
PROJECT REPORT

Multimedia and Mobile Application Development

Higher Diploma in Science in Computing

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1. INTRODUCTION

This report was written by Richard Seaman and forms part of the Project submission for the module Multimedia and Mobile Application Development, given by Dr. Anu Sahni.

Also included as part of the submission are:

- The entire Android Studio project including all source code for the application
- Images required for Google Play
- A Backend folder which includes the files required/produced by the backend.
- Original report for CA1

This report follows the previous report for CA1, which detailed the problem addressed, target audience and proposed features. These items are unchanged since CA1.

This report focuses on the implementation of the proposal and the final product developed. It is arranged as follows:

- The app features are briefly discussed.
- The user interface of the app is discussed in detail, with screenshots provided for each screen.
- The hardware components which the app utilises and how it uses them are discussed.
- The Google Play resources required for publishing the app are provided.

2. APP FEATURES

Leaving Certificate Maths MCQ offers multiple choice maths quizzes based on the Leaving Certificate (LC) curriculum. Many of the features are evident from the details provided in the User Interface section of this report. However, a brief overview of the features is provided below:

Relevant & Quality Questions

The questions which make up the quizzes are provided by a qualified secondary level maths teacher and leaving certificate examiner with over 15 years teaching experience. This ensures the questions asked are relevant and appropriate to each level (higher / ordinary / foundation).

The questions offered are not only filtered by category but also subdivided by level. This allows the user to easily navigate to the questions relevant to them and ensures they're only asked appropriate questions. This prevents time wasted on easier questions and prevents frustration caused by being asked more difficult questions which are not suited to the user.

The level selected by the user is also recorded and automatically selected in future.

Backend

This app uses a restful API on the backend, which provides the available questions in JSON format, which in turn are parsed and stored by the app.

By retrieving the questions from a backend, it makes it possible to load/remove questions dynamically (through syncing). This is beneficial as an exhaustive list of questions is not yet available. The ability to sync new questions means that users will not have to update their apps every time new questions are released (they'll just have to sync).

Some sample JSON returned by the backend is provided below (for two questions):

```
{
  "id": "10",
  "subject": "Maths",
  "level": "HL",
  "language": "EV",
  "category": "Trigonometry",
  "imageLink": null,
  "question": "The cosine formula is....",
  "answer0": "a^2 = b^2 + c^2 - 2ac\cos(A)",
  "answer1": "a^2 = b^2 + c^2 - 2bc\cos(C)",
  "answer2": "a^2 = b^2 + c^2 - 2bc\cos(B)",
  "answer3": "a^2 = b^2 + c^2 - 2bc\cos(A)",
  "answer4": null,
  "answer5": null,
  "correctAnswer": "3",
  "hint": "Remember that the angle being used must be opposite the letter at the start of the formula"
},
{
  "id": "12",
  "subject": "Maths",
  "level": "HL",
  "language": "EV",
  "category": "Trigonometry",
  "imageLink": null,
  "question": "We use the cosine formula when we have.....",
  "answer0": "all 3 angles and we want to find an unknown side",
  "answer1": "2 angles and no sides",
  "answer2": "2 sides and no angles",
  "answer3": "all 3 angles and we want to find a side length",
  "answer4": null,
  "answer5": null,
  "correctAnswer": "0",
  "hint": "Try to imagine a picture of each of the given options"
},
```

Local Database

The app parses the questions provided by the backend and stores them in a local SQLite database.

This allows the app to load just the relevant data for the current activity. For example, if selecting a category for the quiz, the current interface only requires a list of the available categories, not all of the data for each and every question. Similarly, if a particular category is selected, only questions for that category need to be loaded into memory.

Intuitive UI

The user interface is discussed in detail in the following section. It is minimal, appealing and simple and intuitive to use.

Multiple Choice Quizzes

The main feature of this app is the multiple-choice quizzes. Users may select a level and category combination and take a MCQ for it.

Multiple Modes

Two quiz modes are available; study mode and test mode. In study mode, the user is allowed as many attempts as it takes to get the correct answer. If they guess incorrectly twice, a hint is displayed to help them. They may also view this hint at any time by tapping a button on screen.

In test mode, all hints are disabled and the user is only allowed one attempt per question. The user's score is recorded and

displayed at the end of the quiz and their "Personal Best" for each category is displayed on the selection screen. The PB also persists from one app session to another.

Shuffling & Randomisation

Each time a quiz is taken, the order of the questions and the order of answers for each question are shuffled to prevent users from memorising correct sequences. This forces the user to engage with each quiz individually.

A randomised quiz is also made available which draws questions from all available categories. This tests the user's overall knowledge of the curriculum rather than sticking to a particular topic.

Question Images

Some questions are best presented alongside an image. It is possible to download images and display them alongside the question (all of which is handled by the app in the background). An image URL is optionally included within the JSON for questions. If a question has an image URL, it is downloaded and displayed automatically.

The image files can also be viewed and deleted by the user via their device's file storage/management mechanism.

Natural Maths

For a maths MCQ app, it is very important to display all mathematical formulae and symbols in their natural form (i.e.

as they would be written by hand). This was one of the most difficult features of this app to implement.

However, after much trial and error, the app automatically detects maths and displays it using the appropriate UI elements so it appears natural.

Alternative to Internalisation

One of the required features from the Project Specification was *“Internalisation – at least to 1 additional language than English”*. Unfortunately, the questions provided by the teacher/examiner are only available in English. As the main feature of this app is the MCQs, it would not make much sense to translate the static string resources into another language while leaving the majority of the content in English.

That being said, all static resources used followed best practice. For example, all strings were included within the strings.xml file. If it was a requirement to include another language, it could be readily achieved.

From discussion with Dr. Anu Sahni, it was agreed to omit the requirement for an additional language, provided that some additional features were included which go above the requirements of the specification.

Many of the application’s features discussed above go beyond what was required for this project. For example, there was no requirement to allow images to be displayed beside images. This was an additional feature which required a significant amount of code to implement (including adapter logic,

requesting permission, asynchronous tasks, handling downloads etc.).

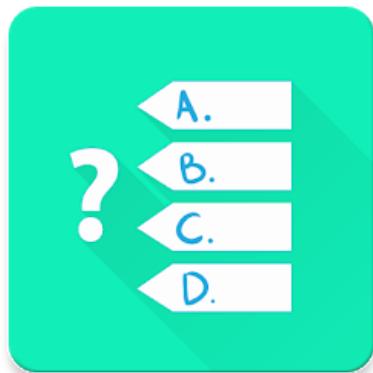
Similarly, there was no real need to include multiple modes. The app would have achieved its requirements if only one mode was included. Again, much more code was required to provide two modes (hint logic, personal best scores, separate summary screens etc.).

The most significant piece of additional work was the development and exposure of the backend in order to allow the questions to be updated remotely and over time without the need to update the app. A much more simpler approach would have been to hardcode the questions. A somewhat more difficult approach would have been to include the questions as a JSON file within the app and parse the questions from it. Using a backend was more difficult than this again as it had to interact with the API just to get the JSON and only then parse it etc. The backend was the most difficult approach yet it was implemented as it was the approach which best suited the application.

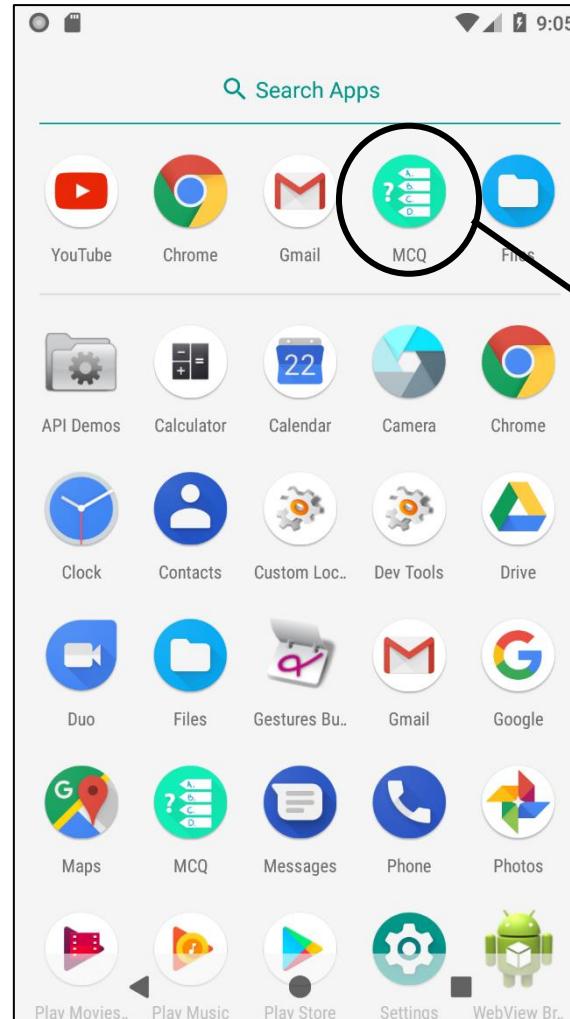
More detailed information on the backend developed is available within the *“Backend”* folder included within this submission.

3. USER INTERFACE

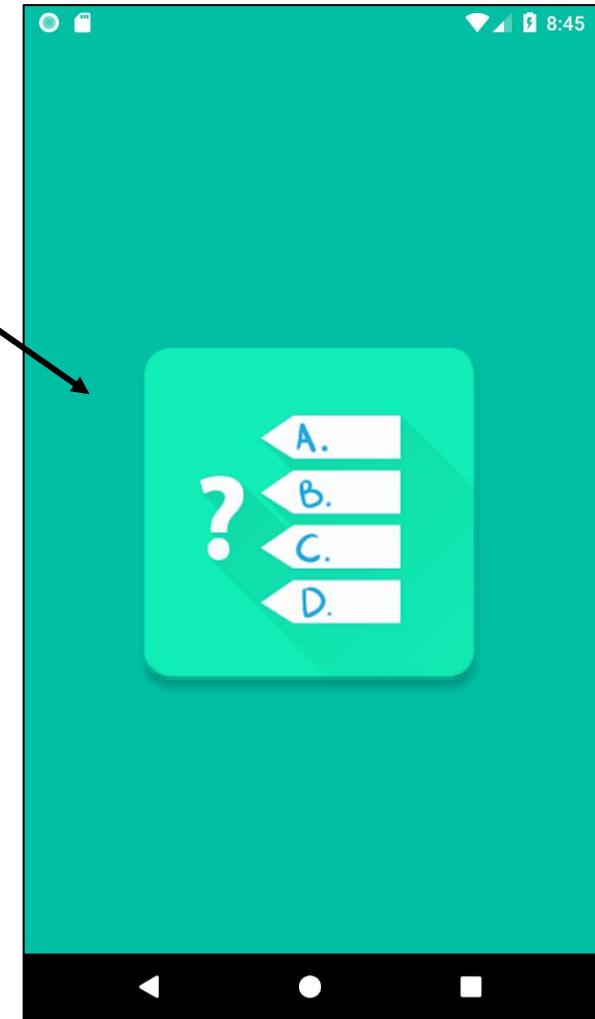
The app icon, app selection screen and app's splash screen are shown in the images below:



App Icon



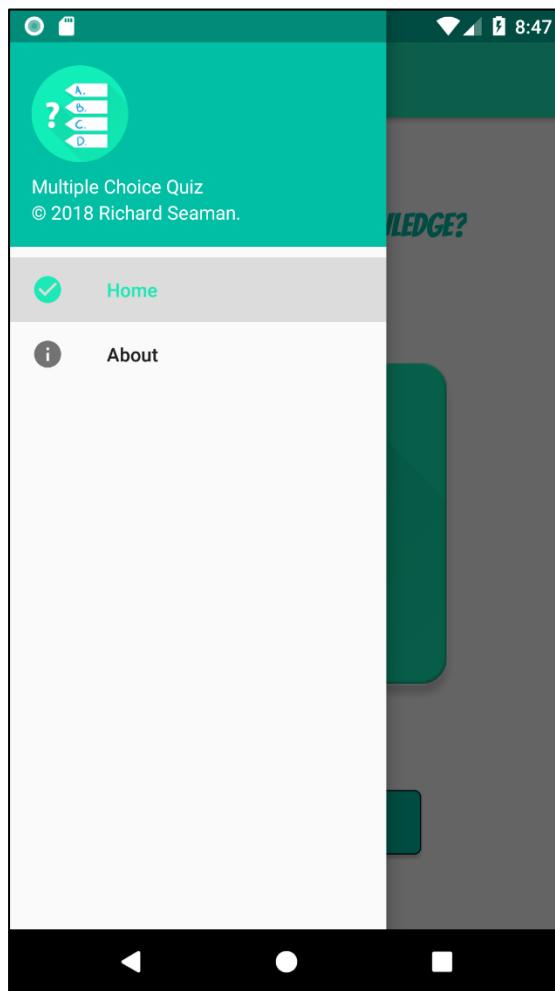
App Selection



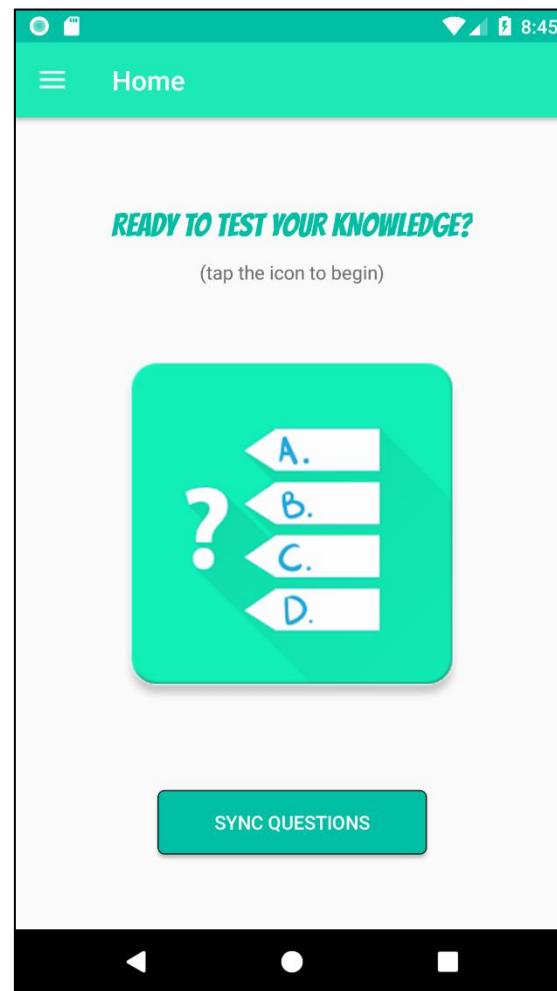
Splash Screen

3.1 Navigation Drawer

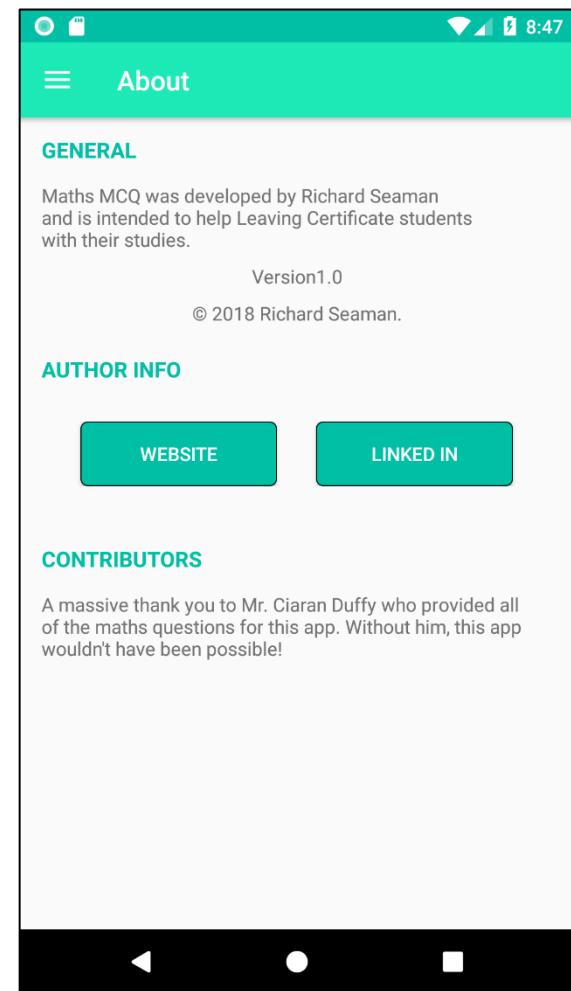
The app follows a Navigation Drawer pattern. Two screens (fragments) are included in the navigation drawer; Home and About. The Home Screen is the default screen and allows the user to either start the quiz or sync the available questions. The About Screen simply offers some static information on the app and links to the author's websites (which are viewed in the browser of their choice).



Navigation Drawer



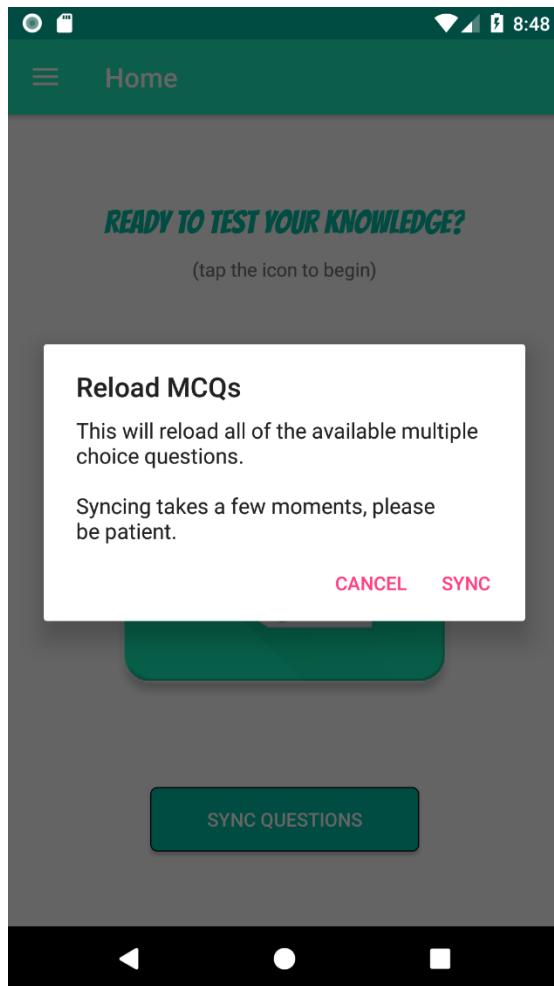
Home Screen



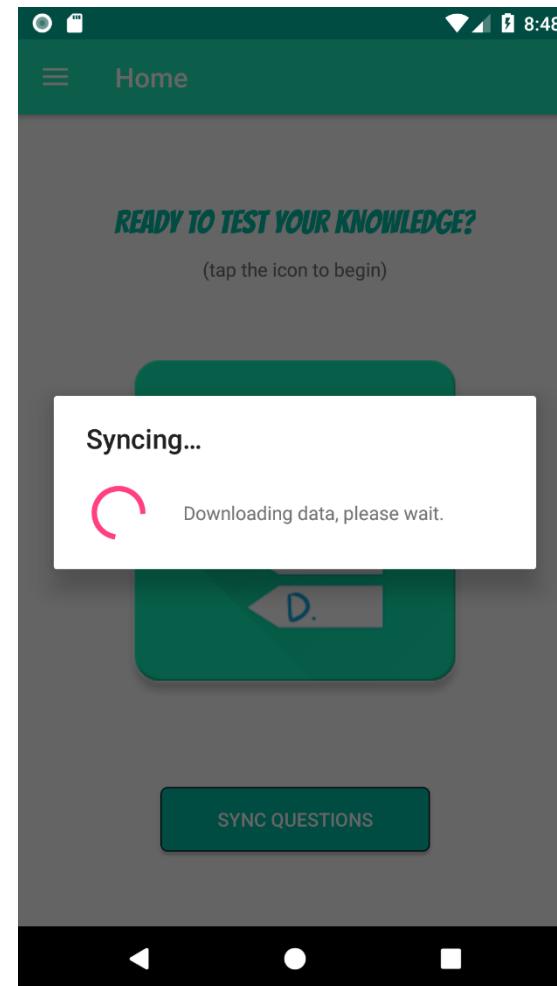
About Screen

3.2 Home Screen

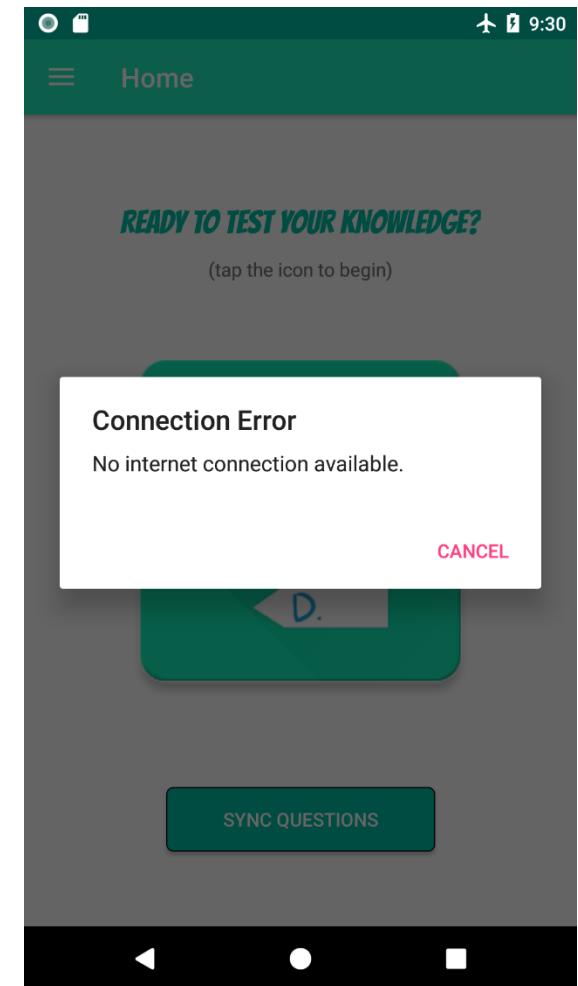
The Home Screen is the default screen selected. It allows the user to either start the quiz or sync the available questions. If it is the first time using the app or there are no questions available (if initially started with no internet connection), the sync questions action will automatically be triggered.



Sync Questions button tapped



Syncing in progress



No internet available error

3.3 Category Screen

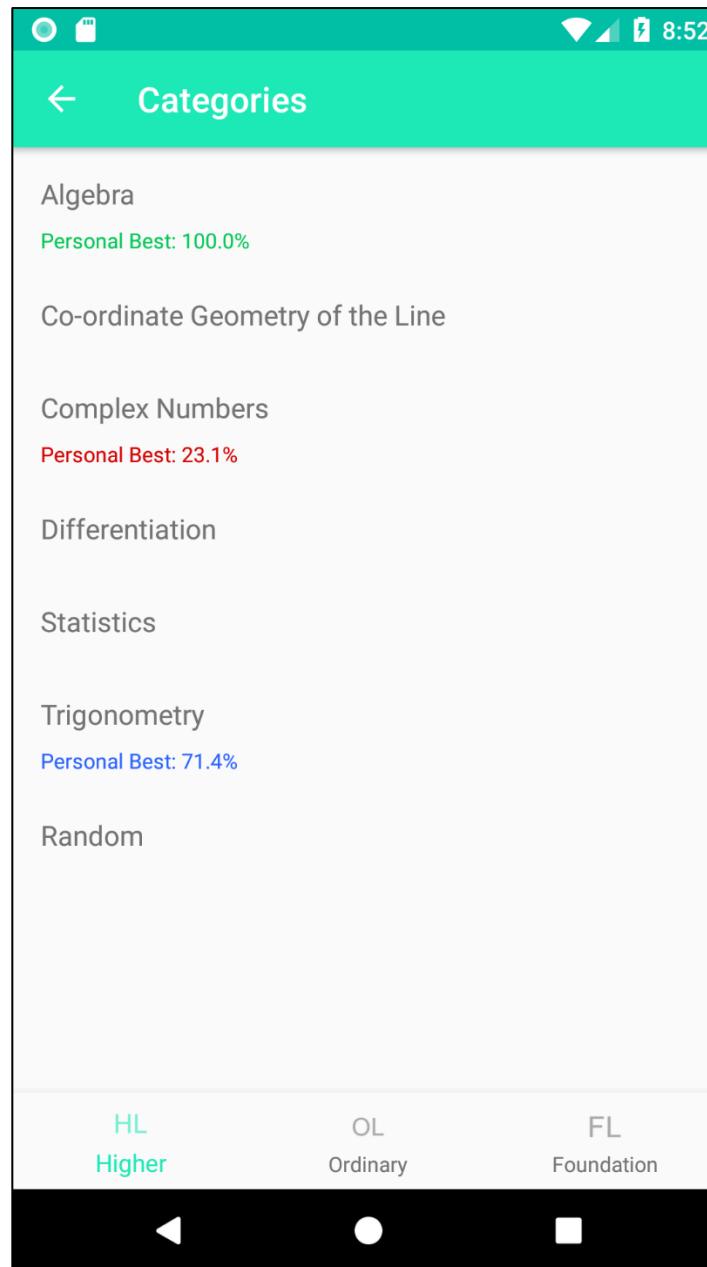
Tapping the icon on the Home Screen will bring the user to the Category Selection screen. Three levels of categories are available, which correspond to the Higher, Ordinary and Foundation levels of the Leaving Certificate.

The user can select their level through a bottom navigation bar. The app remembers the last level selected and automatically navigates to it (and defaults to higher if no previous selections).

The available quiz categories are updated according to the level selected and are displayed in alphabetical order. Tapping on a category will bring the user to the Mode Selector screen (see overleaf).

If there are more than two categories available for the selected level, a “*Random*” category is added. This category is positioned at the end of the list and draws its questions from all other categories.

If the user has previously taken a quiz for a category, their personal best (PB) score will be displayed under the corresponding category. The PB is colour coded according to the score, with red being a low score and green a high score. The PB also persists through app sessions.



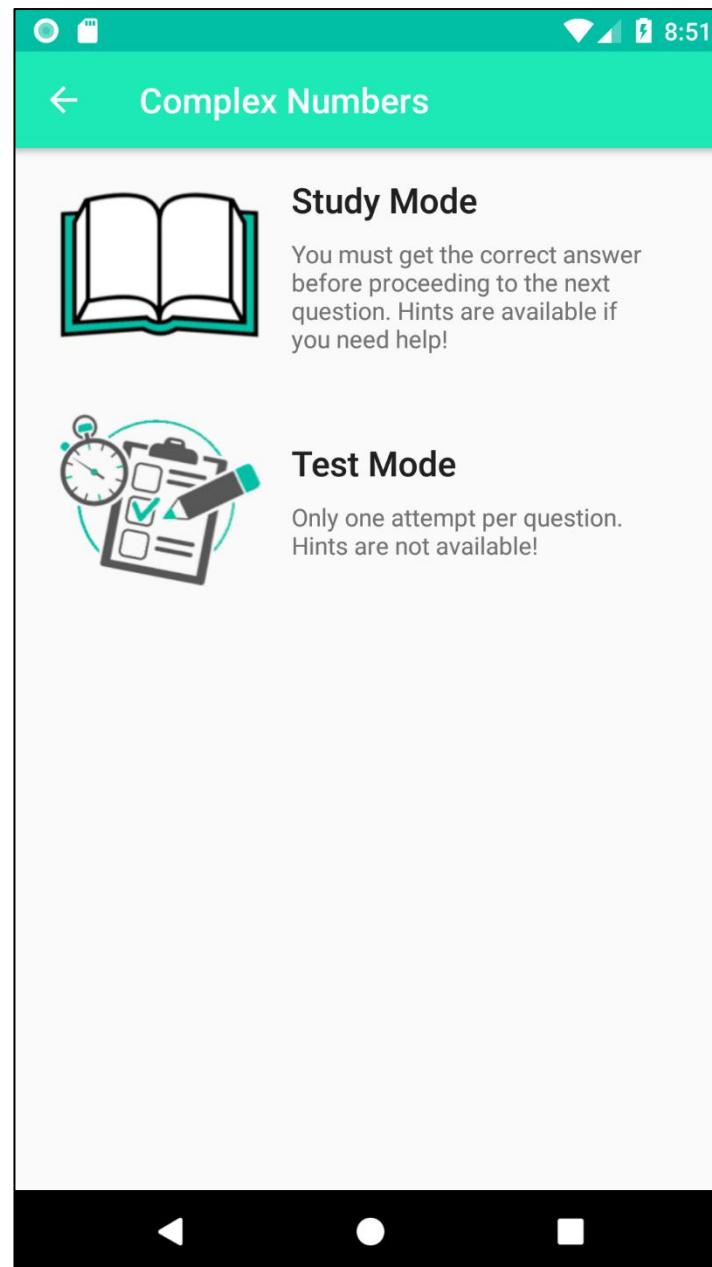
3.4 Mode Selection Screen

Two quiz modes are available; Study Mode and Test Mode.

In study mode, the user is allowed as many attempts as it takes to get the correct answer. If they guess incorrectly twice, a hint will be displayed to help them. They may also view this hint at any time by tapping the question mark button on screen.

In test mode, all hints are disabled and the user is only allowed one attempt per question. The user's score is checked at the end of the quiz and recorded if it is their PB for that category.

The Mode Selector screen displays the currently selected category in the navigation bar and the available modes. Tapping on a mode will start the quiz in that mode for the selected category.



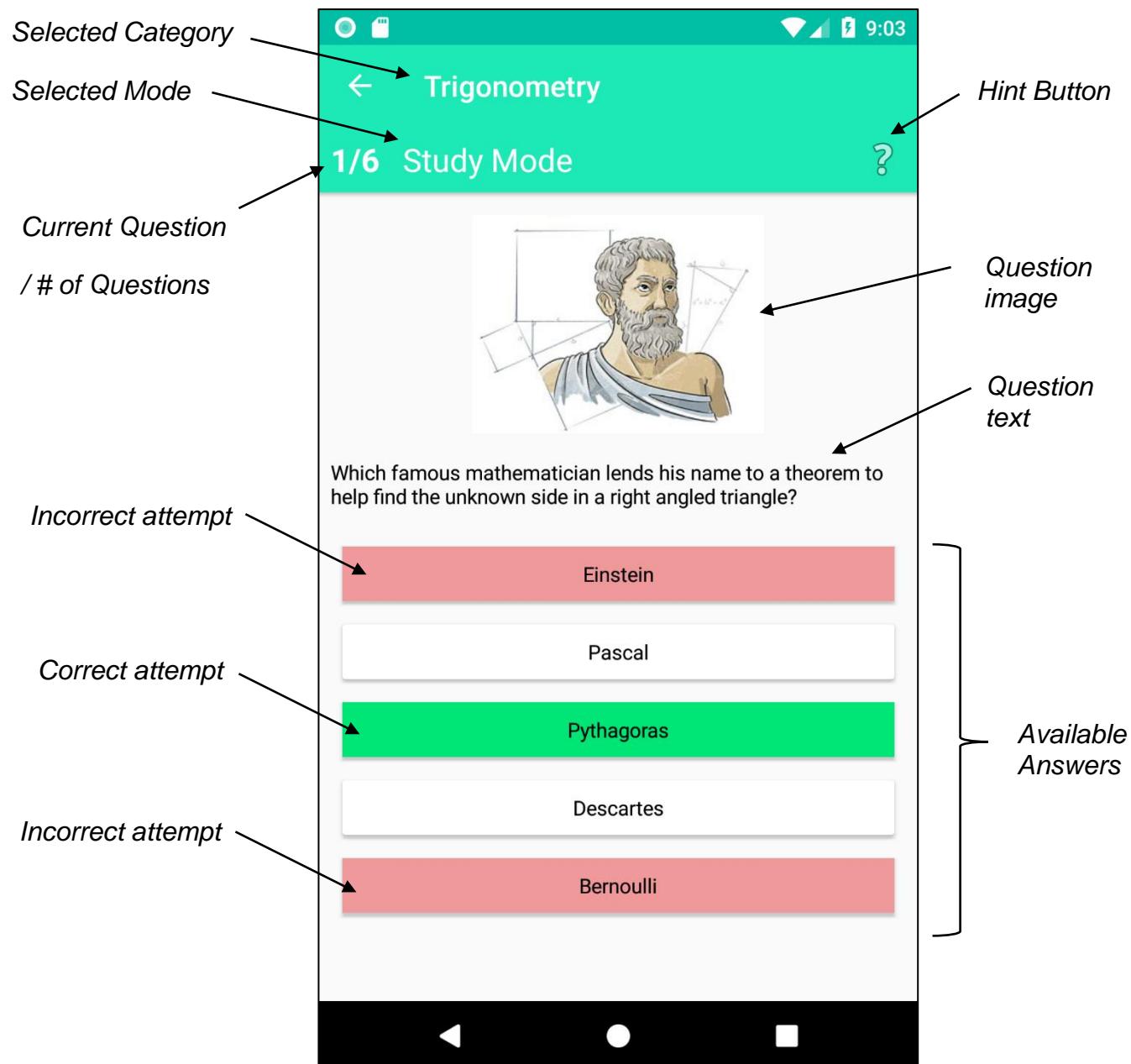
3.5 Quiz Screen

The Quiz Screen is where the user actually does the quiz. Once the user has selected a mode, the quiz will begin and display the first question. There may be a brief loading dialog if the questions are still being asynchronously loaded from the Model.

The selected category and mode are displayed at the top of the screen alongside the current question index and number of questions. If in study mode, the hint button is also displayed.

Each question is presented to the user in turn. If a question has an image, it is shown at the top of the screen. The actual question text is displayed next, followed by each of the available answers (minimum of 2, maximum of 6). Each time the quiz is started, the order of questions and order of answers for each question are shuffled.

The user selects whichever answer they think is correct. If it is incorrect, the answer will turn red and a negative sound will be played. If it is correct, the answer will turn green, a positive sound will be played and the next question will be shown after a slight delay.



← Differentiation

7/11 Study Mode ?

Differentiate

$4x\sqrt{x}$

with respect to x.

6 \sqrt{x}

It's easier to rewrite the surd as a power of $\frac{1}{2}$ at the start and use the laws of indices before you differentiate

(Tap to dismiss)

← Differentiation

2/11 Test Mode

What is the slope of the tangent to the curve

$y = x(1 + \frac{1}{x^4})$

when

$x = \sqrt{2}$

-4

$\frac{1}{4}$

$\frac{1}{2}$

-2

← Differentiation

3/11 Test Mode

Differentiate

$4x\sqrt{x}$

with respect to x.

6 \sqrt{x}

$3x^2\sqrt{x}$

$5x^2\sqrt{x}$

$6\sqrt{x}$

Hints are available in Study Mode.

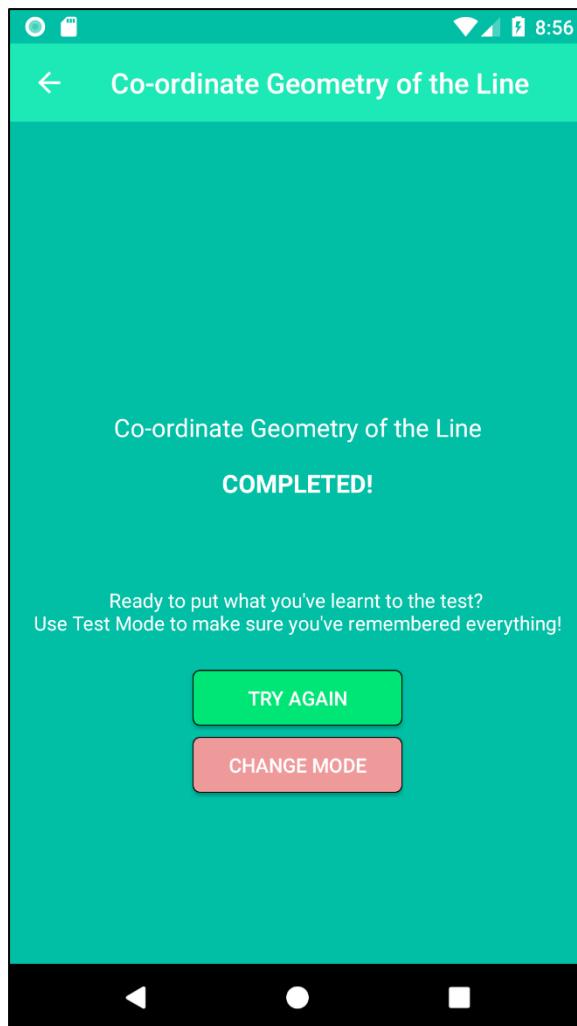
They are shown by tapping the hint button and dismissed by tapping on the hint card (dark green).

In Test Mode the hint button is not shown. The user is only allowed one attempt per question.

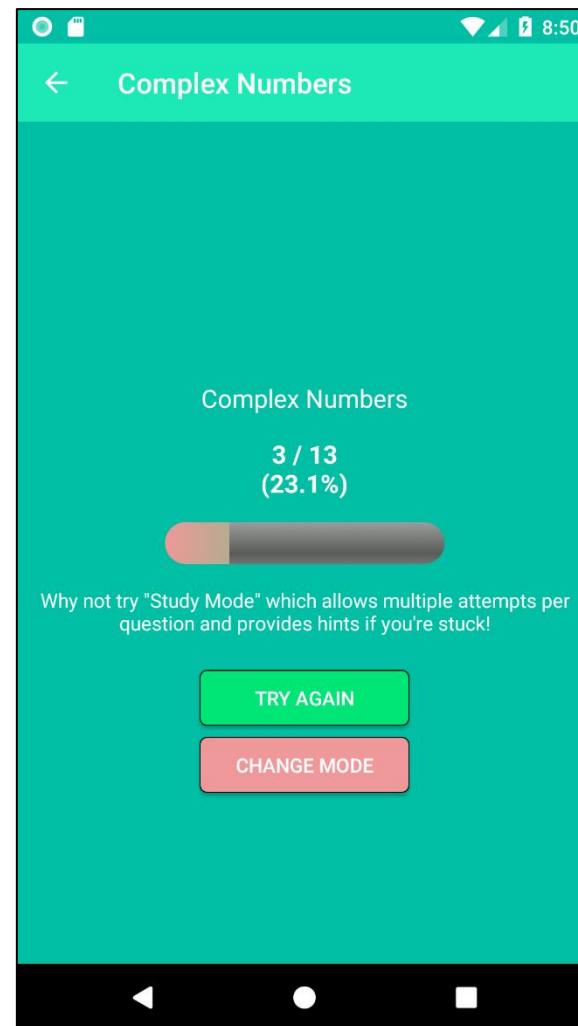
In this example they got the answer correct.

In this example, the user got the answer wrong.

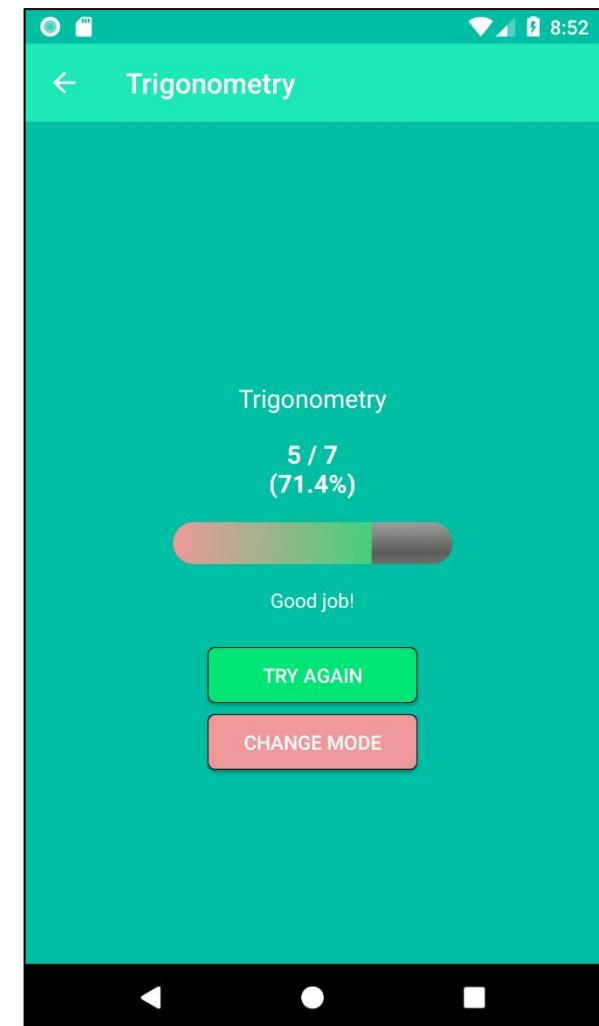
When the user has completed the quiz, they are shown a summary screen. In study mode, the summary screen congratulates the user and encourages them to test their knowledge by retaking the quiz in Test Mode. In test mode, the summary screen shows the user their score and either congratulates them, encourages them or suggests they revert to study mode. Two buttons are also provided to allow the user to try the quiz again or to change mode.



Study Mode summary screen



Test Mode summary screen
(poor score)



Test Mode summary screen
(good score)

4. USE OF HARDWARE

The app integrates with the device's hardware in two ways; file storage and audio.

File Storage

As the questions used by this app are dynamic, it is not possible to include all of their images within the build. They must be downloaded and stored as required.

The app must therefore have permission to write files to the user's external storage. As of Android 6.0 (API 23), permissions are requested at run time rather than at app install. This allows the app to ask for permission at a time which makes sense and gives context to the reason it needs the permission.

In this case, the application only attempts to download question image files once a level and category have been selected, which is at the Mode Selection screen. Permission to write to external storage is requested from the user at this screen. If the user accepts, the downloads begin and the downloaded files are saved locally. If the user declines, the questions will be presented without the images and a more detailed request will be presented next time, as per the Android guidelines.

Screenshots are provided overleaf.

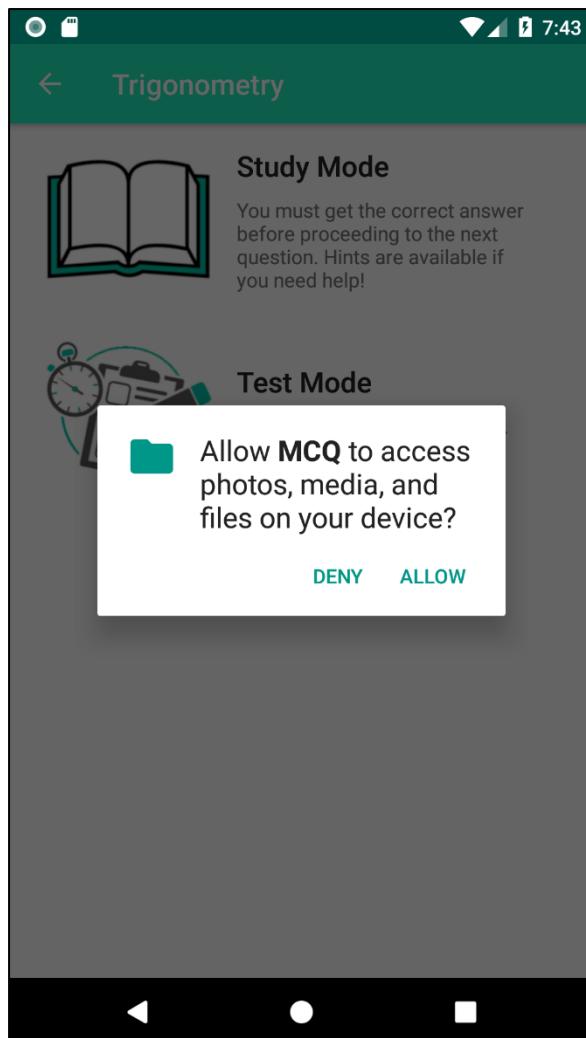
Audio

The app makes use of the device's audio capabilities in order to provide feedback to the user during the quiz.

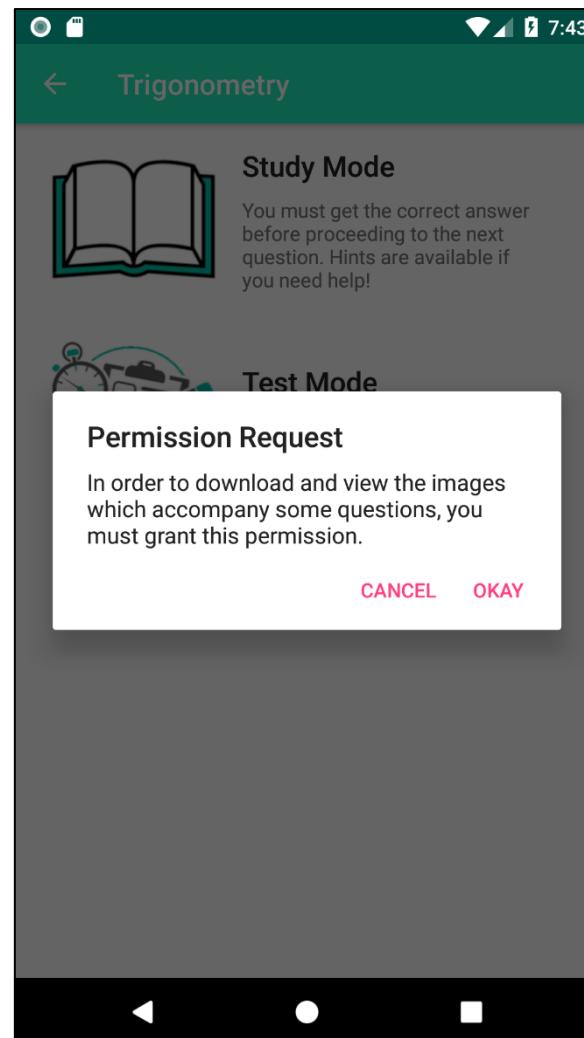
If a user selects the correct answer, a short positive sound is played.

If a user selects an incorrect answer, a short negative sound is played.

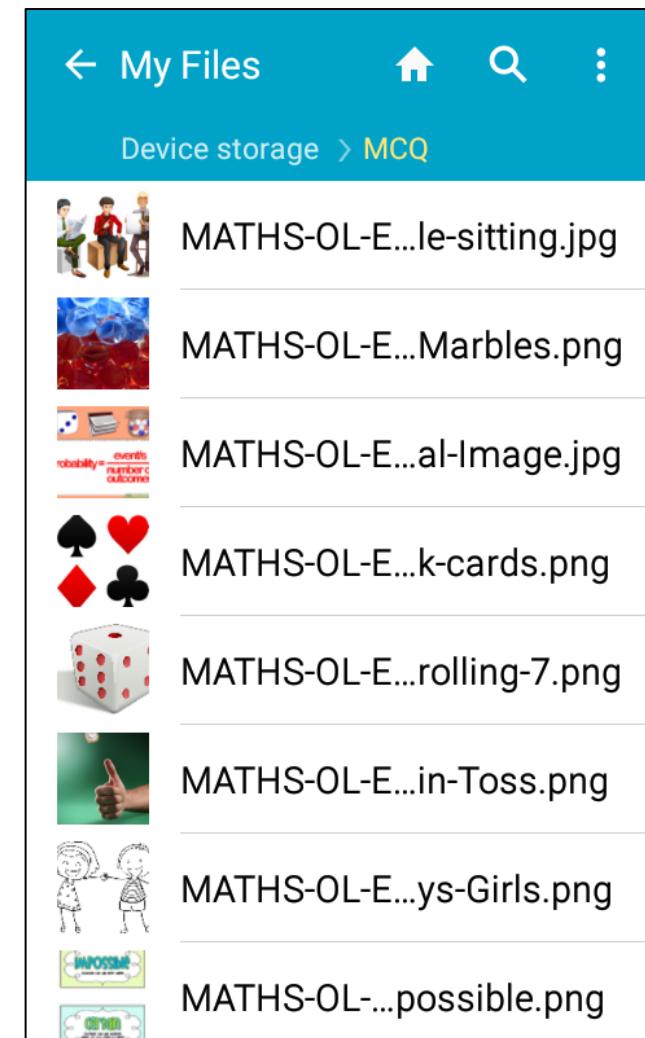
The sound is played on the STREAM_MUSIC audio stream to ensure that the volume is adjusted when the user adjusts their volume buttons and can be silenced when higher priority sounds must be played.



Initial request for permission



Second request for permission with accompanying explanation



External storage file management via device specific mechanism

5. GOOGLE PLAY RESOURCES

This application was not published on Google Play. However, the information required to do so is provided below.

Title

Leaving Cert Maths MCQ

Short description

Multiple choice LC Maths questions, by actual teachers/examiners.

Full description

Leaving Cert Maths MCQ provides multiple choice quizzes that are tailored to the Leaving Certificate maths curriculum. Higher, ordinary and foundation level quizzes are available for a range of categories. All of the questions were provided by actual teachers/examiners and by picking your level, you can be sure that the questions are relevant to you. You can practice using Study Mode where helpful hints are provided or put what you've learnt to the test in Test Mode, where no hints are provided and your scores are recorded!

Application type

Applications

Category

Education

Images

Please refer to the accompanying folder within the zip file for each of the required images.

A Nexus 5X API 26 emulator was used to capture the phone screenshots

A Nexus 7 API 25 emulator was used to capture the 7-inch tablet screenshots.

A Nexus 10 API 25 emulator was used to capture the 10-inch tablet screenshots.