

**CREATING A MOBILE APPLICATION USING ECLIPSE  
WITH MOSYNC SOFTWARE DEVELOPMENT KIT**

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Currently, the mobile application market is rapidly growing. Even though the industry is mainly focused on entertainment, hobbies and operating systems' customization, a huge amount of business and education applications exist. Mathematics is one of the areas where multiple solutions can be found for almost every need. However, the focus of the major amount of such applications is to provide information, not to enhance learning processes. Thus, the decision was made to fulfil the void.

The objective of this project was to design and develop a mobile application of mathematics. The main goal of the application is to serve as a source of information and a self-evaluation tool. Moreover, developing for multiple platforms would be beneficial as cross platform solutions are almost non-existent.

The development focused on three major mobile operating systems, i.e. Android, iOS and Windows Phone. The application itself is based on HyperText Markup Language with JavaScript and jQuery elements. The constructive research method was used in order to analyse existing solutions and provide a new one, which would improve learning processes for possible users. Usability studies were used in order to create a graphical interface of the application. Mathematics textbooks were studied in order to provide the application with content. Finally, monetization possibilities were discovered and discussed.

The results indicate that despite the fact that the initial goal of the application was reached, the implemented version was only one of a countless amount of possible solutions. The created application is fully functional, which was proven by a number of tests. However, further development is suggested in order to enter any of the mobile markets.

Key words: MoSync, Application, Android, iOS, Windows Phone

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## SYMBOLS AND ABBREVIATIONS

CSS	Cascading Style Sheet
HTML	HyperText Markup Language
JS	JavaScript
JSON	JavaScript Object Notation
JQM	JQuery Mobile
OS	Operating System
SDK	Software Development Kit
UI	User Interface

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## 1 INTRODUCTION

The background information to the chosen topic alongside with the motivation of the choice is discussed first. Scope and objectives are also described in this chapter alongside the research methodology, limitations and overall structure of this thesis.

### 1.1 Background Information and Motivation

Today, the amount of mobile applications can hardly be measured. There are hundreds of solutions for almost every need, including mathematics. Despite the fact that all mathematics applications can help to solve the assigned task, they do not provide an opportunity to become personal teachers.

Even though complex solutions were not considered due to specificity of the area, the decision was made to implement the quiz in order to test users' knowledge. Such feature might improve the learning process, especially among people with developed visual and motor memories. Dividing multiple quiz questions into multiple topics and providing the feedback upon answering all questions could help to indicate users' success at particular areas of the science.

My personal interest in software developing and mobile programming is a main motivation for choosing this topic. I am also considering further working in the field, and thus this work can boost my experience and knowledge. Moreover, the possibility to get revenue for the final product is encouraging.

### 1.2 Objectives and Scope

The first objective of this thesis is to design a layout and create the user interface (hereinafter UI) for the application. As the UI is what will be visible for users and widely used by them in order to navigate through the application, it has to be usable and suitable for different screen resolutions. The outcome of the design process will also become a basis for further work.

The second objective is to create a working version of the application with main functions, including the list of formulas and quizzes. This process includes programming and working with content, which are the core parts of this thesis. Success in this stage guarantees the functionality of the application, fulfilling the main goal of the process.

The final objective is to test the functionality of the application, in order to fix the bugs found. If needed, the design may face the final changes. Completing the steps of the testing process will ensure that the development is finished, opening a possibility to enter a market with the application.

This thesis includes the description of the design and programming process with illustrations and code examples. Partial description of the bugs encountered during the programming process is included as well. Possibilities of commercializing are discussed. On the other hand, the thesis does not include detailed information on the software used and its installation. The information on possibilities of monetization is general, and thus it excludes descriptions of differences between mobile application markets alongside with conditions of placing the application on any of them.

### 1.3 Research Methodology

Due to the developmental nature of this thesis, the constructive research method was selected as the most suitable one. According to Lukka (2000), “the constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world”. Dodig-Crnkovic (2010) adds that the goal of outcome of such research is to explain how the initial problem can be solved. Figure 1 below shows the key elements of this method.

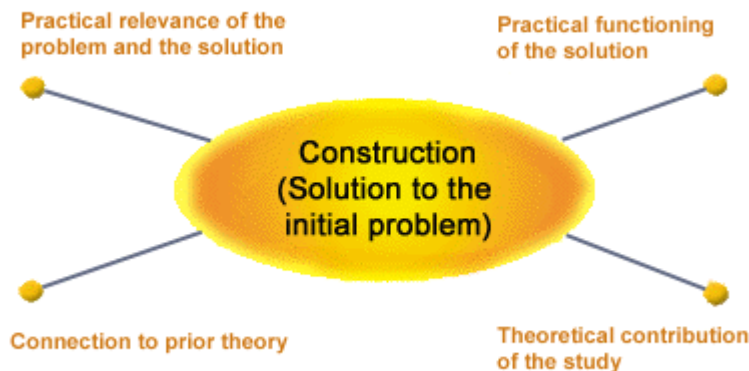


Figure 1. Key elements of the constructive research approach (Lukka 2000)

While practical relevance has been described in previous subchapters, construction and practical functioning are discussed later in this document. Dodig-Crnkovic (2010) draws attention to the fact that “the emphasis should be on the theoretical relevance of the construct”. Despite that, no theoretical contributions were delivered as the final product was based on adding new features based on existing solutions.

In order to implement a valid solution, multiple existing scripts and different elements examples were observed. All inspected materials affected the development process. However, only a few were implemented in the final version due to multiple failures in particular parameters. Usability studies were taken into consideration during the design and construction stages.

Finally, the testing had to be implemented at the end of the development process in order to verify integrity of the application. Even though its importance is discussed further in this document, it has to be stated that one of the distinguishing features of the constructive research is the attempt to test its result explicitly (Lukka 2000).

#### 1.4 Assumptions and Limitations

The thesis is presented with an assumption that the reader has basic knowledge of programming and web design, as well as an ability to differentiate mobile platforms. Inter-



mediate programming level will be useful for better understanding of the development process, but is not required.

The author's lack of knowledge and experience working with Eclipse, MoSync software development kit (hereinafter MoSync SDK) and jQuery is the main limitation. The lack of physical devices limits the possibilities to test the outcome in real conditions.

## 1.5 Structure

The chosen operating systems (hereinafter OS) and tools used in the development process are stated in chapter 2. The process of designing the layout for this research is described in chapter 3. The discussion in this chapter leads to the implementation process, which is discussed in chapter 4. The outcome is tested in chapter 5 and the possibilities of monetization of the final product are included in chapter 6. Chapter 7 contains the conclusion of the research.

## 2 PLATFORMS AND TOOLS

This chapter contains a brief overview of mobile operating systems' popularity alongside with the choice made. The description of the tools used in the development process is included as well.

### 2.1 Mobile Operating Systems

Mobile platforms and their corresponding tools are in a constant process of growth and development. The amount of each operating system's unique features and solutions is increasing as the manufactures try to overtop each other. However, major companies remain the same as well as basic ideas of their systems. In order to evaluate the possibilities of the application distribution and accessibility, the statistics of the worldwide the worldwide mobile OS market share was accessed. Table 1 below illustrates the popularity of multiple operating systems within four years.

Table 1. Worldwide OS market share (International Data Corporation 2014)

Period	Android	iOS	Windows Phone	BlackBerry OS	Others
Q4 2014	76.6%	19.7%	2.8%	0.4%	0.5%
Q4 2013	78.2%	17.5%	3.0%	0.6%	0.8%
Q4 2012	70.4%	20.9%	2.6%	3.2%	2.9%
Q4 2011	52.8%	23.0%	1.5%	8.1%	14.6%

The two major operating systems used at present are Google's Android and Apple's iOS. The popularity of Android can be explained by the massive amount of smartphones and tablets on the market, their variety and, finally, the open distribution of the system's code. In turn, iOS is limited to the devices manufactured by the company itself.

Creating the application for three major systems would cover up to 99% of devices worldwide. Simultaneous programming for multiple OSs with multiple tools and pro-

programming languages was not considered an option for this thesis. The reason is the amount of work and time needed for the development, which would be multiplied by the amount of target OSs. However, a tool was discovered which would eliminate these issue.

## 2.2 MoSync SDK

Eclipse with MoSync SDK is the tool chosen for this project. It grants an opportunity to create multiple packages of single code, which would be suitable for different mobile platforms. The total amount of supported OSs is nine, including Android, iOS, Windows Phone, Windows Mobile, Blackberry OS, Symbian, Java ME, MeeGo and Moblin. Moreover, both Eclipse and MoSync SDK are representatives of open source software. Their combination includes all necessary tools, i.e. programming environment and emulators of mobile platforms, which are extremely important, considering the lack of physical devices.

As the application is not supposed to contain any OS-locked code or data, MoSync was chosen as the main tool for the project. Android, iOS and Windows Phone became the target platforms. Moreover, older versions of the selected Operating Systems would also be supported by the application.

## 2.3 Supporting Tools

GIMP was used in order to work with the content. It is a freely distributed software with a large set of tools, which perfectly fits the needs of this work. Moreover, it does not require any special skills and knowledge for productive work.

Draw.io website was used during the process of the layout creation. The website provides the possibility to create diagrams, flowcharts, tables, Android and iOS interfaces, etc. The result can be either stored on the cloud services, or downloaded in multiple formats.

### 3 DESIGNING THE LAYOUT

This chapter covers the process of designing multiple template options for the application. The choices are made based on usability rules and the target hardware.

#### 3.1 Usability Studies

As the amount of possible design solutions approaches infinity, not all solution can be found suitable as certain usability guidelines have to be followed. “According to ISO 9241, Part 11, usability is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use” (Ferré & Juristo & Juristo & Constantine 2001, 22). Figure 2 shows the involvement of usability in creation of an acceptable system.

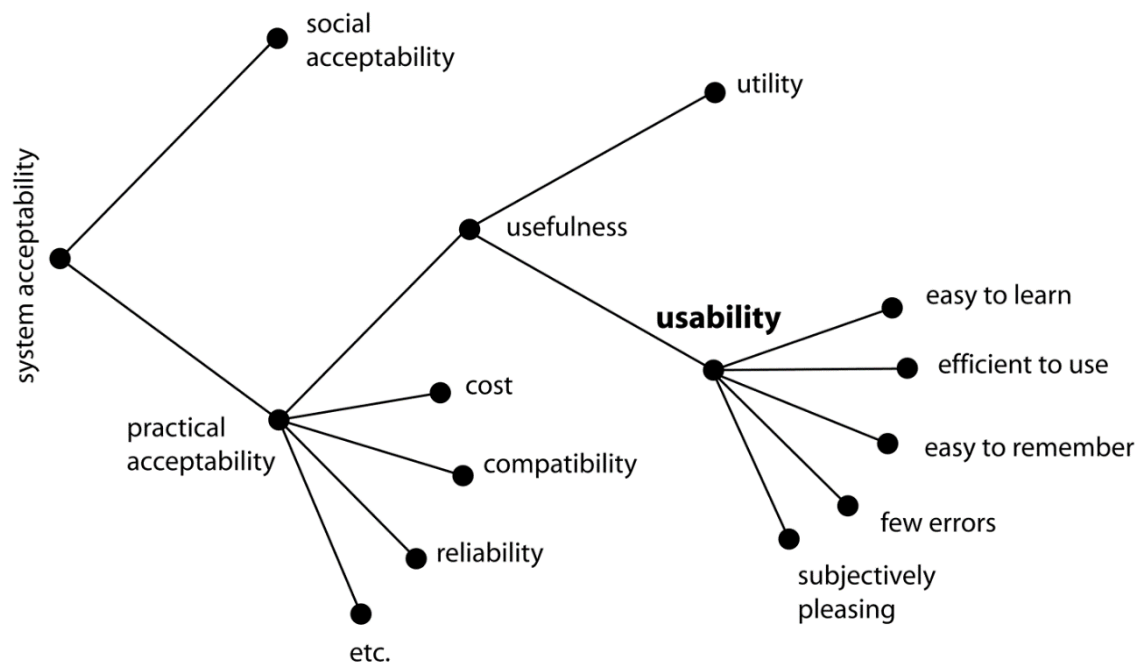


Figure 2. A Model of the Attributes of System Acceptability (adopted from Nielsen 1993 cited by Ferré & Juristo & Juristo & Constantine 2001, 22)

Usefulness of the application is defined by the usability. As Simoes-Marques et al. (2012, 157) state, “when human-machine interfaces are built taking into account usabil-

ity criteria, interfaces are capable of allowing an intuitive, efficient, memorable, effective and enjoyable interaction.” Thus, in order to be acceptable by the users, the application has to be built using these five attributes, which translate into multiple usability guidelines. As the amount of usability rules cannot be measured with double figures, those, that were found crucial and were used during the creation of the application, will be mentioned further, while describing the designing process.

### 3.2 Content Containing Pages

While designing the application, the set of guidelines on a page layout and navigation has to be taken into consideration. Thus, according to the U.S. Department of Health and Human Services (2006), the following aspect are the rules which are applicable for this project and have to be followed:

- Page layout guidelines
  - Avoid Cluttered Displays
  - Place Important Items Consistently
  - Align Items on a Page
  - Use Fluid Layouts
  - Use Moderate White Space
- Navigation guidelines
  - Provide Navigational Options
  - Differentiate and Group Navigation Elements
  - Use a Clickable ‘List of Contents’ on Long Pages
  - Place Primary Navigation Menus in the Left Panel.

After creating multiple draft versions of the layout, two possible options were chosen, illustrated in figures 3 and 4 below. While a version shown in figure 3 includes a static navigation panel, figure 4 presents a layout with a dynamic menu.

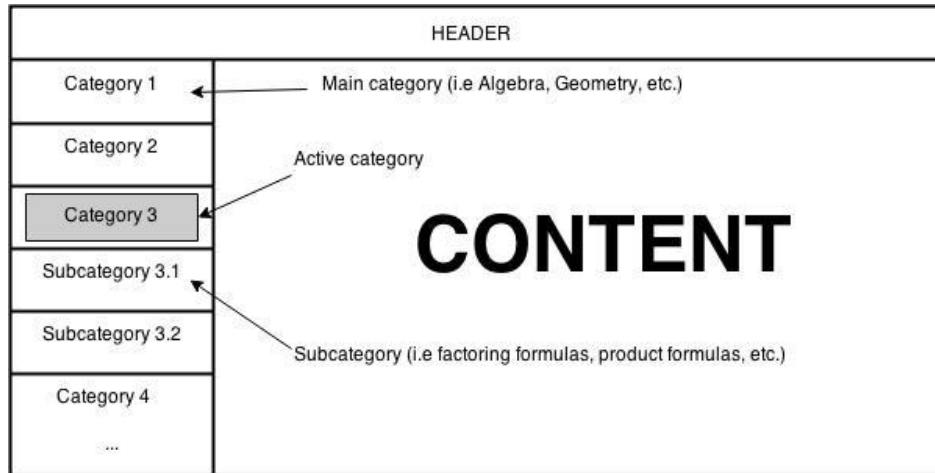


Figure 3. Draft version of a layout with a static navigation panel

After pressing on any category, it would be highlighted, the user would be redirected to the corresponding content and the list of subcategories would be opened for further navigation. There would be no need in creating additional navigation links to home page, as it would not exist in this layout.

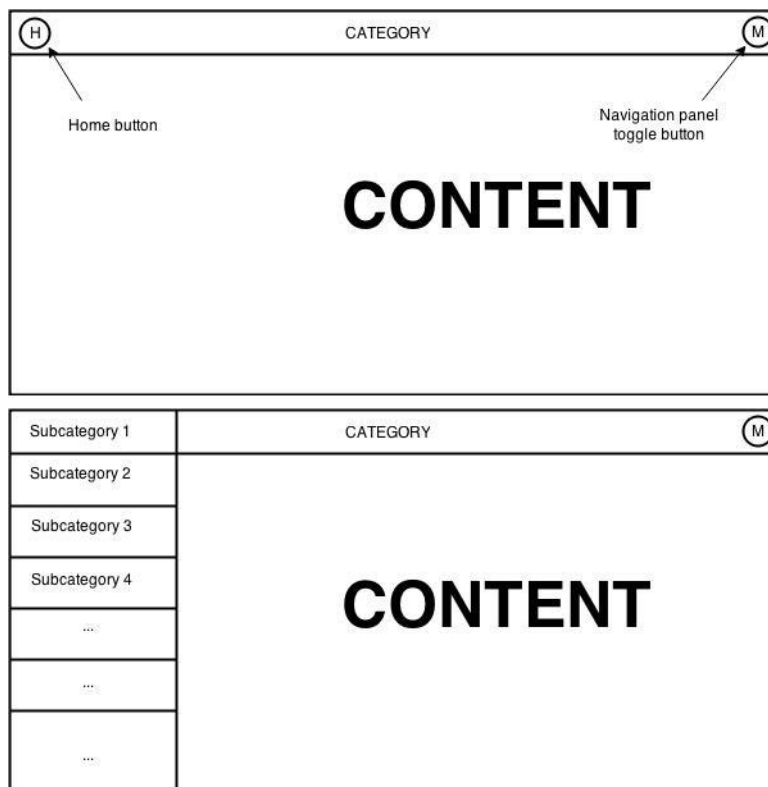


Figure 4. Draft version of a layout with a dynamic navigation panel

Additional buttons would be required as the categories would be located on different pages. The home button would redirect the user to the main page, which would be required to contain a navigation between the categories. Additionally, the menu button would be added in order to toggle the side panel, containing a list of subcategories for navigation. The panel would be closed automatically after choosing a subcategory or manually, by clicking the menu button, clicking outside of the panel or swiping it to the left.

The decision was made to choose the second option, mainly due to its better effectiveness on devices with small screen resolutions. While the first option shrinks either the content or the side panel, making the resized part nearly unreadable, the second layout only resizes the content, leaving everything else untouched. Figure 5 depicts the variety and popularity of devices with small screen resolutions.

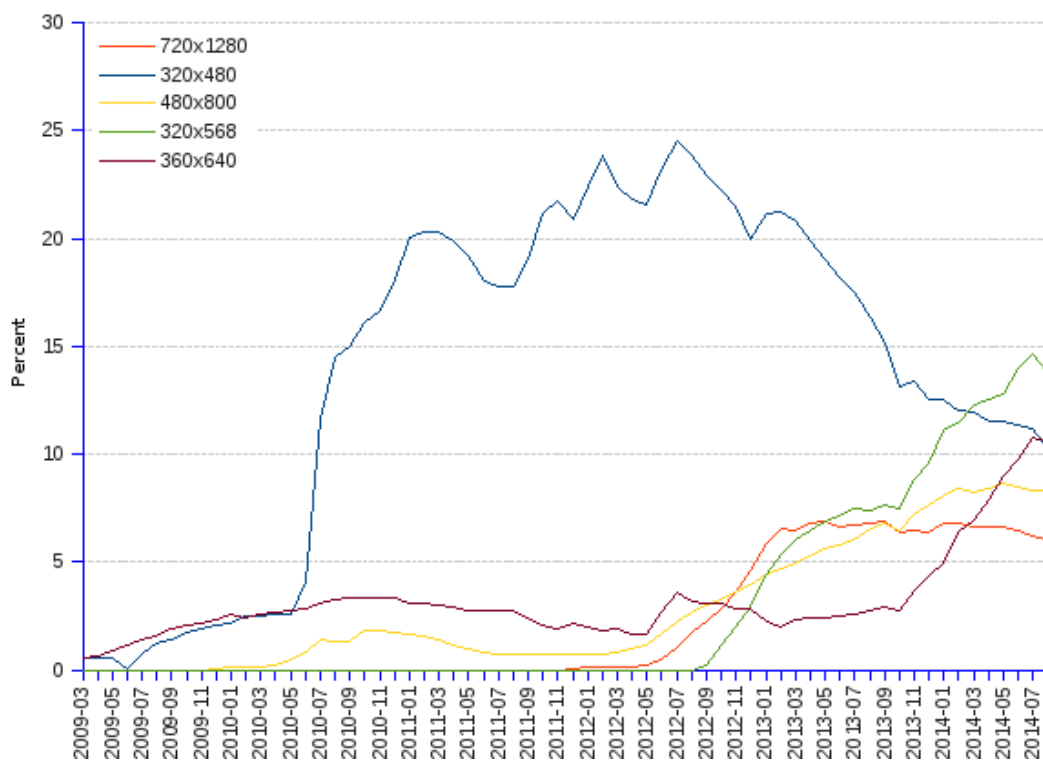


Figure 5. Mobile Screen Resolution Percent Market Share — World (StatCounter Global Stats 2014)

The summed percentage of all illustrated resolutions, excluding 720x1280, is approximately 42-46%. Such devices are still widely manufactured, sold and used worldwide; thus, they cannot be ignored without a massive drop of possible users.

### 3.3 Other Pages

As the main layout was chosen during the previous step, other pages were supposed to have a similar design. However, some changes had to be made, which are represented in figures 6, 7 and 8 below.

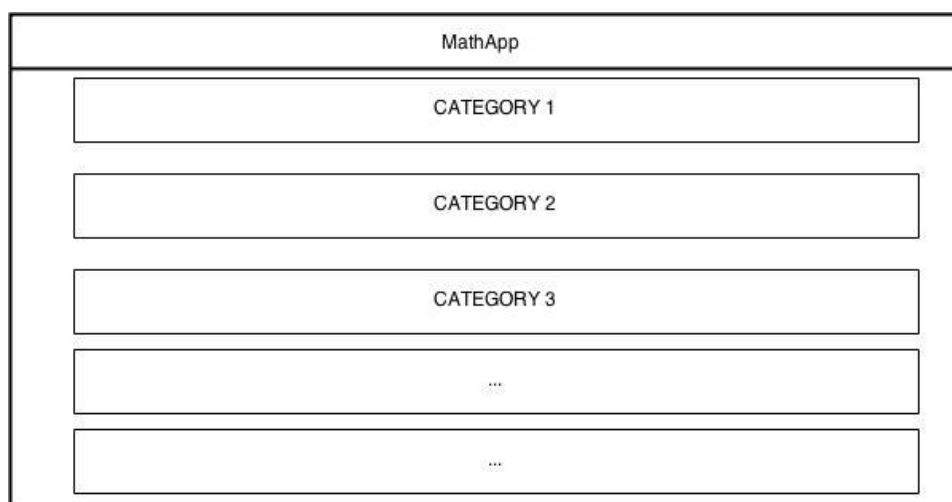


Figure 6. Draft version of a main page

The side panel was removed from these pages due to its ineffectiveness. The navigation had to be put on a place used for formulas on content containing pages. Otherwise, the page would show a white space to users upon opening. Pictures, containing the names of the categories, will serve as a navigation for these pages.



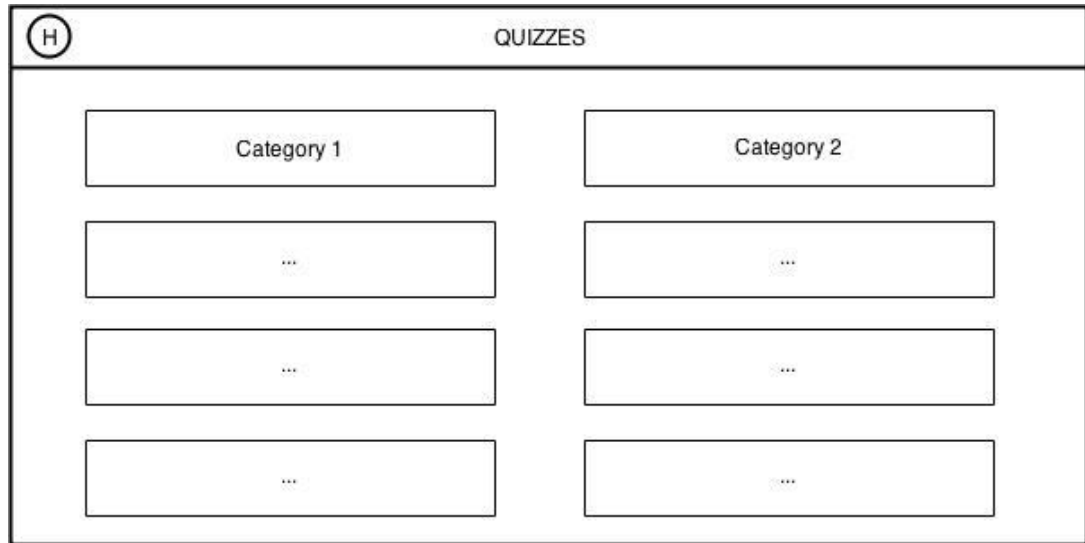


Figure 7. Draft version of a quiz main page

The changes made for the quiz main page are the same as those applied for the main page. The only difference between them is the decision to arrange the navigation pictures in two columns for the quiz main page, as quizzes by categories could be later accompanied by any question compilations.

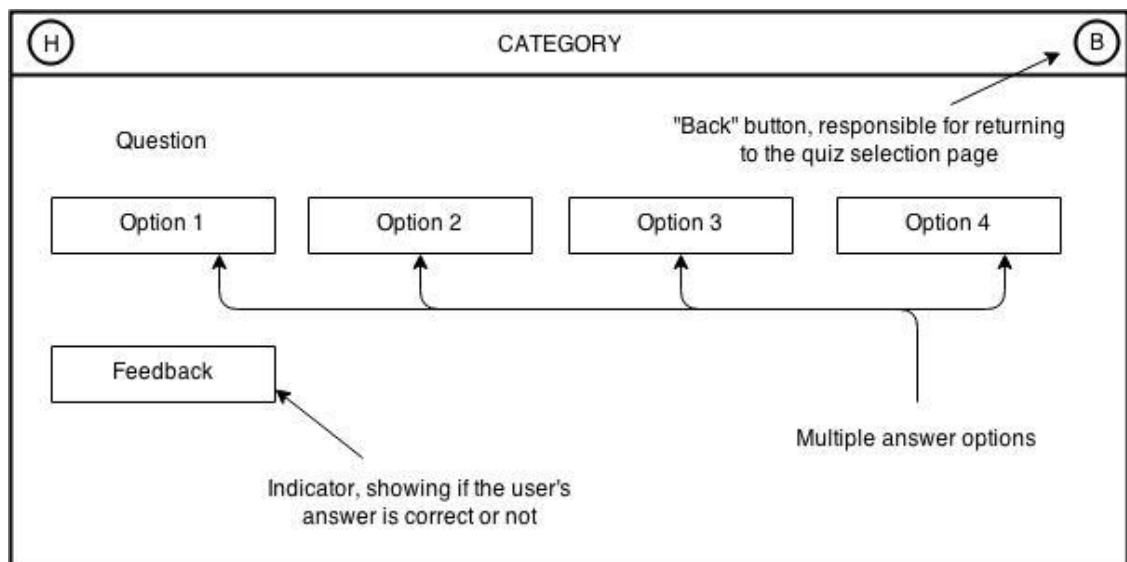


Figure 8. Draft version of a quiz page

Back button was added on a place of a side panel as a mechanism of returning to the quiz list. Depending on the size of the screen and its resolution, there are four different location options for the answer options:

- One row, four columns
- Two rows, two columns
- Two rows, three columns
- Four rows, one column.

The feedback indicator is shown below the answers. Alternatively, if there are four rows on the screen, it is located between the second and the third option. In this way, it always appears in the users' field of view.

## 4 CREATION OF THE APPLICATION

This chapter describes the process of creating the application based on the designed layout. The format of the content is also mentioned.

### 4.1 Implementing the UI

As the main function of the application is providing information via the list of formulas, the decision was made to build the application with HyperText Markup Language (hereinafter HTML) with multiple elements of jQuery Mobile (hereinafter jQM) for interaction and navigation. Moreover, jQM meets the standards of the responsive design, allowing the scaling of the navigation panels for different screen resolutions.

Every page has to include jQM's Cascading Style Sheets (hereinafter CSS) and JavaScript (hereinafter JS) files. They were downloaded from the official website (jQuery Mobile Downloads 2015) and referred locally in the code, which is attached in appendices 1-13 and 16. Among the features needed and used in this project, CSS files define the design of different jQM's elements and their reaction on changes of the screen resolution, while JS files include multiple scripts, responsible for swipe actions and animations of different elements.

The implementation started with a simple header for index.html (Appendix 13). Further development included adding the navigation buttons and the side panel, used in almost all other pages.

```
<div data-role="page">
  <div data-role="header" data-position="fixed" data-tap-toggle="false">
    <h1>MathApp</h1>
  </div>
```

Figure 9. Header source code

Figure 9 above demonstrates the source code for the header, where 'data-position="fixed"' states that the header is attached to its position on the screen, making it visible even when the page is scrolled down. Function 'data-tap-toggle="false"' disa-

bles jQM's feature to toggle the visibility of the header, thus it always remains visible (jQuery Mobile Demos 2015a).

```
<div data-role="page">
  <div data-role="header" data-position="fixed" data-tap-toggle="false">
    <h1>Geometry</h1>
    <a href="index.html" data-ajax="false" data-icon="home" data-iconpos="notext">Home</a>
    <a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
  </div>
```

Figure 10. Header source code with added buttons

Figure 10 above represents a typical header for any content containing page, where two navigation buttons are added. The icons are included in jQM and are referred as 'data-icon="home"' and 'data-icon="bars"'. As jQM uses Ajax when it is possible to open the links, 'data-ajax="false"' had to be added in order to cancel that behaviour and use http requests instead (jQuery Mobile Demos 2015b). However, the "menu" button does not include that parameter as it is linked with the panel, located on the same page and accessed via the id "geom".

```
<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true" data-theme="a" style="overflow-y: auto">
  <ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-16px;" class="nav-search">
```

Figure 11. Side panel source code

Figure 11 above displays the source code of the side panel. jQM has three different types of panel display, which are overlay, reveal and push (jQuery Mobile Demos 2015c). Due to the reasons described in chapter 3 of this paper, overlay was chosen and implemented with 'data-display="overlay"'. The position is fixed as the panel is connected with the navigation, located in the header. Finally, 'style="overflow-y: auto"' was added to ensure that the content of the panel can be scrolled vertically, if needed. The second line is assigned with the class 'nav-search' and it defines the content of the panel, which, in case of this application, is a list and is modified by 'style', presented in figure 12 below.

```

<style>
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;
        border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

```

Figure 12. Side panel content styling

Background of components of the list are defined in 'ui-btn-up-a' section, while 'ui-btn-inner' defines the boulders between those components. To ensure that long titles will not be cut, but warped, the 'white-space: normal; !important' was added. Parameter 'a.ui-link-inherit' was used, indicating that the panel would consist of anchor links.

Further steps of the implementation process include creating the list, adding the content and, finally, creating links between them. The formulas, which were taken from multiple sources, presented in Appendix 19, were split into different categories and subcategories for further representation as images. In order to fit them into any screen, 'img{ max-width:100%; }' was added to 'style'. The result can be observed in figure 13 below.

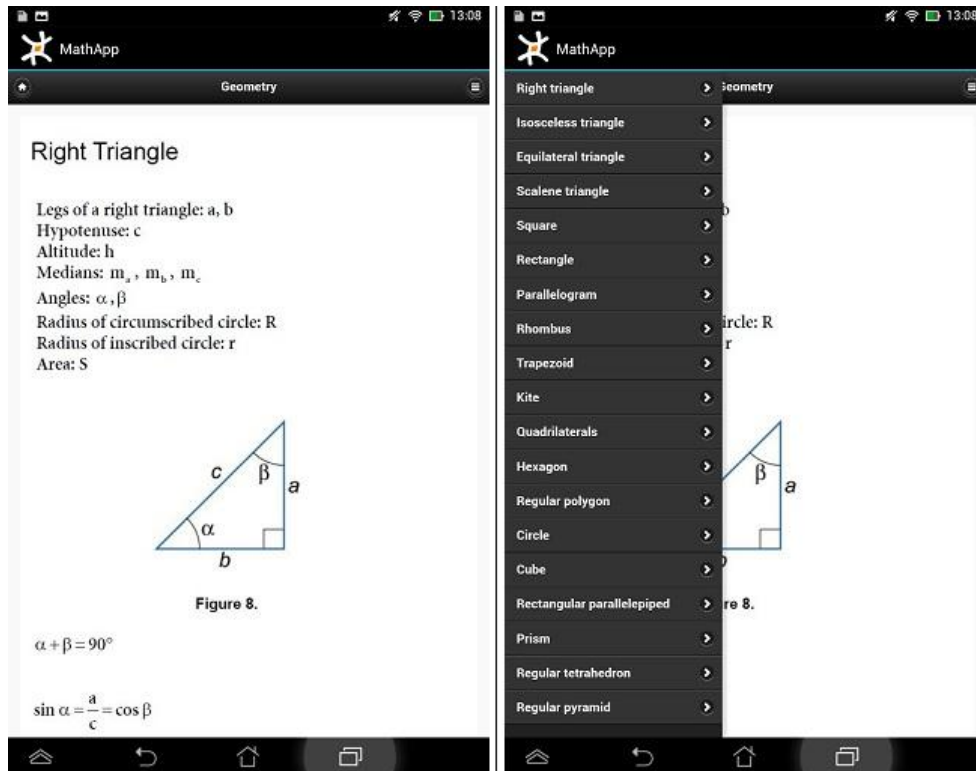


Figure 13. Implemented version of the interface for pages containing formulas (800x1280px)

The side panel content fully fits the height of the screen on vertically disposed devices with 800x1280-screen resolution. If the orientation is changed to horizontal or the resolution is lower than the one stated above, the side panel becomes scrollable as its bottom part becomes hidden. The content is readable on any device in any position.

#### 4.2 Quiz Pages

Quiz pages have a different structure, thus they have to be discussed separately. The main idea is to store four answer options for each question and make them appear in a random order every time they are accessed. Thus, to succeed, the users have to know the correct answer, not its position. The options are represented as pictures as well as the main content. In this case, an array is needed, which is able to contain objects in it. The decision was made to use JavaScript Object Notation (hereinafter JSON) alongside with HTML and JS to achieve this result. However, there is a drawback - JSON files have to be located on the server in order to be accessible via JS. Thus, the application asks for

an internet connection permission, although all the other features are still accessible without it.

```
#navContent{
margin:auto;
width:800px;
height:400px;
position:relative;
overflow:hidden;
}

#game1{
margin:auto;
width:800px;
height:400px;
right:0px;
position:absolute;
}

#game2{
margin:auto;
width:800px;
height:400px;
right:-800px;
position:absolute;
}
```

Figure 14. Styling the content of the quiz

A part of the quiz.css file is presented in figure 14 above. The content area was resized to a 800x400px field. The size does not matter in this case as it is only used for switching the questions. There are two scenes, which contain questions and while the first one is originally visible, the second one is hidden with 'right:-800px;' parameter. The process of navigating between them is described further in this paper.

```
$.getJSON('https://api.myjson.com/bins/3n08i', function(data) {  
  
  for(i=0;i<data.quizlist.length;i++){  
    questionBank[i]=new Array;  
    questionBank[i][0]=data.quizlist[i].question;  
    questionBank[i][1]=data.quizlist[i].option1;  
    questionBank[i][2]=data.quizlist[i].option2;  
    questionBank[i][3]=data.quizlist[i].option3;  
    questionBank[i][4]=data.quizlist[i].option4;  
  }  
  numberOfQuestions=questionBank.length;  
  
  displayQuestion();  
})
```

Figure 15. Reading JSON and filling in an array

After accessing a JSON file from the server, its data is copied into an array of five elements – the question and four answers, as depicted in figure 15 above. The positions of the elements in the array are fixed, and thus their positioning within the defined area is randomized with another algorithm, which can be observed in figure 16 below.



```

function displayQuestion(){
  var rnd=Math.random()*4;
rnd=Math.ceil(rnd);
  var q1;
  var q2;
  var q3;
  var q4;

if(rnd==1){q1=questionBank[questionNumber][1];q2=questionBank[questionNumber][2];
q3=questionBank[questionNumber][3];q4=questionBank[questionNumber][4]}

if(rnd==2){q2=questionBank[questionNumber][1];q3=questionBank[questionNumber][2];
q4=questionBank[questionNumber][3];q1=questionBank[questionNumber][4]}

if(rnd==3){q3=questionBank[questionNumber][1];q4=questionBank[questionNumber][2];
q1=questionBank[questionNumber][3];q2=questionBank[questionNumber][4]}

if(rnd==4){q4=questionBank[questionNumber][1];q1=questionBank[questionNumber][2];
q2=questionBank[questionNumber][3];q3=questionBank[questionNumber][4]}

$(stage).append('<div class="questionText">'+questionBank[questionNumber][0]+
'</div><div id="1" class="pix"></div><div id="2" class="pix"></div><div id="3" class="pix"></div><div id="4" class="pix"></div>');

```

Figure 16. Question display function

Even though there are  $4 \times 3 \times 2 \times 1 = 24$  possible nonrecurring variants for displaying four answers, only four of them were implemented. The function randomizes a number, based on which the position of the answers is defined. Finally, everything is displayed on the screen, starting with the question and ending up with the answers.

As the question and possible answers become visible, the choice can be made and the feedback is displayed after user's decision. The statistics is gathered on the amount of correct answers, therefore a counter had to be added. As the data kept in JSON file is structured in a way that the first option stated there is always the correct one, the position of the corresponding answer is equal to a randomized number. A timeout is also added to ensure that the stage is not changed immediately after choosing the answer, as it would make the feedback be visible for a split second only. Figure 17 below suggests the implementation of these features.

```

$( '.pix' ).click(function() {
  if(questionLock==false) {questionLock=true;
  //correct answer
  if(this.id==rnd) {
    $(stage).append('<div class="feedback1">CORRECT</div>');
    score++;
  }
  //wrong answer
  if(this.id!=rnd) {
    $(stage).append('<div class="feedback2">WRONG</div>');
  }
  setTimeout(function() {changeQuestion() }, 750);
  })
}

```

Figure 17. Feedback implementation

Finally, as the feedback is received, the following question has to replace the current one. As there are two stages in the code, the active one is replaced by the hidden, containing a new set of answers. If the current question is the last one, it will be replaced with the final slide, representing the amount of answered questions alongside with the amount of those answered correctly. Figure 18 shows the implementation of a transaction.

```

function changeQuestion() {
  questionNumber++;
  if(stage=="#game1") {stage2="#game1";stage="#game2";}
  else {stage2="#game2";stage="#game1";}
  if(questionNumber<numberOfQuestions) {displayQuestion();} else {displayFinalSlide();}
  $(stage2).animate({"right": "+=800px"}, "very fast", function() {$(stage2).css('right', '-800px');$(stage2).empty();});
  $(stage).animate({"right": "+=800px"}, "very fast", function() {questionLock=false;});
  //change question
}

```

Figure 18. Changing question stages

The last step is adding the script to a quiz page. As can be observed in Appendix 16, this is achieved by including 'quiz.css' and 'quiz.js' files in the '<head>' and adding both 'game1' and 'game2' stages to the '<body>'. Figure 19 presents the implemented version of the quiz.

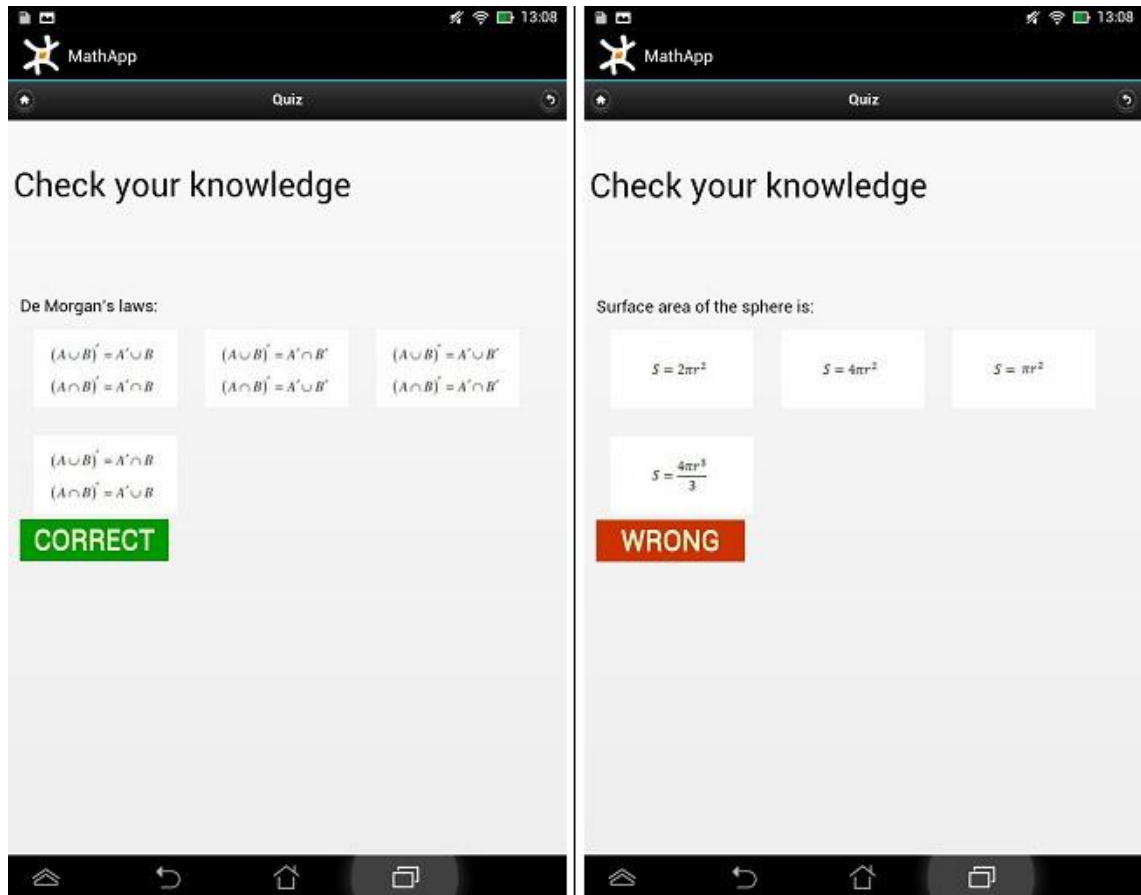


Figure 19. Implemented version of the quiz (800x1280px)

The quiz is displayed with two rows and three columns on vertically disposed devices with 800x1280-screen resolution. As was stated during the designing process, the feedback is shown below the answer options. Originally, the chosen answer was highlighted using borders. However, such an approach caused a shift of the layout during the transaction process, and the borders were removed.

#### 4.3 Main.cpp

The initial launch in MoSync is controlled by 'main.cpp' file, which can be seen in Appendix 18. Function 'showPage("index.html");' is used in 'MyMoblet' class in order to display the main page of the application upon the launch. Another part of the 'main.cpp' file is exiting upon pressing the device's "back" button. Moreover, the support of all screen orientations was added.

The original decision was to provide a possibility to switch to the previous page with the “back” button. However, the function in MoSync, which allowed implementing that, would only return to previous C++ files. As the application is based on HTML and is controlled by only one .cpp file, there are no pages to be referred.

## 5 TESTING

Testing was an important part of this development process as it allowed verifying the functionality of the created product. Thus, this chapter presents the testing process and its results, while also mentioning the testing method used.

### 5.1 Testing Method

As the application focuses on providing output of various information for the users, black box testing was selected as the most suitable method. According to Williams (2006), “black box testing, also called functional testing and behavioural testing, focuses on determining whether a program does what it is supposed to do based on its functional requirements.”

The testing occurred simultaneously with the development process to validate the functionality and efficiency of implemented solutions before proceeding to the next component. The connections between those solutions were also tested at the end of the process.

Windows Phone and iOS emulators integrated into MoSync SDK were used in order to test the functionality of the application. Multiple physical devices were also involved in the testing process, providing a possibility to identify potential hardware-based problems. Table 2 below contains the core information about these devices.

Table 2. Physical mobile devices used during the testing process

Manufacturer	Model	OS	Screen resolution, px
ASUS	ME173X	Android 4.2	1280x800
Alcatel OneTouch	POP C2 4032D	Android 4.2	480 x 800
BlackBerry	Z30	BlackBerry 10 OS	720x1280
HTC	Wildfire	Android 2.2	240x320

The testing was held on Android based mobile devices. Different OS versions were used in order to check the compatibility, and different screen resolutions helped to ensure the readability of the content. Even though BlackBerry has its own OS, Android version of the application could still be installed and launched. It also has to be mentioned that the application in its final form cannot be launched on HTC Wildfire due to the lack of Random Access Memory. However, initial tests of older versions were successful.

## 5.2 Test Cases

As the errors in this application were most likely to occur with the links and quiz pages, the testing focused on these elements. Thus, every single link was checked and multiple different options for passing the quiz were implemented to ensure correct functionality. However, all other solutions discussed in this document before, were also tested.

Table 3. Main.cpp test case

Page	Main.cpp
Test procedure	<ol style="list-style-type: none"> <li>1. User launches the application</li> <li>2. User rotates the screen and its orientation is changed accordingly</li> <li>3. User presses “back” button when applicable and the application is closed</li> </ol>
Expected result	<ol style="list-style-type: none"> <li>1. The application is launched and main menu is opened</li> <li>2. The screen is rotated according to its positioning</li> <li>3. The application is closed after “back” button is hit</li> </ol>
Actual result	<ol style="list-style-type: none"> <li>1. The main menu is opened upon the launch of the application</li> <li>2. The screen orientation is changed after rotations</li> <li>3. The application is closed after “back” button is hit</li> </ol>
Status	Success
Notes	Screen orientation is changed even if it is disabled in the OS

Table 3 above shows the test case for the ‘main.cpp’ file, which launches the application and defines some of its options. When the application was launched, the main page was opened and it could be closed upon pressing the “back” button. The screen orientation changed upon rotating the screen. However, it re-writes the settings of the OS, thus even

if an automatic screen orientation is disabled in the device, the application will still change it. The solution to this problem was not found.

Table 4. Main page test case

Page	Main page
Prerequisites	The application is launched
Test procedure	User chooses any category presented in the menu
Expected result	The related category page is opened
Actual result	The chosen category page is opened
Status	Success

Table 4 above contains the test case for the main page. Upon choosing any category, located on the main page, the user is relocated to the related category page. Table 5 below illustrates the test case for those pages.

Table 5. Category pages test case

Page	Category pages
Prerequisites	The application is launched and the user is located on one of the category pages
Test procedure	<ol style="list-style-type: none"> <li>1. User opens the side panel with a menu button, located in the header</li> <li>2. User clicks on any subcategory</li> <li>3. User opens the side panel and closes it using multiple methods</li> <li>4. User presses the home button</li> </ol>
Expected result	<ol style="list-style-type: none"> <li>1. The side panel with the list of subcategories is opened</li> <li>2. The current location on the page is changed to the start of the subcategory. The side panel is automatically closed</li> <li>3. The side panel is closed upon clicking outside of it, clicking the menu button again and by swiping it to the left</li> <li>4. Main page is opened</li> </ol>
Actual result	<ol style="list-style-type: none"> <li>1. The side panel with the list of subcategories is opened</li> <li>2. The current location on the page is changed to the start of the subcategory. The side panel is automatically closed</li> <li>3. The side panel can be closed upon clicking outside of it, clicking the menu button again and by swiping it to the left</li> <li>4. Main page is opened</li> </ol>
Status	Success

While in a category page, the user can open the side panel with a “menu” button, located in the header. When the button is pressed, a side menu appears, containing the list of subcategories. Upon choosing the subcategory, the user is relocated to it and the side menu is closed. However, it can also be closed without choosing the category, using swipe, pressing the “menu” button again or by clicking on the content outside the panel. “Home” button located in the header redirects the user to the main page.

Table 6. Quiz main page test case

Page	Quiz main page
Prerequisites	The application is launched and “quiz” category is chosen
Test procedure	User chooses any category presented in the menu
Expected result	The related category quiz page is opened
Actual result	The chosen category quiz page is opened
Status	Success

Table 6 above shows the test case for the quiz main page. Upon choosing any category, located on the quiz main page, the user is relocated to the related quiz page. The test case for that page is included in table 7 below.

Table 7. Quiz pages test case

Page	Quiz page
Prerequisites	The application is launched and the user is located on one of the quiz pages, excluding the quiz main page
Test procedure	<ol style="list-style-type: none"> <li>1. User selects a correct answer for the presented question</li> <li>2. User selects a wrong answer for the presented question</li> <li>3. User finishes the quiz</li> <li>4. User presses the “back” button, located in the header</li> </ol>
Expected result	<ol style="list-style-type: none"> <li>1. The positive feedback appears and the question is changed</li> <li>2. The negative feedback appears and the question is changed</li> <li>3. The final slide appears, showing the total number of questions answered and the amount of those answered correctly</li> <li>4. The user is redirected to the quiz main page</li> </ol>
Actual result	<ol style="list-style-type: none"> <li>1. The positive feedback appears and the question is changed</li> <li>2. The negative feedback appears and the question is changed</li> <li>3. The final slide appears, showing the total number of questions answered and the amount of those answered correctly</li> <li>4. The user is redirected to the quiz main page</li> </ol>
Status	Success
Notes	Internet connection is required



Upon entering the quiz, the user chooses one of the presented options. Depending on the answer, the feedback is shown, indicating if the user is correct or wrong. As last question of the quiz is answered, the final slide appears, containing the information on the amount of answered questions and the amount of those answered correctly. Upon pressing the “back” button located in the header, the user is redirected to the quiz main page.

The testing is considered successful as all the implemented features are working as they were originally supposed to. The screen orientation problems, stated in the first test case, did not affect the functionality of the application. Moreover, upon finishing the process, a notification was added to “quiz.html” regarding the required internet connection.

## 6 COMMERCIALIZATION

This chapter covers the possibilities of getting revenue from the work done. Major monetization models are stated and the choice is made for this particular application.

### 6.1 General Monetization Possibilities

While the process of placing the application on a specific OS market is straightforward, the commercialization part has to be planned carefully. To begin with, different ways of getting a possible revenue have to be defined. According to App Annie and IDC (2014, 6), there are four major business models as follows:

- Freemium, when the application can be downloaded, installed and used for free, but some in-app purchases are available
- Paid, when the application has to be bought before providing a possibility to download it. In-app purchases are disabled
- Paidmium, when the application has to be bought, but in-app purchases are also available
- In-App advertising, when the application contains advertisements, e.g. banners, videos, etc. Such applications are usually free to download and use.

Figure 20 below depicts the App store composition by business model, provided by IDC and App Annie (2014, 9). The freemium model is dominant in both number of applications on the market and revenue.

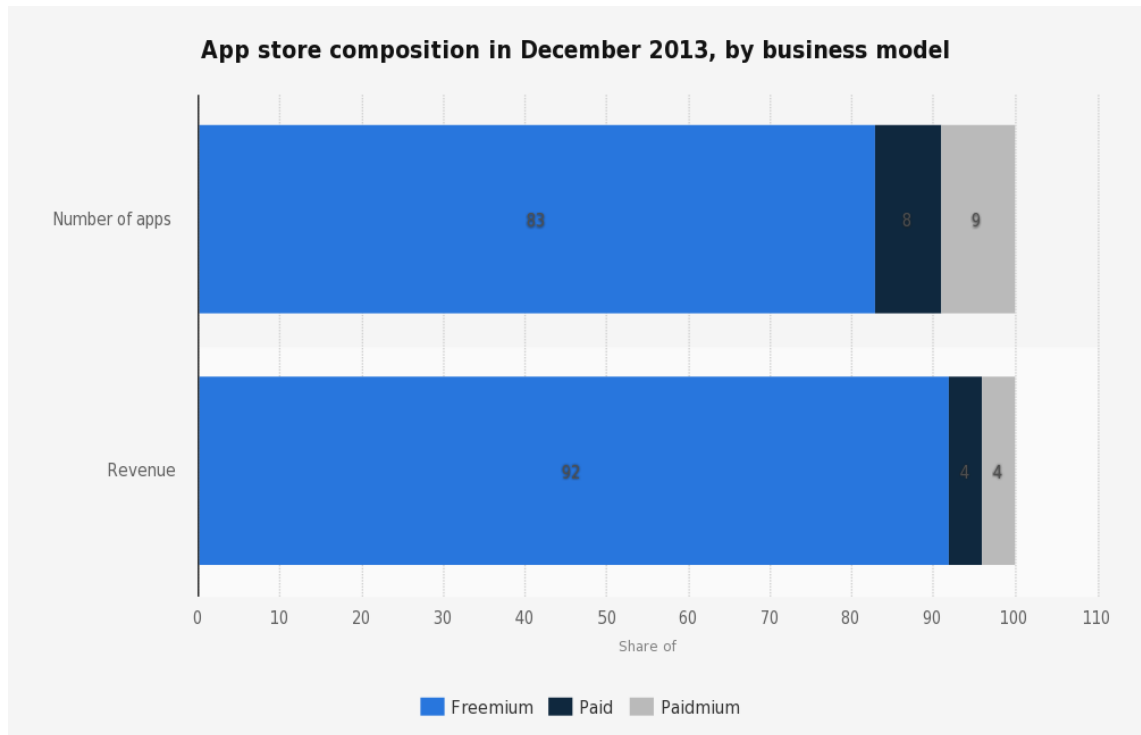


Figure 20. App store composition by business model in December 2013 (Statista 2015)

Even though not stated in the figure above, freely distributed applications with in-app advertising are also widespread within the mobile markets. According to Trademob studies (2013), there are multiple ways of displaying advertisements, including the following:

- Banners, which is one of the most used and versatile forms of digital advertising.
- Incentivized traffic, engaging the download of partners' applications. Mostly used in freemium models, encouraging users to follow the links with some rewards.
- Video, one of the most engaging ad format. Mostly used within games, during the pauses there.

As the application does not contain any in-app currency, incentivized traffic is the first type of the advertising to be excluded. Showing video after completing any quiz, in theory, can be considered as a valid option. However, in practice, it would be a massive repel for a major part of the potential audience, as the amount of time spent on passing

the quiz at some points might get lower than the amount of time spent on watching the advertisement. Properly located banners, however, would be much less bothersome for the users and still bring some revenue to the developer.

## 6.2 Possible Monetization Model for the Application

As studies discussed above show, freemium would be the best choice over other business models. However, the application created during this thesis process does not envisage in-app purchases. Considering a target group for this application, which would mainly consist of students, and the fact that the information contained in this application can be found in other sources freely, paid distribution is not considered a valid option either. Thus, the application would be distributed freely, with in-app advertising.

The situation can be changed with further development of the application. Adding functions, e.g. personal profiles with explicit statistics on quiz attempts, favourite formulas and automated calculations can make either the freemium model or paid version with disabled advertisements suitable.

## 7 CONCLUSION

The objective of this thesis was to create the application, containing an explicit list of formulas and quizzes for different sections. The focus on three major mobile operating systems, the decision to pay attention to devices with small screen resolutions and, finally, MoSync SDK's support of both current and previous versions of OSs maximized the amount of possible users.

A solid amount of draft options implemented in different ways with different solutions provided a basis for further implementation. Original implementations had multiple issues with either scaling the layout or navigating between the pages, thus the final version with jQuery Mobile has proven to be the most successful one. However, it does not mean that the implemented solution was the only way to achieve the desired result.

The coding process was not hard due to previous programming experience. On the other hand, modifying the content was a challenging and lasting process, which also contained working with a solid amount of sources. Multiple draft options were implemented as well, though a simple list was the best choice. Even though the application is fully functional at this point and can be distributed over the application markets, further development will be beneficial.

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## APPENDICES

Appendix 1. sets.html

Appendix 2. algebra.html

Appendix 3. geometry.html

Appendix 4. trigonom.html

Appendix 5. matdet.html

Appendix 6. vectors.html

Appendix 7. angeometry.html

Appendix 8. differecalc.html

Appendix 9. integral.html

Appendix 10. series.html

Appendix 11. probability.html

Appendix 12. quiz.html

Appendix 13. index.html

Appendix 14. quiz.css

Appendix 15. quiz.js

Appendix 16. general.html

Appendix 17. example.json

Appendix 18. main.cpp

Appendix 19. The list of sources used for creating the content



```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Sets</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
img
    {
    max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {

```

```
border-top: 1px solid #888;
    border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>
```

```
<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
```

```
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">
```

```
<li><a href="#a1" data-ajax="false">Set identities</a></li>
```

```
<li><a href="#a2" data-ajax="false">Sets of numbers</a></li>
```

```
<li><a href="#a3" data-ajax="false">Basic identities</a></li>
```

```
<li><a href="#a4" data-ajax="false">Complex numbers</a></li>
```

```
</ul>
```

```
</div>
```

```
<div data-role="content">
```

```
<a id="a1"></a>
```

```
<a id="a2"></a>
```

```
<a id="a3"></a>
```

```
<a id="a4"></a>
```

```
</div>
```

```
</div>
```

```
</body></html>
```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Algebra</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img
    {
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {

```

```

border-top: 1px solid #888;
        border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Factoring formulas</a></li>
    <li><a href="#a2" data-ajax="false">Product formulas</a></li>
    <li><a href="#a3" data-ajax="false">Powers & roots</a></li>
    <li><a href="#a4" data-ajax="false">Logarithms</a></li>
    <li><a href="#a5" data-ajax="false">Equations</a></li>
    <li><a href="#a6" data-ajax="false">Inequalities</a></li>
    <li><a href="#a7" data-ajax="false">Compound interest formulas</a></li>

</ul>
</div>
<div data-role="content">
    <a id="a1"></a>
    <a id="a2"></a>
    <a id="a3"></a>
    <a id="a4"></a>
    <a id="a5"></a>
    <a id="a6"></a>

```

```
<a id="a7"></a>
```

```
</div>
```

```
</div>
```

```
</body>
```

```
</html>
```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Geometry</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img
    {
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {

```

```

border-top: 1px solid #888;
        border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Right triangle</a></li>
    <li><a href="#a2" data-ajax="false">Isosceless triangle</a></li>
    <li><a href="#a3" data-ajax="false">Equilateral triangle</a></li>
    <li><a href="#a4" data-ajax="false">Scalene triangle</a></li>
    <li><a href="#a5" data-ajax="false">Square</a></li>
    <li><a href="#a6" data-ajax="false">Rectangle</a></li>
    <li><a href="#a7" data-ajax="false">Parallelogram</a></li>
    <li><a href="#a8" data-ajax="false">Rhombus</a></li>
    <li><a href="#a9" data-ajax="false">Trapezoid</a></li>
    <li><a href="#a10" data-ajax="false">Kite</a></li>
    <li><a href="#a11" data-ajax="false">Quadrilaterals</a></li>
    <li><a href="#a12" data-ajax="false" >Hexagon</a></li>
    <li><a href="#a13" data-ajax="false">Regular polygon</a></li>
    <li><a href="#a14" data-ajax="false">Circle</a></li>
    <li><a href="#a15" data-ajax="false">Cube</a></li>
    <li><a href="#a16" data-ajax="false">Rectangular parallelepiped</a></li>
    <li><a href="#a17" data-ajax="false">Prism</a></li>

```

```

<li><a href="#a18" data-ajax="false">Regular tetrahedron</a></li>
  <li><a href="#a19" data-ajax="false">Regular pyramid</a></li>
</ul>
</div>

```

```

<div data-role="content">

```

```

  <a id="a1"></a>
  <a id="a2"></a>
  <a id="a3"></a>
  <a id="a4"></a>
  <a id="a5"></a>
  <a id="a6"></a>
  <a id="a7"></a>
  <a id="a8"></a>
  <a id="a9"></a>
  <a id="a10"></a>
  <a id="a11"></a>
  <a id="a12"></a>
  <a id="a13"></a>
  <a id="a14"></a>
  <a id="a15"></a>
  <a id="a16"></a>
  <a id="a17"></a>
  <a id="a18"></a>
  <a id="a19"></a>

```

```

</div>

```

```

</div>

```

```

</body></html>

```



```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>
<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Trigonometry</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Menu</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img
    {
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;

```

```

border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Basic formulas and graphs</a></li>
    <li><a href="#a2" data-ajax="false">Relations between trigonometric func-
tions</a></li>
    <li><a href="#a3" data-ajax="false">Addition and subtraction formulas</a></li>
    <li><a href="#a4" data-ajax="false">Double angle and half angle formulas</a></li>
    <li><a href="#a5" data-ajax="false">Transforming of trigonometric expres-
sions</a></li>
    <li><a href="#a6" data-ajax="false">Powers of trigonometric functions</a></li>
    <li><a href="#a7" data-ajax="false">Inverse trigonometric functions</a></li>
    <li><a href="#a8" data-ajax="false">Trigonometric equations</a></li>
    <li><a href="#a9" data-ajax="false">Relations to hyperbolic function</a></li>

</ul>
</div>

<div data-role="content">
    <a id="a1"></a>
    <a id="a2"></a>

```

<a id="a3"></a>

<a id="a4"></a>

<a id="a5"></a>

<a id="a6"></a>

<a id="a7"></a>

<a id="a8"></a>

<a id="a9"></a>

</div>

</div>

</body>

</html>

```
<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>
<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Matrices and Determinants</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img
    {
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;
```

```

border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Determinants</a></li>
    <li><a href="#a2" data-ajax="false">Matrices</a></li>
    <li><a href="#a3" data-ajax="false">Systems of linear equations</a></li>

</ul>
</div>

<div data-role="content">

    <a id="a1"></a>
    <a id="a2"></a>
    <a id="a3"></a>

</div>
</div>
</body>
</html>

```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Vectors</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img
    {
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {

```

```

border-top: 1px solid #888;
        border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Vector coordinates</a></li>
    <li><a href="#a2" data-ajax="false">Vector addition and subtraction</a></li>
    <li><a href="#a3" data-ajax="false">Scaling vectors</a></li>
    <li><a href="#a4" data-ajax="false">Scalar product</a></li>
    <li><a href="#a5" data-ajax="false">Vector product</a></li>
    <li><a href="#a6" data-ajax="false">Triple product</a></li>

</ul>
</div>

<div data-role="content">

    <a id="a1"></a>
    <a id="a2"></a>
    <a id="a3"></a>
    <a id="a4"></a>
    <a id="a5"></a>

```

```
<a id="a6"></a>
```

```
</div>
```

```
</div>
```

```
</body>
```

```
</html>
```



```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Analytic Geometry</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img{
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;

```

```

border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">1D and 2D coordinate systems</a></li>
    <li><a href="#a2" data-ajax="false">Straight line in plane</a></li>
    <li><a href="#a3" data-ajax="false">Circle</a></li>
    <li><a href="#a4" data-ajax="false">Ellipse</a></li>
    <li><a href="#a5" data-ajax="false">Hyperbola</a></li>
    <li><a href="#a6" data-ajax="false">Parabola</a></li>
    <li><a href="#a7" data-ajax="false">3D coordinate system</a></li>
    <li><a href="#a8" data-ajax="false">Plane</a></li>
    <li><a href="#a9" data-ajax="false">Straight line in space</a></li>
    <li><a href="#a10" data-ajax="false">Quadric surfaces</a></li>
    <li><a href="#a11" data-ajax="false">Sphere</a></li>

</ul>
</div>

<div data-role="content">

    <a id="a1"></a>

```

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<a id="a2"></a>
<a id="a3"></a>
<a id="a4"></a>
<a id="a5"></a>
<a id="a6"></a>
<a id="a7"></a>
<a id="a8"></a>
<a id="a9"></a>
<a id="a10"></a>
<a id="a11"></a>
```

```
</div>
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```
</div>
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```
</body>
```

```
</html>
```

```

<!DOCTYPE html>
<html>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Differential Calculus</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img{
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;
        border-color: rgba(255, 255, 255, .1);
    }

```

```

}

.ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
    white-space: normal; !important
}
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Functions and their graphs</a></li>
    <li><a href="#a2" data-ajax="false">Limits of functions</a></li>
    <li><a href="#a3" data-ajax="false">Derivative. Definition & properties</a></li>
    <li><a href="#a4" data-ajax="false">Table of derivatives</a></li>
    <li><a href="#a5" data-ajax="false">Higher order derivatives</a></li>
    <li><a href="#a6" data-ajax="false">Applications of derivative</a></li>
    <li><a href="#a7" data-ajax="false">Differential</a></li>
    <li><a href="#a8" data-ajax="false">Multivariable functions</a></li>
    <li><a href="#a9" data-ajax="false">Differential operators</a></li>

</ul>
</div>

<div data-role="content">

    <a id="a1"></a>
    <a id="a2"></a>
    <a id="a3"></a>
    <a id="a4"></a>

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<a id="a5"></a>
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<a id="a6"></a>
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<a id="a7"></a>
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<a id="a8"></a>
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<a id="a9"></a>
```

```
</div>
```

```
</div>
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```
</body>
```

```
</html>
```

```
<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Integral Calculus</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img{
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;
```

```
border-color: rgba(255, 255, 255, .1);
```

```
}
```

```
.ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
```

```
white-space: normal; !important
```

```
}
```

```
</style>
```

```
<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
```

```
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">
```

```
<li><a href="#a1" data-ajax="false">Indefinite integral</a></li>
```

```
<li><a href="#a2" data-ajax="false">Integrals of rational functions</a></li>
```

```
<li><a href="#a3" data-ajax="false">Integrals of irrational functions</a></li>
```

```
<li><a href="#a4" data-ajax="false">Integrals of trigonometric functions</a></li>
```

```
<li><a href="#a5" data-ajax="false">Integrals of hyperbolic functions</a></li>
```

```
<li><a href="#a6" data-ajax="false">Integrals of exponential and logarithmic func-
tions</a></li>
```

```
<li><a href="#a7" data-ajax="false">Reduction formulas</a></li>
```

```
<li><a href="#a8" data-ajax="false">Definite integral</a></li>
```

```
<li><a href="#a9" data-ajax="false">Improper integral</a></li>
```

```
<li><a href="#a10" data-ajax="false">Double integral</a></li>
```

```
<li><a href="#a11" data-ajax="false">Triple integral</a></li>
```

```
<li><a href="#a12" data-ajax="false">Line integral</a></li>
```

```
<li><a href="#a13" data-ajax="false">Surface integral</a></li>
```

```
</ul>
```

```
</div>
```



```
<div data-role="content">
```

```
  <a id="a1"></a>  
  <a id="a2"></a>  
  <a id="a3"></a>  
  <a id="a4"></a>  
  <a id="a5"></a>  
  <a id="a6"></a>  
  <a id="a7"></a>  
  <a id="a8"></a>  
  <a id="a9"></a>  
  <a id="a10"></a>  
  <a id="a11"></a>  
  <a id="a12"></a>  
  <a id="a13"></a>
```

```
</div>
```

```
</div>
```

```
</body>
```

```
</html>
```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Series</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img{
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;

```

```

border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Arithmetic series</a></li>
    <li><a href="#a2" data-ajax="false">Geometric series</a></li>
    <li><a href="#a3" data-ajax="false">Some finite series</a></li>
    <li><a href="#a4" data-ajax="false">Infinite series</a></li>
    <li><a href="#a5" data-ajax="false">Convergent series</a></li>
    <li><a href="#a6" data-ajax="false">Alternating series</a></li>
    <li><a href="#a7" data-ajax="false">Power series</a></li>
    <li><a href="#a8" data-ajax="false">Differentiation and integration of power se-
ries</a></li>
    <li><a href="#a9" data-ajax="false">Taylor and Maclaurin series</a></li>
    <li><a href="#a10" data-ajax="false">Power series expansions for some func-
tions</a></li>
    <li><a href="#a11" data-ajax="false">Binomial series</a></li>
    <li><a href="#a12" data-ajax="false">Fourier series</a></li>

</ul>
</div>

```

```
<div data-role="content">
```

```
<a id="a1"></a>
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<a id="a2"></a>
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<a id="a3"></a>
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<a id="a4"></a>
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<a id="a5"></a>
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<a id="a6"></a>
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<a id="a7"></a>
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<a id="a8"></a>
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<a id="a9"></a>
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```
<a id="a10"></a>
```

```
<a id="a11"></a>
```

```
<a id="a12"></a>
```

```
</div>
```

```
</div>
```

```
</body>
```

```
</html>
```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Probability</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="#geom" data-icon="bars" data-iconpos="notext">Menu</a>
</div>

<style>
    img{
        max-width:100%;
    }
    .nav-search .ui-btn-up-a {
        background-image:none;
        background-color:#333333;
    }
    .nav-search .ui-btn-inner {
        border-top: 1px solid #888;

```

```

border-color: rgba(255, 255, 255, .1);
    }
    .ui-li .ui-btn-inner a.ui-link-inherit, .ui-li-static.ui-li {
        white-space: normal; !important
    }
</style>

<div data-role="panel" id="geom" data-display="overlay" data-position-fixed="true"
data-theme="a" style="overflow-y: auto">
<ul data-role="listview" data-theme="a" data-divider-theme="a" style="margin-top:-
16px;" class="nav-search">

    <li><a href="#a1" data-ajax="false">Permutations and combinations</a></li>
    <li><a href="#a2" data-ajax="false">Probability formulas</a></li>

</ul>
</div>

<div data-role="content">

    <a id="a1"></a>
    <a id="a2"></a>

</div>
</div>
</body>
</html>

```

```

<!DOCTYPE html>
<html>
<head>
<link href="css/quiz.css"rel="stylesheet"type="text/css"/>
<meta name=viewport content="width=device-width, initial-scale=1.0, maximum-
scale=1.0, user-scalable=no">
<link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
<script src="jqm/jquery-1.8.3.min.js"></script>
<script src="jqm/jquery.mobile-1.3.2.min.js"></script>
<script src="js/quiz.js"></script>
</head>
<body>

<div data-role="page">
<div data-role="header" data-position="fixed" data-tap-toggle="false">
<h1>Quiz</h1>
<a href="index.html" data-ajax="false" data-icon="home" data-
iconpos="notext">Home</a>
<a href="quiz.html" data-ajax="false" data-icon="back" data-
iconpos="notext">Back</a>
</div>

<div id="topbar">Check your knowledge</div>
<div class="spacer"></div>

<div id="navContent">
    <div id="game1"></div>
    <div id="game2"></div>
</div>
</body></html>

```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
    <div data-role="header" data-position="fixed" data-tap-toggle="false">
        <h1>MathApp</h1>
    </div>

<style>
    img{
        max-width:100%;
    }
</style>

<div data-role="content">

    <a href="sets.html" data-ajax="false"></a>
    <a href="algebra.html" data-ajax="false"></a>
    <a href="geometry.html" data-ajax="false"></a>
    <a href="trigonom.html" data-ajax="false"></a>
    <a href="matdet.html" data-ajax="false"></a>
    <a href="vectors.html" data-ajax="false"></a>
    <a href="angeometry.html" data-ajax="false"></a>
    <a href="differcalc.html" data-ajax="false"></a>
    <a href="integral.html" data-ajax="false"></a>
    <a href="series.html" data-ajax="false"></a>
    <a href="probability.html" data-ajax="false"></a>
    <a href="quiz.html" data-ajax="false"></a>

</div>
</div>
</body>
</html>

```



```
html, body {
margin: 0;
padding: 0;
font-family: 'Glyphicons Halflings';

src: url('fonts/glyphicons-halflings-regular.eot');
src: url('fonts/glyphicons-halflings-regular.eot?#iefix') format('embedded-opentype'),
url('fonts/glyphicons-halflings-regular.woff') format('woff'), url('fonts/glyphicons-
halflings-regular.ttf') format('truetype'), url('fonts/glyphicons-halflings-
regular.svg#glyphicons_halfingsregular') format('svg');
}

#navContent{
margin:auto;
width:800px;
height:400px;
position:relative;
overflow:hidden;
}

#game1{
margin:auto;
width:800px;
height:400px;
right:0px;
position:absolute;
}

#game2{
margin:auto;
width:800px;
height:400px;
right:-800px;
position:absolute;
}

.questionText{
font-size:18px;
color:#000;
}

.pix{
width:150px;
height:80px;
margin:15px;
```

```
float:left;

border:#fff 2px solid;
cursor:pointer;
}

#topbar{
height:100px;
margin:auto;
margin-top:50px;
color:#000;
font-size:36px;
font-family:Arial, Helvetica, sans-serif;
width:800px;
}

.spacer{
height:30px;
}

.feedback1 {
width:150px;
padding:5px;
font-size:30px;
color:#FFFFCC;
background-color:#009900;
font-family:Arial, Helvetica, sans-serif;
text-align:center;
position:absolute;
top:240px;
}

.feedback2{
width:150px;
padding:5px;
font-size:30px;
color:#FFFFCC;
background-color:#CC3300;
font-family:Arial, Helvetica, sans-serif;
text-align:center;
position:absolute;
top:240px;
}

@media screen and (max-width:800px) {
```

```
#game2{margin:1%; width:98%;}
#topbar{margin-left:1%;margin-right:1%; width:98%;}
    #navContent{margin:1%; width:98%;}
    #game1{margin:1%; width:98%;}
}
@media screen and (max-width:400px) {
    .pix{margin:1px;margin-top:10px;}
}
```

```

$(document).ready(function () {

var questionNumber=0;
var questionBank=new Array();
var stage="#game1";
var stage2=new Object;
var questionLock=false;
var numberOfQuestions;
var score=0;

$.getJSON('https://api.myjson.com/bins/3n08j', function(data) {

    for(i=0;i<data.quizlist.length;i++){
        questionBank[i]=new Array;
        questionBank[i][0]=data.quizlist[i].question;
        questionBank[i][1]=data.quizlist[i].option1;
        questionBank[i][2]=data.quizlist[i].option2;
        questionBank[i][3]=data.quizlist[i].option3;
        questionBank[i][4]=data.quizlist[i].option4;
    }

    numberOfQuestions=questionBank.length;

    displayQuestion();
})//gtjson

fillDB();

function displayQuestion(){
    var rnd=Math.random()*4;
    rnd=Math.ceil(rnd);
    var q1;
    var q2;
    var q3;
    var q4;

    if(rnd==1){q1=questionBank[questionNumber][1];q2=questionBank[questionNumber][2];q3=questionBank[questionNumber][3];q4=questionBank[questionNumber][4]}
    if(rnd==2){q2=questionBank[questionNumber][1];q3=questionBank[questionNumber][2];q4=questionBank[questionNumber][3];q1=questionBank[questionNumber][4]}
    if(rnd==3){q3=questionBank[questionNumber][1];q4=questionBank[questionNumber][2];q1=questionBank[questionNumber][3];q2=questionBank[questionNumber][4]}
    if(rnd==4){q4=questionBank[questionNumber][1];q1=questionBank[questionNumber][2];q2=questionBank[questionNumber][3];q3=questionBank[questionNumber][4]}

```

```
$(stage).append('<div
class="questionText">'+questionBank[questionNumber][0]+'</div><div id="1"
class="pix"></div><div id="2" class="pix"></div><div id="3" class="pix"></div><div id="4" class="pix"></div>');
```

```
$('.pix').click(function(){
  if(questionLock==false){questionLock=true;
  //correct answer
  if(this.id==rnd){
    $(stage).append('<div class="feedback1">CORRECT</div>');
    score++;
  }
  //wrong answer
  if(this.id!=rnd){
    $(stage).append('<div class="feedback2">WRONG</div>');
  }
  setTimeout(function(){changeQuestion()},750);
  })
} //display question
```

```
function changeQuestion(){
  questionNumber++;
  if(stage=="#game1"){
    stage2="#game1";stage="#game2";
  }
  else{
    stage2="#game2";
    stage="#game1";
  }
  if(questionNumber<numberOfQuestions){
    displayQuestion();
  }
  else{
    displayFinalSlide();
  }
  $(stage2).animate({"right": "+=800px"},"very fast", function()
  {$(stage2).css('right','-800px');$(stage2).empty();});
```

```
$(stage).animate({"right": "+=800px"},"very fast", function() {questionLock=false;});
    }//change question

    function displayFinalSlide(){

$(stage).append('<div class="questionText">You have finished the quiz!<br><br>Total
questions: '+numberOfQuestions+'<br>Correct answers: '+score+'<br><br><a
href="index.html">Home</a><br> &nbsp; <a href="quiz.html">Quiz list</a></div>');

}//display final slide
});//doc ready
```

```

<!DOCTYPE html>
<html>
<head>
<title>MathApp</title>
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="jqm/jquery.mobile-1.3.2.min.css"/>
    <script src="jqm/jquery-1.8.3.min.js"></script>
    <script src="jqm/jquery.mobile-1.3.2.min.js"></script>
    <meta name="viewport" content="width=device-width, initial-scale=1">
</head>
<body>

<div data-role="page">
    <div data-role="header" data-position="fixed" data-tap-toggle="false">
        <h1>Quizzes</h1>
        <a href="index.html" data-ajax="false" data-icon="home" data-
        iconpos="notext">Home</a>
    </div>

<style>
    img
    {
        max-width:48%;
    }
</style>

<div data-role="content">

<button disabled="">Please note that internet connection is required to access the
tests</button>

    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"> </a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>
    <a href="" data-ajax="false"></a>

```

Appendix 16  
2(2)

```
<a href="general.html" data-ajax="false"></a>
```

```
</div>
```

```
</div>
```

```
</body>
```

```
</html>
```



```

"quizlist":[

{
"question":"Roots of a quadric equation are:",
"option1":"1_1.jpg",
"option2":"1_2.jpg",
"option3":"1_3.jpg",
"option4":"1_4.jpg"
},
{
"question":"De Morgan's laws:",
"option1":"2_1.jpg",
"option2":"2_2.jpg",
"option3":"2_3.jpg",
"option4":"2_4.jpg"
},
{
"question":"Squared difference between a and b is:",
"option1":"3_1.jpg",
"option2":"3_2.jpg",
"option3":"3_3.jpg",
"option4":"3_4.jpg"
},
{
"question":"Choose the correct equality:",
"option1":"4_1.jpg",
"option2":"4_2.jpg",
"option3":"4_3.jpg",
"option4":"4_4.jpg"
},
{
"question":"Choose the correct equality:",
"option1":"5_1.jpg",
"option2":"5_2.jpg",
"option3":"5_3.jpg",
"option4":"5_4.jpg"
},
{
"question":"Sum of the first n terms in arithmetic series:",
"option1":"6_1.jpg",
"option2":"6_2.jpg",
"option3":"6_3.jpg",
"option4":"6_4.jpg"
},
{
"question":"Surface area of the sphere is:",

```

```
"option2": "7_2.jpg",
"option1": "7_1.jpg",
"option3": "7_3.jpg",
"option4": "7_4.jpg"
},
{
"question": "Choose the correct equality:",
"option1": "8_1.jpg",
"option2": "8_2.jpg",
"option3": "8_3.jpg",
"option4": "8_4.jpg"
},
{
"question": "Choose the correct equality:",
"option1": "9_1.jpg",
"option2": "9_2.jpg",
"option3": "9_3.jpg",
"option4": "9_4.jpg"
},
{
"question": "Choose the correct equality:",
"option1": "10_1.jpg",
"option2": "10_2.jpg",
"option3": "10_3.jpg",
"option4": "10_4.jpg"
}
]
}
```

```
#include <Wormhole/HybridMoblet.h>

#include "MAHeaders.h"

// Namespaces we want to access.
using namespace NativeUI; // WebView widget.
using namespace Wormhole; // Wormhole library.

class MyMoblet : public HybridMoblet
{
public:

MyMoblet()
{
//Support all screen orientations
maScreenSetOrientation(SCREEN_ORIENTATION_DYNAMIC);
maScreenSetSupportedOrientations
(MA_SCREEN_ORIENTATION_LANDSCAPE_LEFT |
MA_SCREEN_ORIENTATION_LANDSCAPE_RIGHT |
MA_SCREEN_ORIENTATION_PORTRAIT |
MA_SCREEN_ORIENTATION_PORTRAIT_UPSIDE_DOWN);

// Show the start page.
showPage("index.html");
}

void keyPressEvent(int keyCode, int nativeCode)
{
if (MAK_0 == keyCode || MAK_BACK == keyCode)
{
    maExit(0);
}
}

};

extern "C" int MAMain()
{
    (new MyMoblet()->enterEventLoop();
return 0;
}
```

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