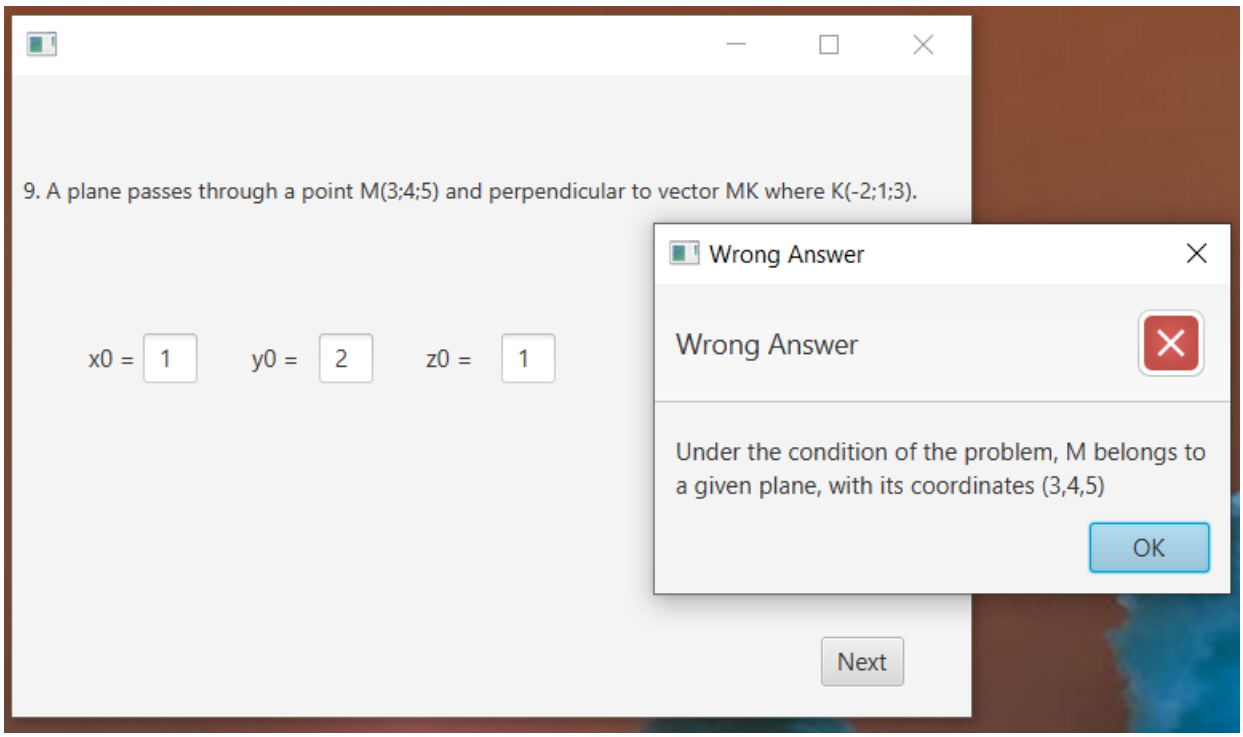


Fig 4.10 – Hint pop-up

Program ends when there are no more further questions (Fig 4.11)

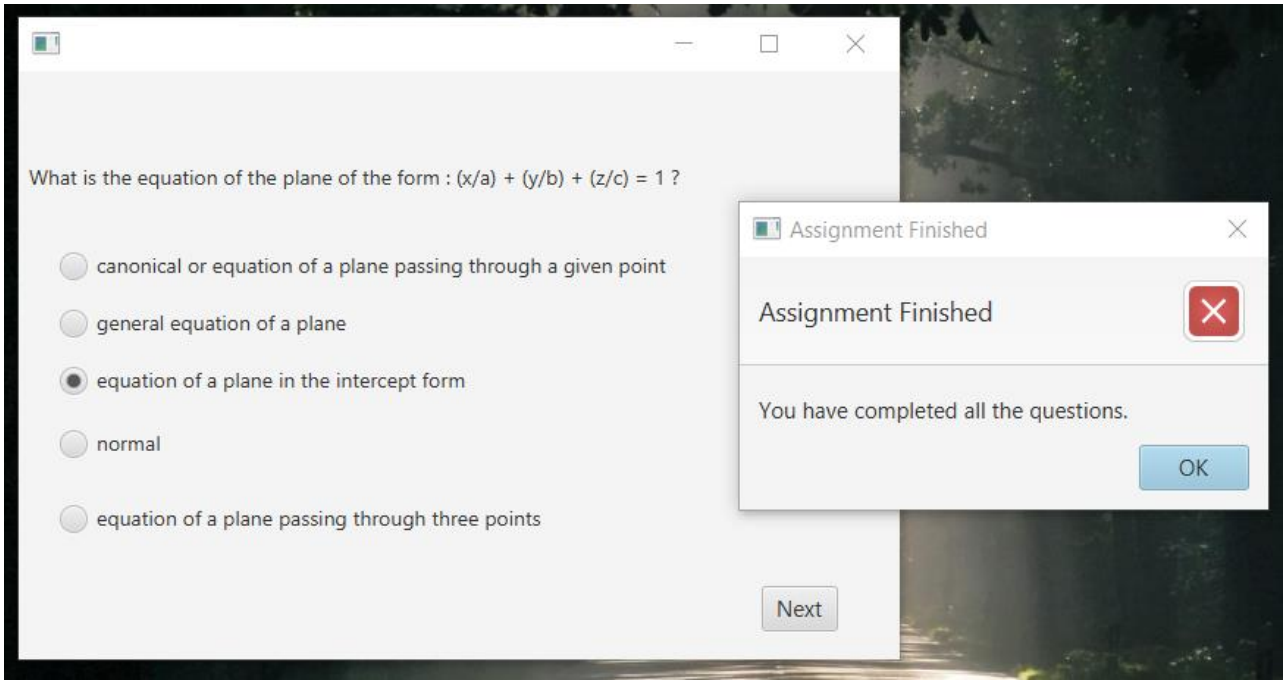


Fig 4.11 – Program end

4.3. Testing

Program was successful to start (Fig 4.12)

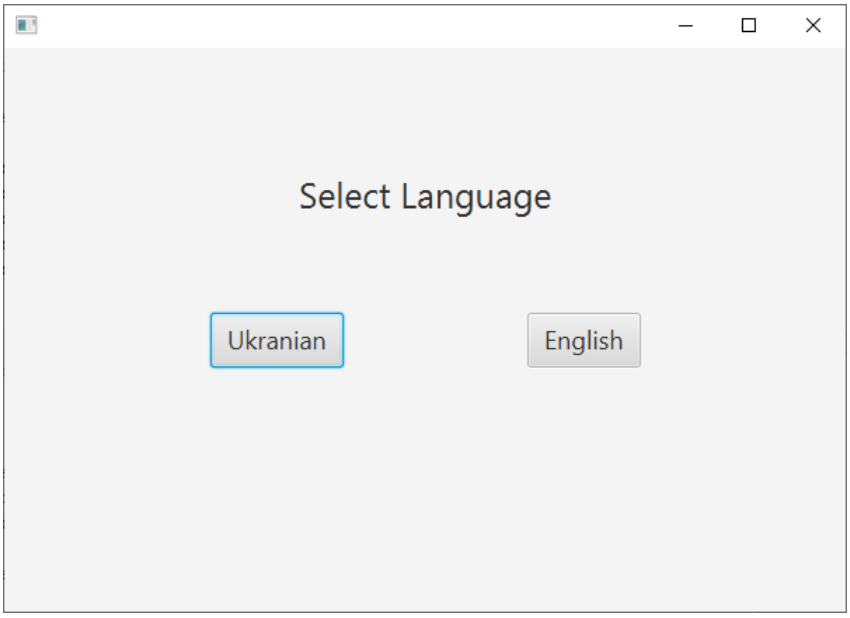


Fig 4.12 - Start

Selected the “English” button and the first question was presented (Fig 4.13)

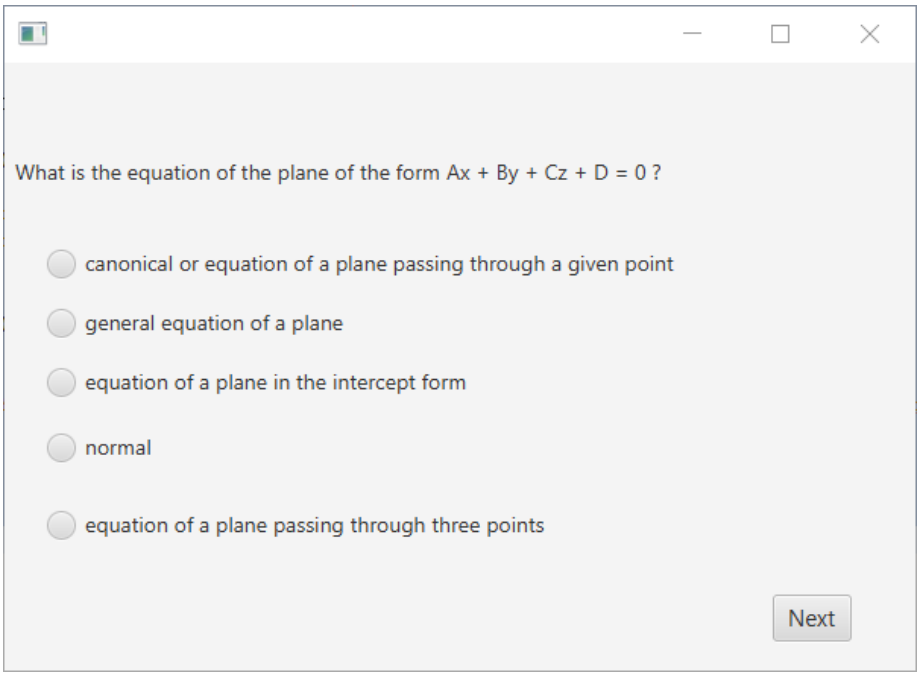


Fig 4.13 – First English question

Selected a wrong answer and the notification pop-up message with a hint is presented on the screen (Fig 4.14)

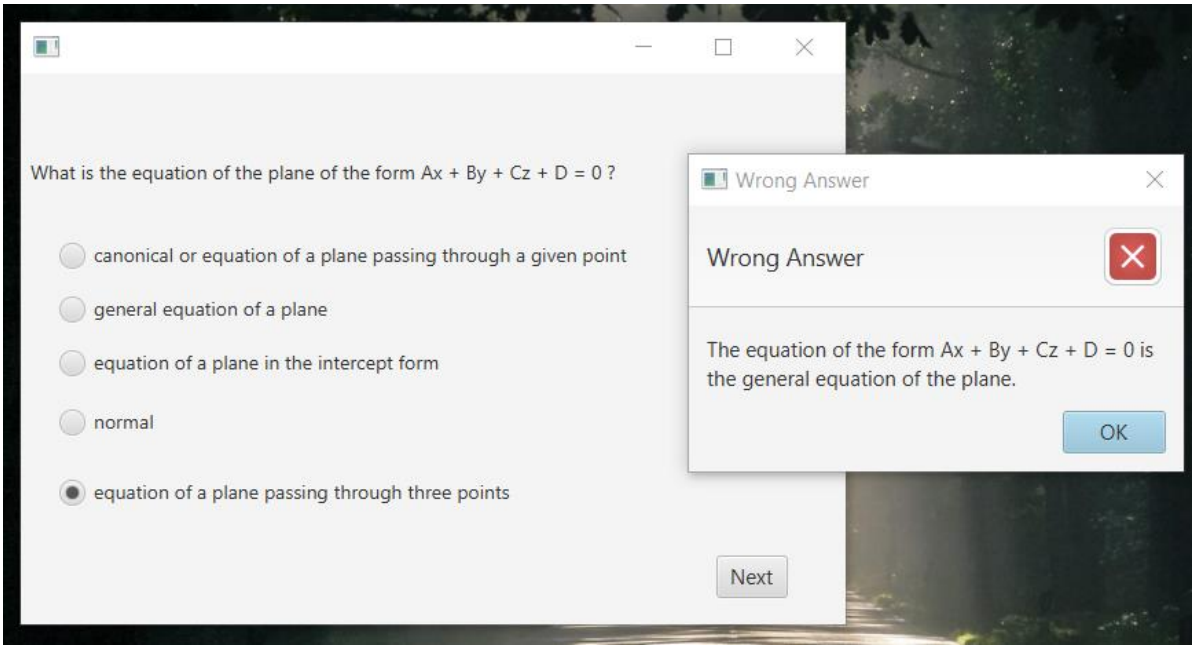


Fig 4.14 – Wrong answer notification

Input the correct answer and the simulator works as intended and the next question is presented on screen (Fig 4.15)

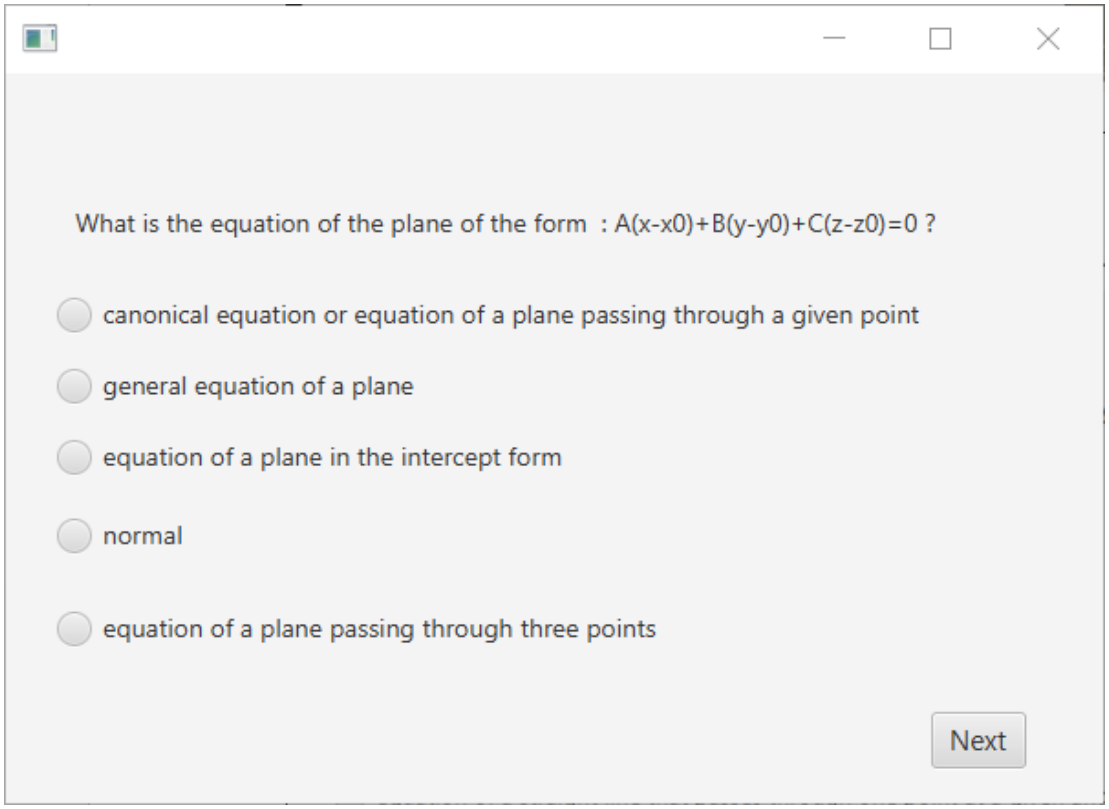


Fig 4.15 – New question

Input a correct answer on the last question and the simulator successfully ends (Fig 4.16)

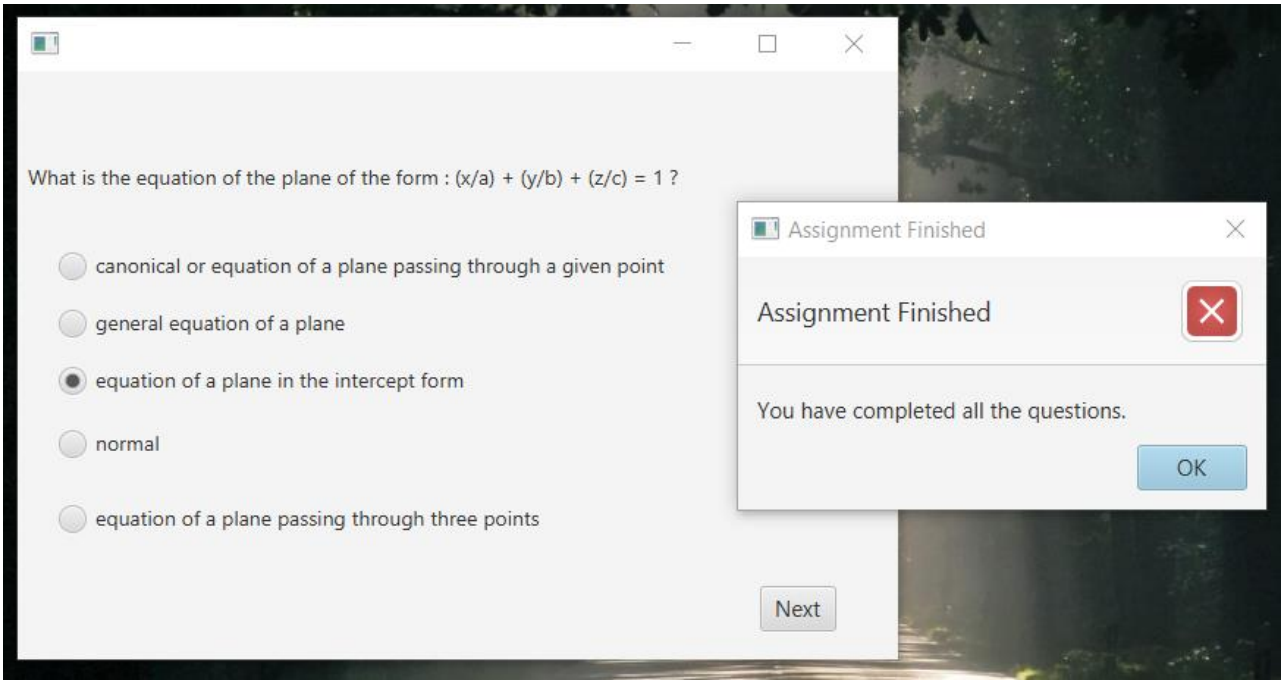


Fig 4.16 - End assignment

Select Ukrainian Language and first question was presented (Fig 4.17)

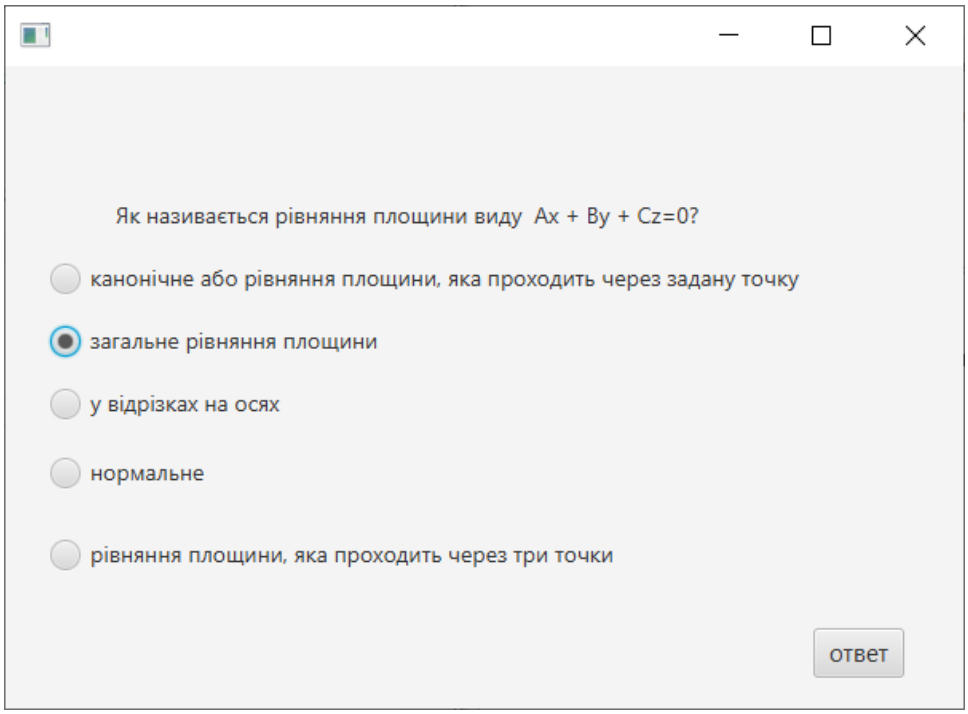


Fig 4.17 – Ukrainian question 1

Hint in the Ukrainian Language version works as intended (Fig 4.18)

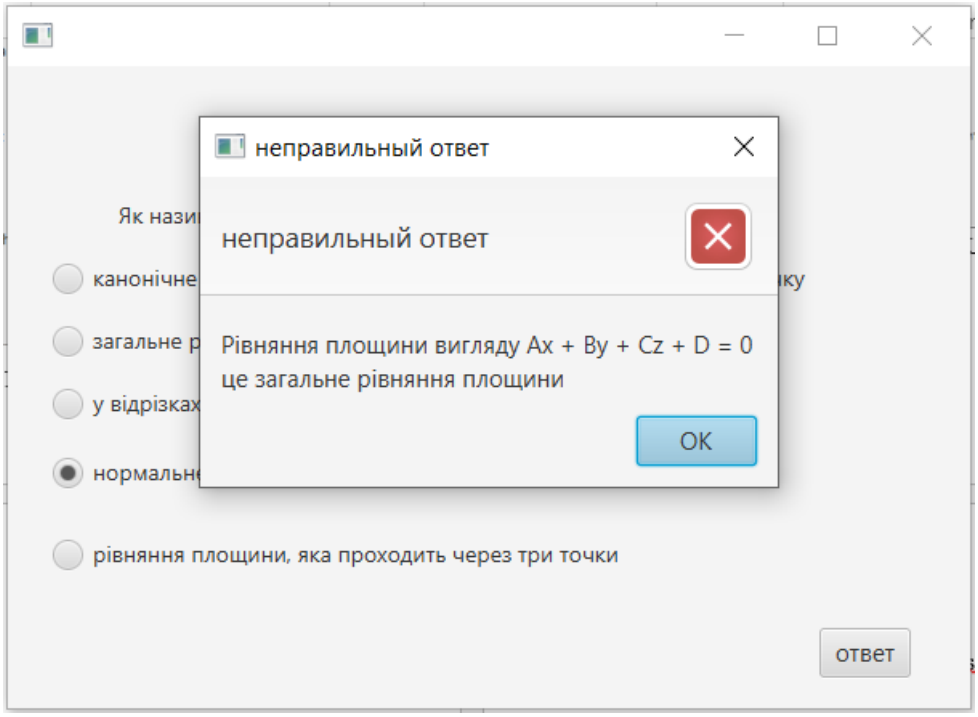


Fig 4.18 – Ukrainian Hint

Input the correct answer in the Ukrainian Language version and it successfully presents the user with a new question (Fig 4.19)

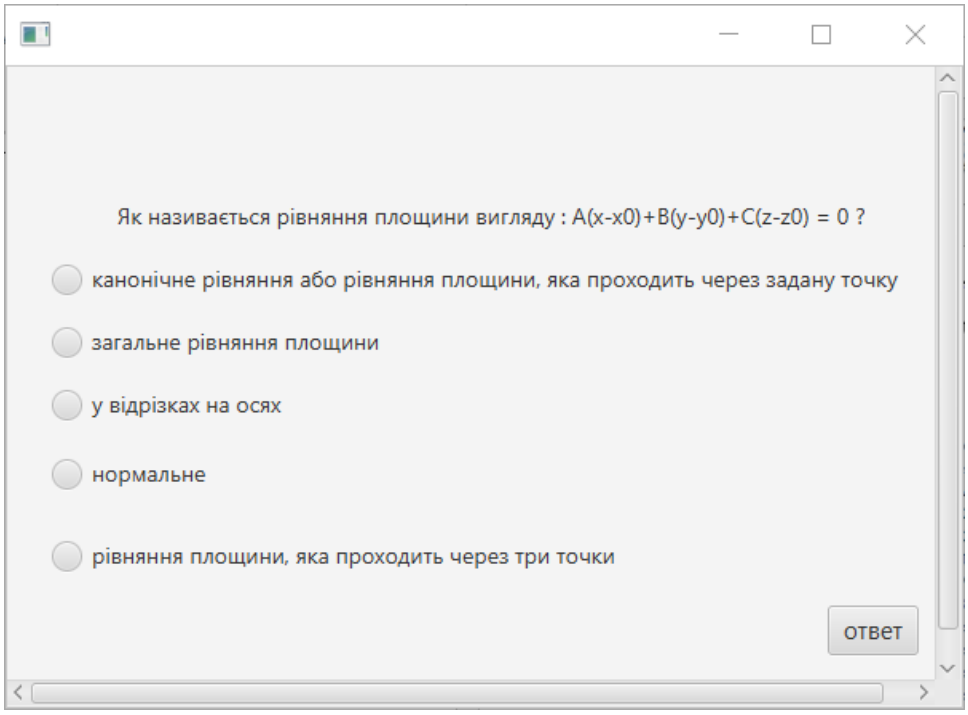


Fig 4.19 – New question in Ukrainian

Algorithm 2 is realized and question 14 is successfully presented on screen (Fig 4.20)

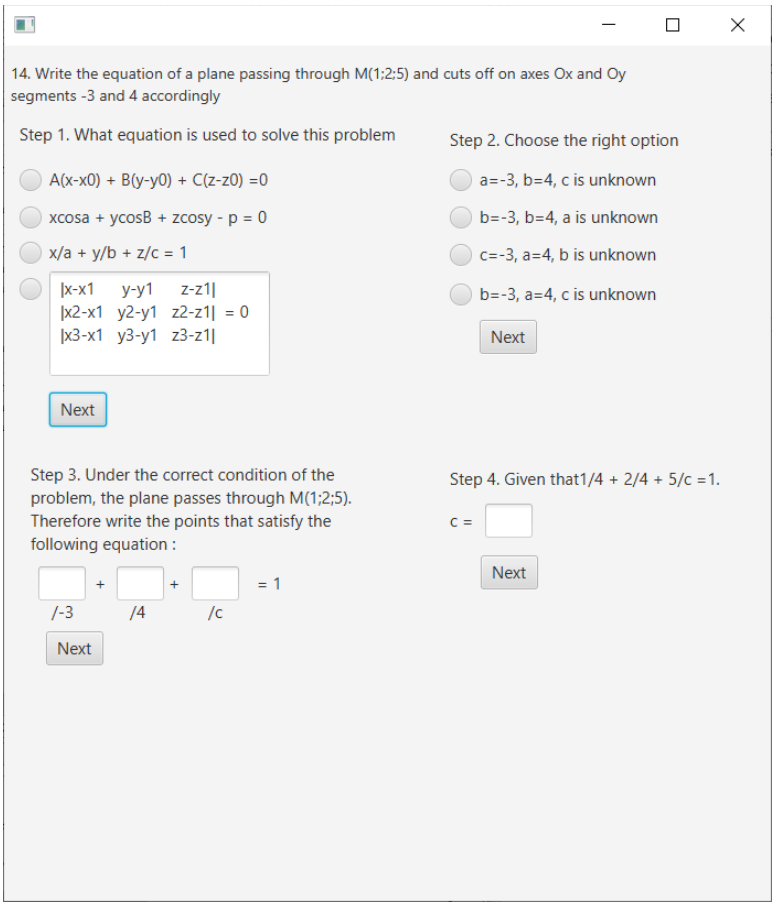


Fig 4.20 – Question 14

Step 1 successfully rejects a wrong answers and presents a hint on screen (Fig 4.21)

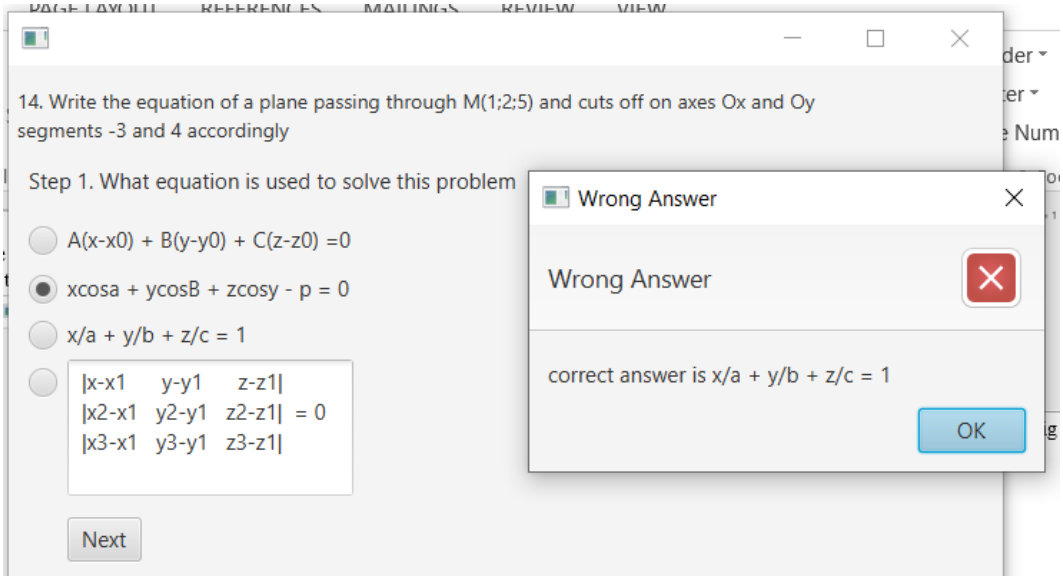


Fig 4.21 – Step 1 Hint

Step 1 successfully accepts the right answer and notifies the user (Fig 4.22)

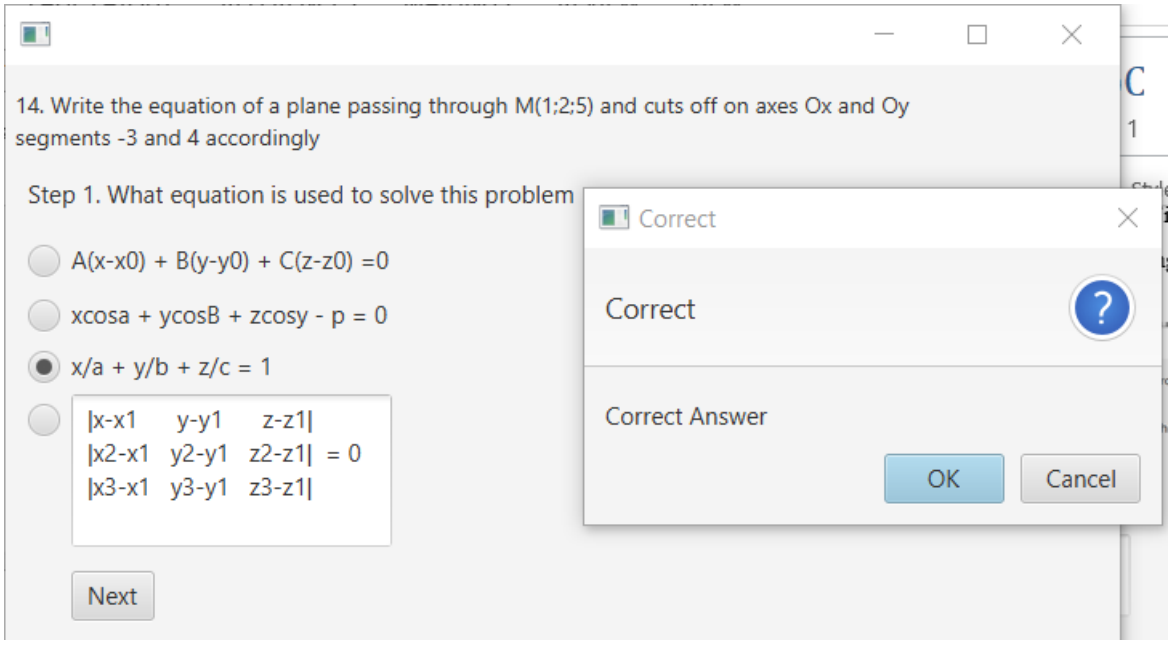


Fig 4.22 – Step 1 Correct

Step 2 successfully rejects a wrong answer and presents a hint on screen (Fig 4.23)

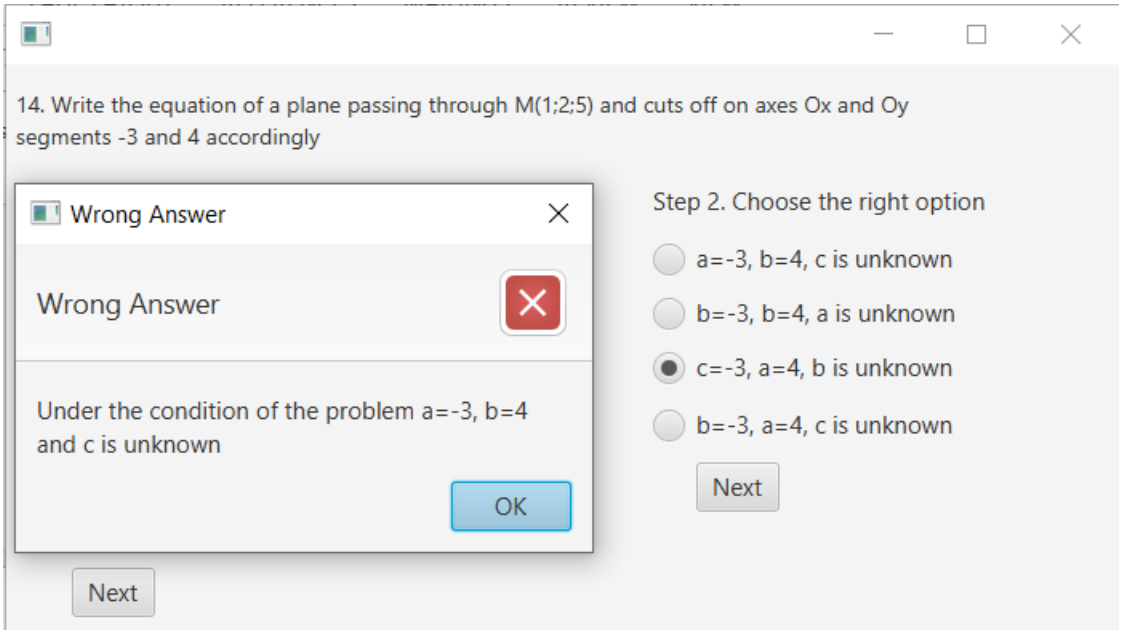


Fig 4.23 – Step 2 Hint

Step 1 successfully accepts the right answer and notifies the user (Fig 4.24)

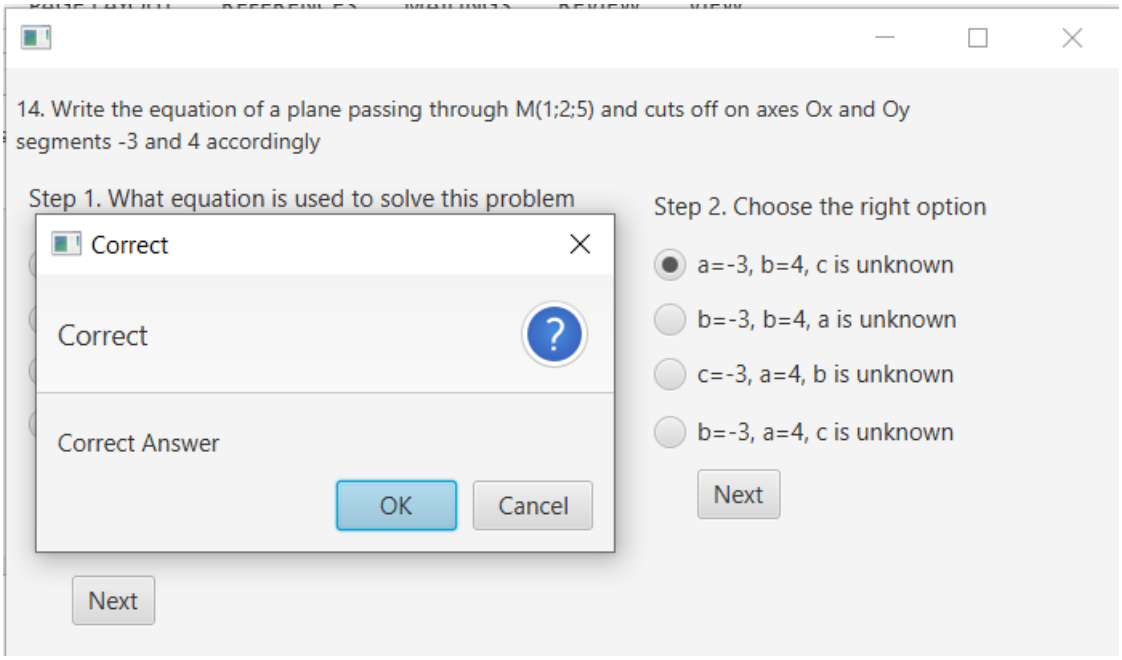


Fig 4.24 – Step 2 Correct

Step 3 successfully rejects a wrong answer and presents a hint on screen (Fig 4.25)

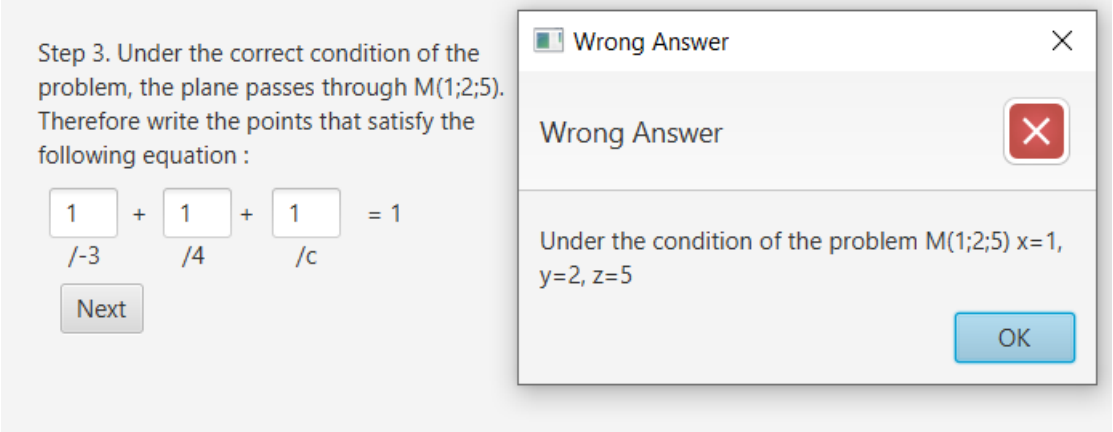


Fig 4.25 – Step 3 Hint

Step 3 successfully accepts the right answer and notifies the user (Fig 4.26)

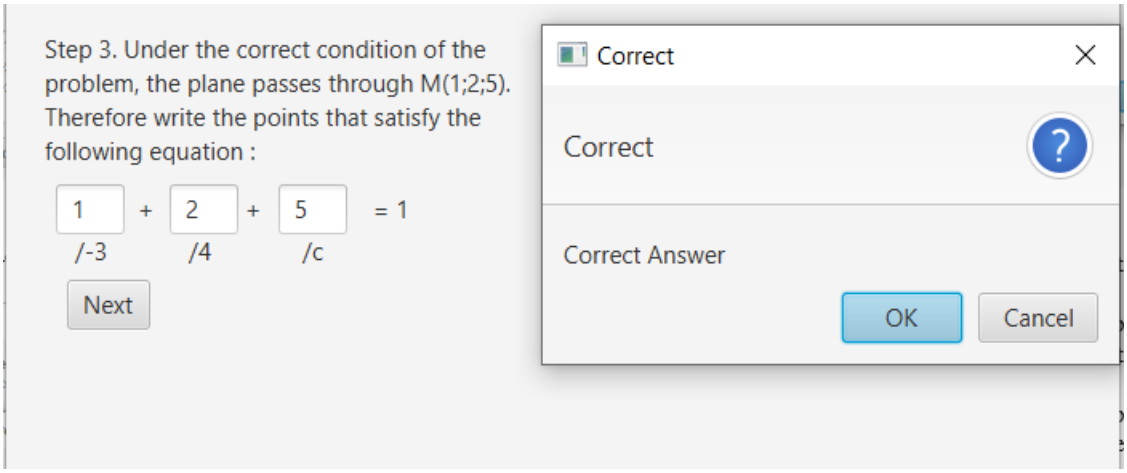


Fig 4.26 – Step 3 Correct

Step 4 successfully rejects a wrong answer and presents a hint on screen (Fig 4.25)

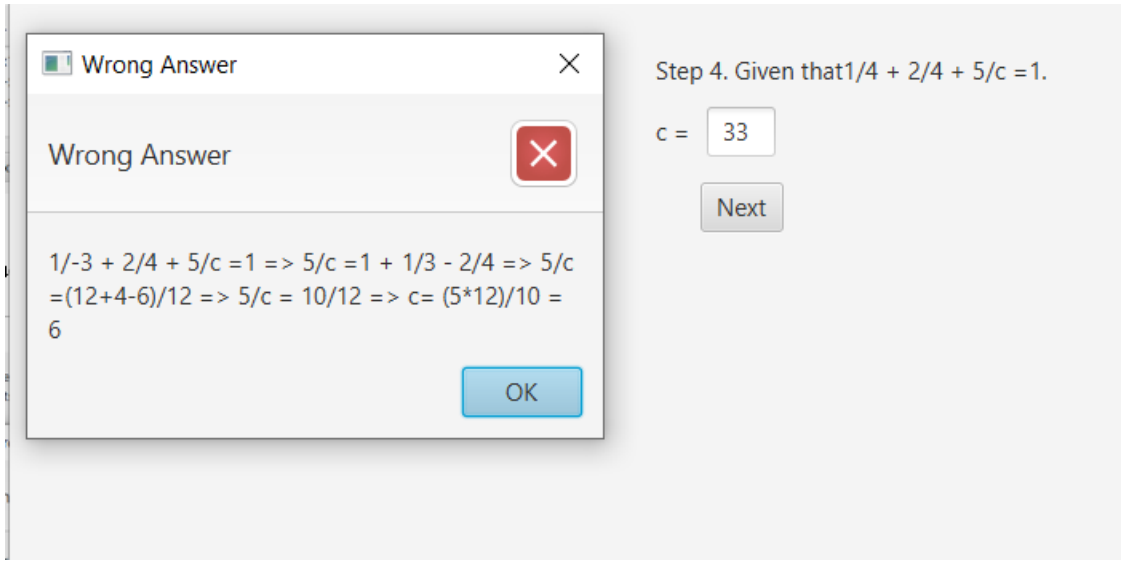


Fig 4.25 – Step 4 Hint

Step 4 successfully accepts the right answer and notifies the user and allows the user to advance to the next question (Fig 4.26)

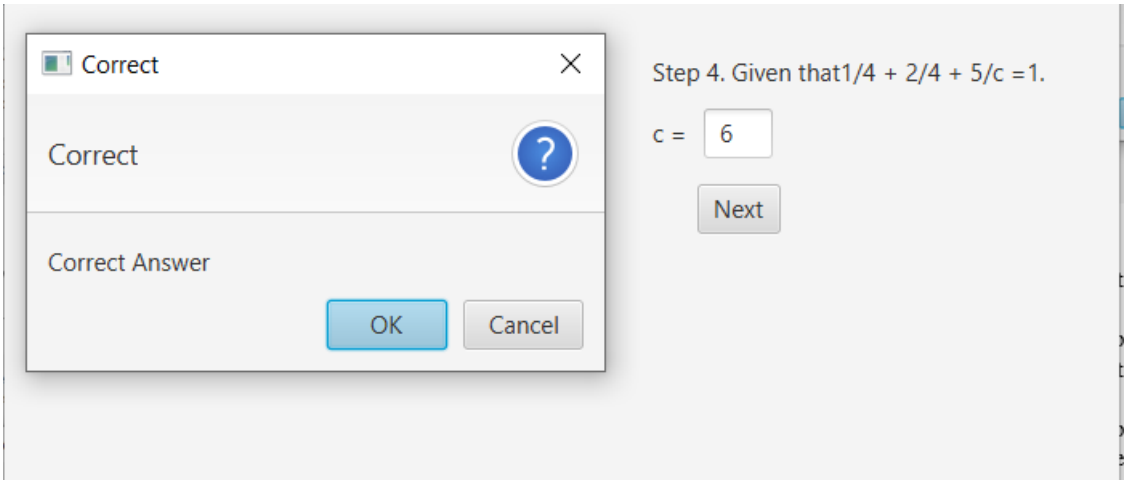
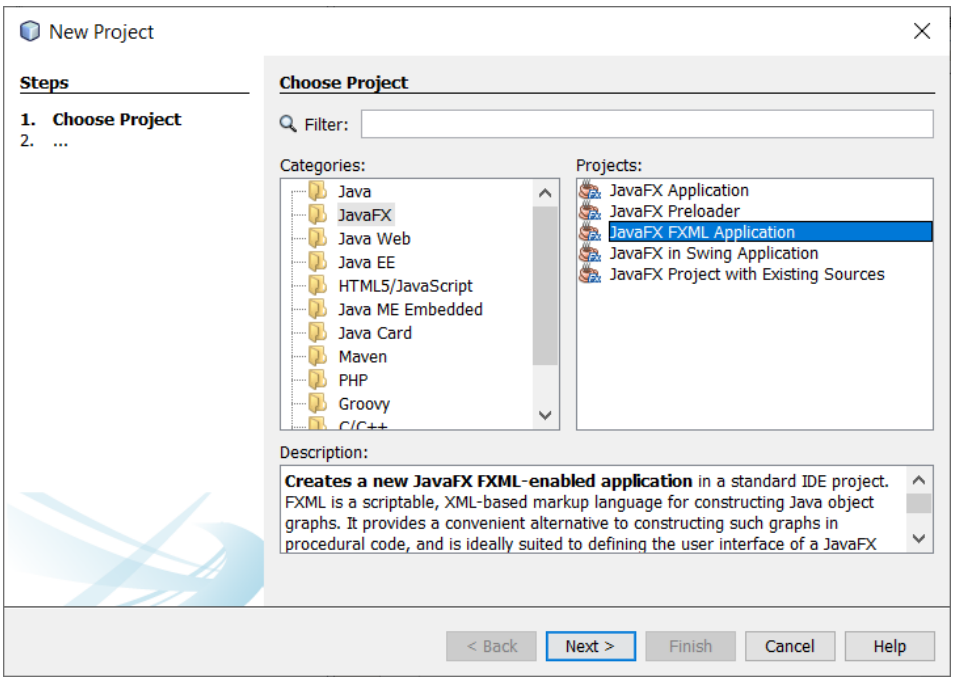


Fig 4.26 – Step 4 Correct

4.4 Program Description

The simulator is developed in Netbeans IDE and using Java programming language.

Create a new project. (Fig 4.27)



Fig(4.27) – New project

Import packages into FXMLDocumentController.java (Fig 4.18)

```
package project;

import java.net.URL;
import java.util.ResourceBundle;
import java.io.IOException;
import javafx.event.ActionEvent;
import javafx.fxml.FXML;
import javafx.fxml.FXMLLoader;
import javafx.scene.Node;
import javafx.scene.Parent;
import javafx.scene.Scene;
import javafx.scene.control.Alert;
import javafx.scene.control.Alert.AlertType;
import javafx.scene.control.Button;
import javafx.scene.control.Label;
import javafx.scene.control.RadioButton;
import javafx.scene.control.TextField;
import javafx.stage.Stage;
```

Fig 4.28 – Java imports

Create pages for all every question, both for English and Ukrainian language (Fig 4.29)

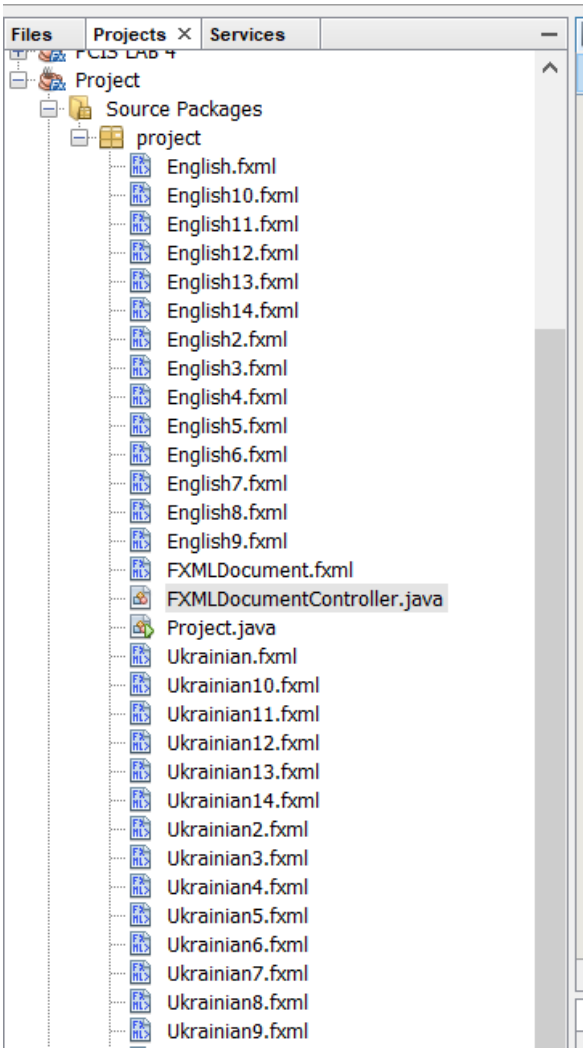


Fig 4.29 - pages

Declare all variables used in the FXML files in FXMLDocumentController.java (Fig 4.30)

```
@FXML
private Label label;
@FXML
private Button englishbutton;
@FXML
private Button ukrainianbutton;
@FXML
private RadioButton a,b,c,d,e,f,g,h,i,j,k,l,m;
@FXML
private RadioButton en_1b,en_2a,en_3d,en_4c,en_5e,en_6c,en_7b,en_8b,en_10b,eng_14a_c,eng_14b_a;
@FXML
private RadioButton uk_1b,uk_2a,uk_3d,uk_4c,uk_5e,uk_6c,uk_7b,uk_8b,uk_10b,uk_14b_c,uk_14b_a;
@FXML
private TextField x_textfield, y_textfield, z_textfield,a_textfield, b_textfield, c_textfield,eng_14c_x_textfield,eng_14c_y_textf
```

Fig 4.30 – FXML variables

Code that is responsible for the selection of the language. After clicking the button the user will be presented with a new page (Fig 4.31)

```
private Stage stage;
private Scene scene;
private Parent root;

@FXML
public void switchToUkrainian(ActionEvent event) throws IOException {
    root = FXMLLoader.load(getClass().getResource("ukrversus.fxml"));
    stage = (Stage) ((Node) event.getSource()).getScene().getWindow();
    scene = new Scene(root);
    stage.setScene(scene);
    stage.show();
}
@FXML
public void switchToEnglish(ActionEvent event) throws IOException{
    root = FXMLLoader.load(getClass().getResource("engversus.fxml"));
    stage = (Stage) ((Node) event.getSource()).getScene().getWindow();
    scene = new Scene(root);
    stage.setScene(scene);
    stage.show();
}
```

Fig 4.31 Start function

For the first question it is necessary for the user to choose the correct variant among the multiple answers that are presented. To advance to the next question the user is supposed to select, the correct answer, which in this case is option B otherwise they are not permitted to advance to the next question and they are presented with a hint. Highlighted in grey is the Hint text presented on screen (Fig 4.32)

```
@FXML
public void engnext1(ActionEvent event) throws IOException {
    if (en_lb.isSelected()) {
        root = FXMLLoader.load(getClass().getResource("English2.fxml"));
        stage = (Stage) ((Node) event.getSource()).getScene().getWindow();
        scene = new Scene(root);
        stage.setScene(scene);
        stage.show();
    } else {
        Alert alert = new Alert(AlertType.ERROR);
        alert.setTitle("Wrong Answer");
        alert.setHeaderText("Wrong Answer");
        alert.setContentText("The equation of the form Ax + By + Cz + D = 0 is "
                + "the general equation of the plane.");
        alert.showAndWait();
    }
}
```

Fig 4.32 – First question

The methodology used in Fig 4.19 is the same for the Question 1 to 8 and Questions 10, 14a and 14b

Question 9 requires the user to input three correct values for x0, y0, and z0 in order to advance to the next question or a prompt message appears on the screen with a hint (Fig 4.33)

```
@FXML
public void engnext9(ActionEvent event) throws IOException {
    int x0 = Integer.parseInt(x_textfield.getText());
    int y0 = Integer.parseInt(x_textfield.getText());
    int z0 = Integer.parseInt(x_textfield.getText());
    if (x0 == 3 && y0 == 4 && z0 == 5) {
        root = FXMLLoader.load(getClass().getResource("English10.fxml"));
        stage = (Stage) ((Node) event.getSource()).getScene().getWindow();
        scene = new Scene(root);
        stage.setScene(scene);
        stage.show();
    } else {
        Alert alert = new Alert(AlertType.ERROR);
        alert.setTitle("Wrong Answer");
        alert.setHeaderText("Wrong Answer");
        alert.setContentText("Under the condition of the problem, M belongs to a given plane,"
                + " with its coordinates (3,4,5)");
        alert.showAndWait();
    }
}
```

Fig 4.33 – Input code

The methodology us in Fig 4.33 is the same for question 14, 15, 16 and Questions 14c and 14d

The methods shown in Fig 4.27 to Fig 4.33 are all the same for the Ukrainian language version of the simulator.

CONCLUSION

The task was to create a simulator for the distance course. The topic was “Plane in space”. This was achieved by the creation of an algorithm in both English and Ukrainian language in order to accommodate to people who speak either language.

Multiple similar works were reviewed and outlined a series of advantages and disadvantages of creating a simulator, where the benefit is greater than the downside. A training simulator is a cost effective tool to aid with distance learning course. The research also highlights the history,

The algorithm of the work of the simulator has been successfully created and offers clear and followable steps on how to create the training simulator. Detailed flowcharts are also presented that show the creation process of the simulator, and the run manual also shows how the simulator works. Several testing was carried out and the simulator works as intended.

The simulator succeeds at solving the task, it provides relevant material that is well detailed and is easily understood by students, and can definitely be utilized as a training aid on the topic “Plane in space”. The user interface is clear, easy to understand and self-explanatory. A series of easy to understand questions and hints make it easy for users to master the concepts described in the simulator.

The simulator can be improved by connecting it to a database for easy update of information and new exercises.

LIST OF LITERATURE USED

1. Syvokin O. The Simulator on the Topic “Land And Doig Method” of the Distance Learning Course “Optimization Methods and Operations Research”: Development and Software Realization./ Oleksandr Syvokin, Oleg Iemets // Proceedings of the VI international scientific conference “Advanced information systems and technologies”, May 16–18, 2018, Sumy. - Sumy State University .Ukrainian federation of informatics –P. 72 – 75. Access mode: https://elib.puet.edu.ua/action.php?kt_path_info=lm.web.view&fDocumentId=670571

2. Barbour, M, Grzebyk, T, Eye, J. / Any Time, Any Place, Any Pace-Really?Examining Mobile Learning In A Virtual School Environment / M. Barbour, T. Gzebyk / J. Eye // Turkish Online Journal of Distance Education, 15 (1), 114-127. DOI: 10.17718/tojde.458282 / Access mode: https://dergipark.org.tr/en/pub/tojde/issue/16891/175934

3. Doug Valentine / Online Journal of Distance Learning Administration. Volume V, NumberIII, Fall 2002 / Valentine Doug // State University of West Georgia, Distance Education Center / Access mode: https://www.westga.edu/~distance/ojdla/fall53/valentine53.html

4. Bloch Joshua. Effective Java / Joshua Bloch // 3 rd Edition / Released: 27 December 2017/ Editor: Addison-Wesley Professional / ISBN-13: 978-0134685991.

5. Drton Mathias / Lectures on Algebraic Statistics/ Mathias Drton, Sturmfels Bernd,Sullivant Seth // Published: 2009 / Publisher: Springer / ISBN 978-3-7643-8904-8.

6. The Historical Development of Algebraic Geometry (Q55886951). –1972. – Access mode: https://www.wikidata.org/wiki/Q55886951

7. Brown G / Introducing FXML A Markup Language for JavaFX / Greg Brown // 2011 / Access mode http://fxexperience.com/wp-content/uploads/2011/08/Introducing-FXML.pdf.