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Research paper

Mobile Application for Hearing Impaired Based on Cordova Framework and Web Technologies

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Abstract

This paper will be looking at the design and development process of GRAMMROOM, a mobile application specifically aimed to aid the hearing impaired students in mastering English Language grammar skills. GRAMMROOM is build based on the Cordova framework incorporated with the web technologies. Cordova is chosen instead of any other open-source mobile development framework as it is stable and it allows the using of standard web technologies for the cross-platform development. This is just like creating a normal web application and is very helpful for novice developers who are at the beginning stage of developing a mobile application. GRAMMROOM will run on Android mobile phones and it is hoped that the hearing impaired students and those involved in the teaching and learning of the hearing impaired will benefit much from it.

Keywords: *Cordova framework; grammar learning; hearing impaired; mobile application; web application.*

1. Introduction

Generally there are various issues in the teaching and learning of the hearing impaired students in Malaysia, where in this study specifically looking at the hearing impaired students in the polytechnic system. The first issue that can be pointed out is regarding the performance of the hearing impaired students where English language is concerned. [1] in his study stated that deaf and hard of hearing people can find it difficult to follow the rapid pace of our daily life and the problem is due to the lack of services that increase access to information. This concurred with [2], who found out that not only do they have problems with reading, but they also have difficulties in written language. Without the ability to write, the hearing impaired may have difficulty in their work environment later on, so it is important for the hearing impaired students to master their reading and writing skills as both are the main means of communication for them with the outside world. To be good in writing, they have to first be proficient in their grammar. The statement is also in evidence with the major problem faced by the hearing impaired students in the Malaysian polytechnics based on the results of a preliminary study done by the researchers.

The preliminary study examines errors in a corpus of 40 essays written by 20 participants. The participants are from various semesters studying at Ungku Omar Polytechnic, one of the Premier Polytechnics in Malaysia. The instrument used for this preliminary study was participants' written essays and Markin software. All of the errors in the essays were identified and classified into various categorizations. The results of the study showed that six most common errors committed by the participants were subject-verb agreement, singular/plural form, word choice, verb tense, preposition, and word order. These aspects of writing in English seems to be the most difficult problems to participants. This study has shed light on the first major problem of the hearing impaired students when they learn English, specifically in writing. It has proven that the students are weak in their grammar and they do not have the proper sentence constructions.

In another study related to the hearing impaired students, [3] concluded that identifying the main problem and successfully addressing the issues regarding the teaching and learning will be very meaningful to them. This is supported by [4] who pointed out that nowadays, teaching them using the normal modules and books will not be sufficient anymore, while [5] agreed that there are needs to enhance the teaching and learning of the hearing impaired by using the mobile version of the module instead of the printed or just online module.

Mobile learning involves the use of mobile technology, either alone or in combination with other information and communication technology (ICT), to enable learning anytime and anywhere. Learning can unfold in a variety of ways: people can use mobile devices to access educational resources, connect with others, or create content, both inside and outside classrooms. Mobile learning also encompasses efforts to support broad educational goals such as the effective administration of school systems and improved communication between schools and families. These factors are very crucial in the development of the hearing impaired students teaching and learning as discussed by [6] who pointed out that learning in a different way is crucial in the deaf learners' development, thus the researchers who are also the developer decided to contribute by designing and developing a mobile application which is named as GRAMMROOM in order to help them in mastering their grammar skills. This act is also in conjunction with the remarkable growth trends in mobile applications and smart phone currently [7,8,9]. There are also evidence that mobile apps have been increasing popularity in Malaysia over the past few years as proven by [10] in his study.

The hearing impaired preferences of the grammar learning strategies will be the basic guidance in developing GRAMMROOM. Based on the students' feedback, the contents and activities designed will include their preferences. GRAMMROOM will consists of 8 learning units pertaining to the 8 parts of speech : article, nouns, pronouns, adjectives, verbs, adverbs, conjunctions, and prepositions. Each learning unit activities will be based on the 17 preferred grammar learning strategies where possible. The content of GRAMMROOM is later transferred to the android medium and the next step that is developing GRAMMROOM via Android Studio.Cordova Framework and the web technologies are the main foundation in developing GRAMMROOM. When developing applications, configuring a variety of components and elements are very crucial. Learning about the components and elements involved when developing an application helps the developers developmental steps proceed smoothly. It is very important to take note that the process for developing applications has steps that are common to all environments: setting up a server, creating an initial server registration and corresponding configuration files, creating a new (or opening an existing) project in the chosen platforms and also adding the necessary files to the main project.

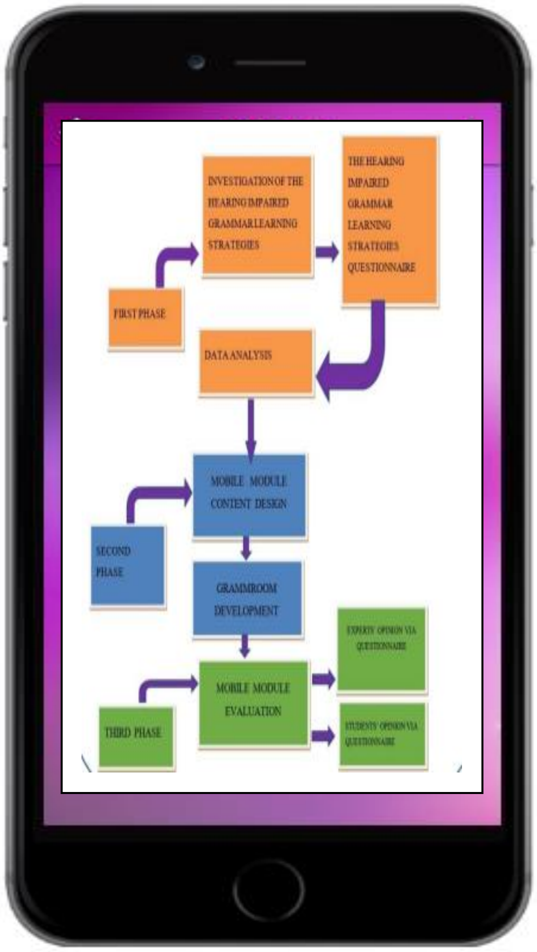

FIRST PHASE
INVESTIGATION OF THE HEARING IMPAIRED GRAMMAR LEARNING STRATEGIES
THE HEARING IMPAIRED GRAMMAR LEARNING STRATEGIES QUESTIONNAIRE
DATA ANALYSIS
MOBILE MODULE CONTENT DESIGN
SECOND PHASE
GRAMMROOM DEVELOPMENT
EXPERTS' OPINION VIA QUESTIONNAIRE
MOBILE MODULE EVALUATION
THIRD PHASE
STUDENTS' OPINION VIA QUESTIONNAIRE

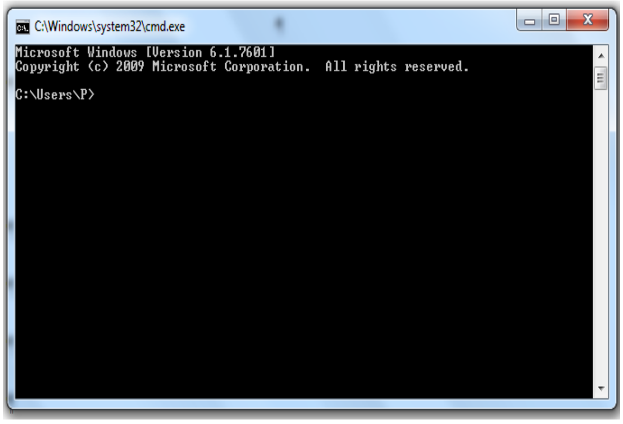
Fig. 1: The structure of GRAMMROOM development

2. Methodology

GRAMMROOM is developed by using Cordova and all the necessary web technologies. Cordova is a mobile application development framework that is primarily intended for apps' developers. It allows apps developers to use web technologies, such as HTML, CSS and JavaScript, to create mobile applications. Cordova is easy to learn and novice developers can easily apply their skills to build an app with Cordova.

Installing Cordova Using Command Prompt

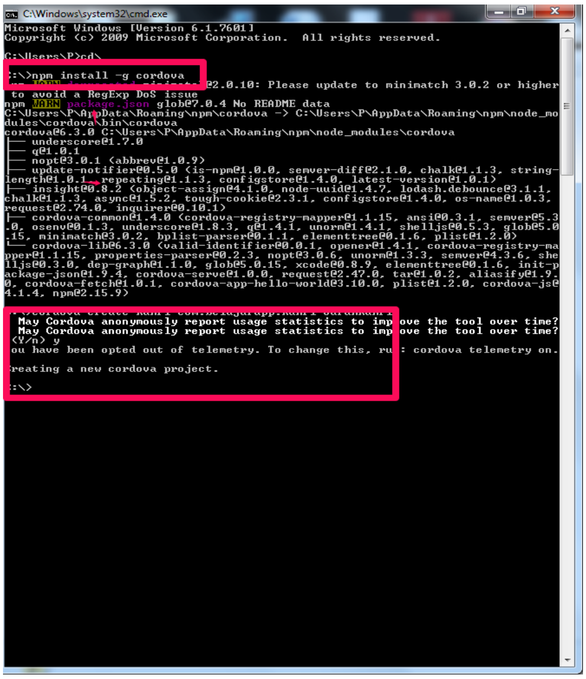
Command prompt is used for installing Cordova to the computer. To open the command prompt, click the Windows logo at the left end of the computer screen In the search program and files box type the word "cmd" and click the Enter button. The command prompt window will appear for the next steps.



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\P>
```

Fig. 2: Command prompt window

To install Cordova, type the instruction "npm install -g cordova" at the command prompt window and the installation process will start.



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\P>cd\

:\>npm install -g cordova
                                   @2.0.10: Please update to minimatch 3.0.2 or higher
 to avoid a RegExp DoS issue
npm WARN package.json glob@7.0.4 No README data
C:\Users\P\AppData\Roaming\npm\cordova -> C:\Users\P\AppData\Roaming\npm\node_mo
dules\cordova\bin\cordova
cordova@6.3.0 C:\Users\P\AppData\Roaming\npm\node_modules\cordova
├── underscore@1.7.0
├── q@1.0.1
├── nopt@3.0.1 (abbrev@1.0.9)
├── update-notifier@0.5.0 (is-npm@1.0.0, semver-diff@2.1.0, chalk@1.1.3, string-
length@1.0.1, repeating@1.1.3, configstore@1.4.0, latest-version@1.0.1)
├── insight@0.8.2 (object-assign@4.1.0, node-uuid@1.4.7, lodash.debounce@3.1.1,
chalk@1.1.3, async@1.5.2, tough-cookie@2.3.1, configstore@1.4.0, os-name@1.0.3,
request@2.74.0, inquirer@0.10.1)
├── cordova-common@1.4.0 (cordova-registry-mapper@1.1.15, ansi@0.3.1, semver@5.3
.0, osenv@0.1.3, underscore@1.8.3, q@1.4.1, unorm@1.4.1, shelljs@0.5.3, glob@5.0
.15, minimatch@3.0.2, bplist-parser@0.1.1, elementtree@0.1.6, plist@1.2.0)
└── cordova-lib@6.3.0 (valid-identifier@0.0.1, opener@1.4.1, cordova-registry-ma
pper@1.1.15, properties-parser@0.2.3, nopt@3.0.6, unorm@1.3.3, semver@4.3.6, she
lljs@0.3.0, dep-graph@1.1.0, glob@5.0.15, xcode@0.8.9, elementtree@0.1.6, init-p
ackage-json@1.9.4, cordova-serve@1.0.0, request@2.47.0, tar@1.0.2, aliasify@1.9.
0, cordova-fetch@1.0.1, cordova-app-hello-world@3.10.0, plist@1.2.0, cordova-js@
4.1.4, npm@2.15.9)

[illegible]
  May Cordova anonymously report usage statistics to imp ove the tool over time?
  May Cordova anonymously report usage statistics to imp ove the tool over time?
 (Y/n) y
 ou have been opted out of telemetry. To change this, ru : cordova telemetry on.

 reating a new cordova project.

:\>
```

Fig. 3: Successful installation process of Cordova

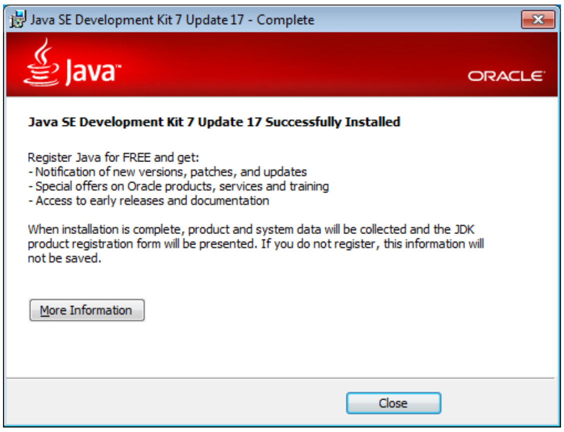
Basic Tools for Developing Grammroom

After Cordova is successfully installed, the developer has to set up all the basic tools that is related . Regardless of the target device platform, all basic tools need to be set up before any application can be developed. There are seven basic tools in setting up the development of GRAMMROOM.

Java Se Development Kit (Jdk)

The Java Development Kit (JDK) is a software development environment used for developing Java applications and applets. It includes the Java Runtime Environment (JRE), an interpreter/loader (java), a compiler (javac), an archiver (jar), a documentation generator (javadoc) and other tools needed in Java development. People new to Java may be confused about whether to use the JRE or the JDK. To run Java applications and applets, simply download the JRE. However, to develop Java applications and applets as well as run them, the JDK is needed. Java developers are initially presented with two JDK tools, java and javac. Both run from the command prompt. Java source files are simple text files saved with an extension of .java. After writing and saving Java source code, the javac compiler is invoked to create .class files. Once the .class files are created, the 'java' command can be used to run the java program.

For developers who wish to work in an integrated development environment (IDE), a JDK bundled with Netbeans can be downloaded from the Oracle website. Such IDEs speed up the development process by introducing point-and-click and drag-and-drop features for creating an application. There are different JDKs for various platforms. The supported platforms include Windows, Linux and Solaris. Mac users need a different software development kit, which includes adaptations of some tools found in the JDK.



Java SE Development Kit 7 Update 17 Successfully Installed

Register Java for FREE and get:
- Notification of new versions, patches, and updates
- Special offers on Oracle products, services and training
- Access to early releases and documentation

When installation is complete, product and system data will be collected and the JDK product registration form will be presented. If you do not register, this information will not be saved.

Fig.4: Installation of Java JDK for Android

Android Studio

Android Studio provides the fastest tools for building applications on every type of Android device. It is a world-class code editing, debugging, performance tooling, a flexible build system, and an instant build or deploy system that allow us to focus on building unique and high quality application. Android Studio is the official integrated development environment (IDE) for Android development, and with a single download includes everything that the researchers need to begin for developing GRAMMROOM.

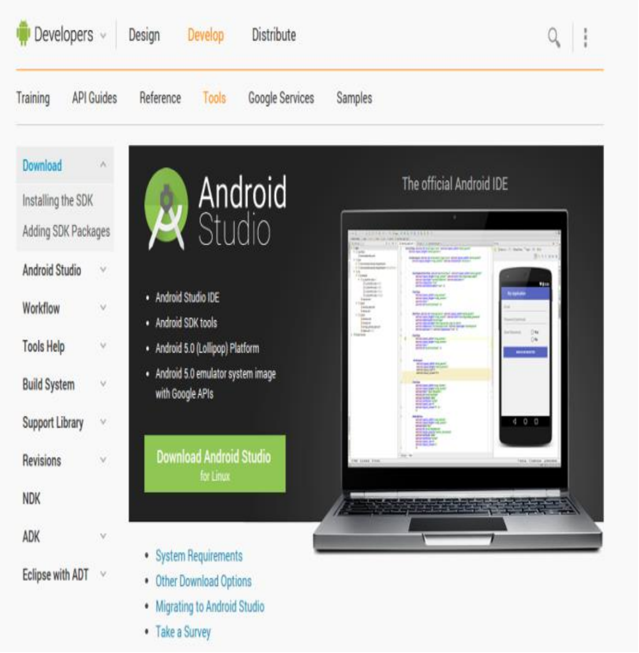
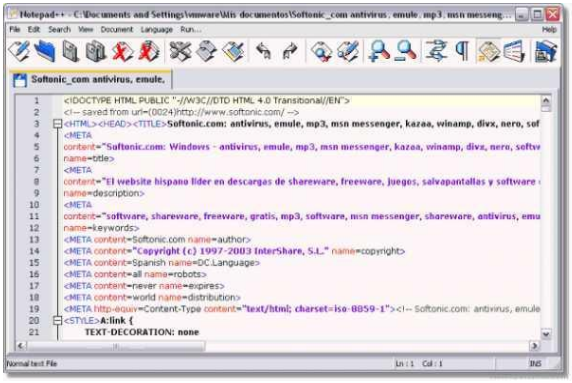


Fig.5: Downloading Android Studio from developer.android.com

Notepad++

Notepad++ is a text editor and source code editor for use with Microsoft Windows. Unlike Microsoft Notepad, the built-in Windows text editor, it supports tabbed editing, which allows working with multiple open files in a single window. Notepad++ is distributed as free software. Notepad++ supports several languages. Running in the MS Windows environment, its use is governed by GPL License. Based on the powerful editing component Scintilla, Notepad++ is written in C++ and uses pure Win32 API and STL which ensures a higher execution speed and smaller program size.

While the Notepad tool bundled with Windows is fine for making quick text notes, for anything more than this it is somewhat lacking in features. There is always the option of using a word processor for creating more in depth documents, but sometimes a middle ground is needed .This is the gap that Notepad++ has been designed to fill. The program has a small footprint and is quick to load, and while it has been designed as a replacement for Notepad, it has a great deal more to offer. The tabbed interface makes it possible to work with multiple documents simultaneously without the need to open several instances of the program and simple touches such as line numbering and syntax highlighting make it ideal for programmers editing code. Notepad++ can be used to record and playback macros, and sections of large documents can be bookmarked for easy access. The program recognising a range of different coding styles, from C++ and Java to HTML and Perl and multiple documents can be viewed at the same time for the purposes of comparison, or a document can be cloned ready for editing while retaining the original version. The researchers used this versatile tool which is just not incredibly useful for any coder, but also operates well as a more powerful text editor.


Notepad++ - C:\Documents and Settings\vmware\Mis documentos\Softonic_com antivirus, emule, mp3, msn messeng...
File
Edit
Search
View
Document
Language
Run...
Help
Softonic_com antivirus, emule.
Normal text File
Ln : 1 Col : 1
INS

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<!-- saved from url=(0024)http://www.softonic.com/ -->
<HTML><HEAD><TITLE>Softonic.com: antivirus, emule, mp3, msn messenger, kazaa, winamp, divx, nero, sof
<META
content="Softonic.com: Windows - antivirus, emule, mp3, msn messenger, kazaa, winamp, divx, nero, softw
name=title>
<META
content="El website hispano lider en descargas de shareware, freeware, juegos, salvapantallas y software
name=description>
<META
content="software, shareware, freeware, gratis, mp3, software, msn messenger, shareware, antivirus, emu
name=keywords>
<META content=Softonic.com name=author>
<META content="Copyright (c) 1997-2003 InterShare, S.L." name=copyright>
<META content=Spanish name=DC.Language>
<META content=all name=robots>
<META content=never name=expires>
<META content=world name=distribution>
<META http-equiv=Content-Type content="text/html; charset=iso-8859-1"><!-- Softonic.com: antivirus, emule
<STYLE>A:link {
    TEXT-DECORATION: none
```

Fig. 6 : Notepad++ Interface

Node.Js

Node.js is a server-side platform built on Google Chrome's JavaScript Engine (V8 Engine). Node.js was developed by Ryan Dahl in 2009 and its latest version is v0.10.36. Node.js is built on Chrome's JavaScript runtime for easily building fast and scalable network applications. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient, perfect for data-intensive real-time applications that run across distributed devices. It is an open source, cross-platform runtime environment for developing server-side and networking applications. Node.js applications are written in JavaScript, and can be run within the Node.js runtime on OS X, Microsoft Windows, and Linux. Node.js also provides a rich library of various JavaScript modules which simplifies the development of web applications using Node.js to a great extent.

Git

Large projects that are distributed over multiple repositories needs an open source version-control system which is designed to handle the projects. One of it is called Git. In the context of Android applications development, Git is use for local operations such as local branching, commits, diffs and edits. It also tracks changes in computer files and coordinate work on those files among multiple people. Git is primarily used for software development, but it can be used to keep track of changes in any files.

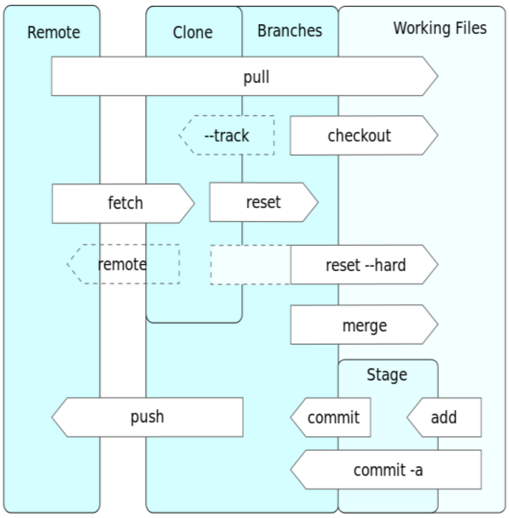


Fig.7 : Some data flows and storage levels in the Git revision control system

As explained, Git is an important version control system There are many version of control systems out there such as CVS, SVN, Mercurial, Fossil, and, of course, Git. Git serves as the foundation for many services, like GitHub and GitLab, but developers can use Git without using any other service. This means that developers can use Git privately or publicly.

ANT

Developing an application incorporates compiling, linking and packaging codes into a usable or executable form. Developers need build tools for this. Build tools are programs that automate the creation of executable applications from source code In small projects, developers will often manually invoke the build process. This is not practical for larger projects, where it is very hard to keep track of what needs to be built, in what sequence and what dependencies there are in the building process. Using an automation tool allows the build process to be more consistent.
Ant is one of the Java-based build tools which the researchers use in developing GRAMMROOM. It is basically a tool that is required to build an application system. Typically, there is much more to building applications than just typing in and then compiling the source code. There are a number of steps required to transform the source into a deployable and useable application solution and missing any of them might result in failure of launching the application.

Bluestacks

Bluestacks App Player is a quick, compact install to the boot drive and works like an Android emulator on Windows or Mac computers and run all of the Android apps that have been developed. It is a versatile program that bridges the gap between mobile and desktop by allowing users to run their favourite Android apps on their Windows or Mac computers. Installing Bluestacks is very important as the researcher develop GRAMMROOM using Windows and needs to run it with the computer first before uploading the application to the mobile phone.

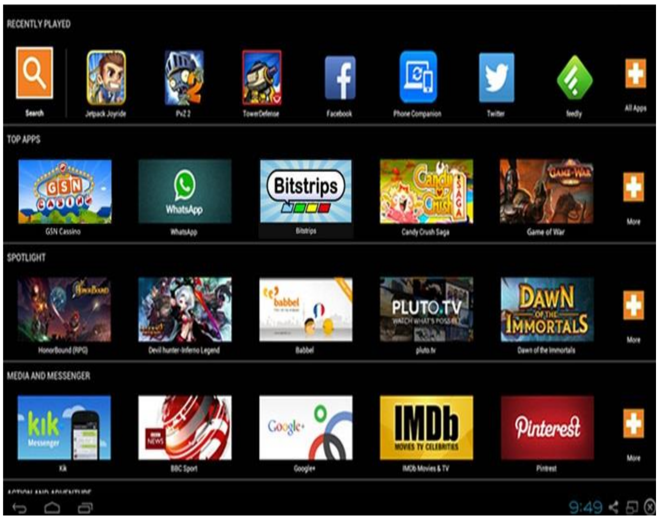


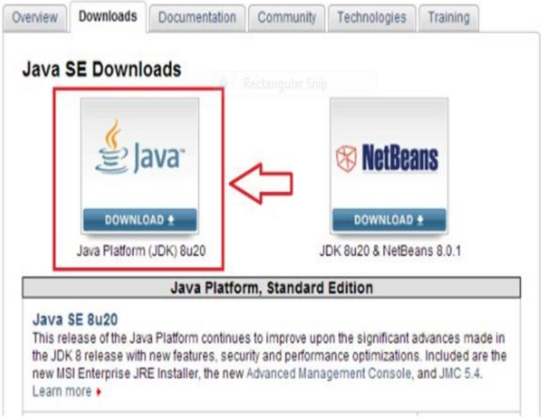
Fig 8 : A screenshot of Bluestacks Apps Player

Installing the Tools

Before starting this step it is advised to follow all the necessary rules. The first part of the installation is very crucial to prepare the computer for developing GRAMMROOM in the later steps. The Operating System (OS) that the researchers use in this apps development is Windows 7 .

Downloading Jdk Tool.

To start this first step, the researchers download the Java Platform file or JDK at : http://www.oracle.com/technetwork/javajjavase/downloads/inclex.html. After downloading, install the file and click next until the last step. The JDK tool should be installed without having to change any specification.



Java SE Downloads

Java Platform (JDK) 8u20

JDK 8u20 & NetBeans 8.0.1

Java Platform, Standard Edition

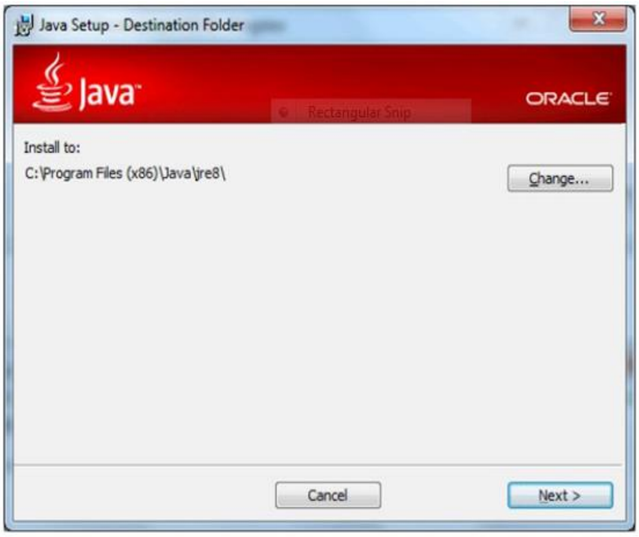
Java SE 8u20

This release of the Java Platform continues to improve upon the significant advances made in the JDK 8 release with new features, security and performance optimizations. Included are the new MSI Enterprise JRE Installer, the new Advanced Management Console, and JMC 5.4.

Learn more

Fig 9 : The Java Icon for installing the JDK tool

Next, tick Accept the License Agreement button and click on Windows x86 to download. When download is ready, click on the file to install. You only need to press Next until the process is complete but the important step here is you need to remember and know the location of the file installed as in the figure below.



Java Setup - Destination Folder

Install to:

C:\Program Files (x86)\Java\jre8\

Fig 10 : The location of the installed file.

Preparing the Working Area

For ease of reference in the future, create a new folder in the hard disk partition, either partition C, D or E with the name of 'Development'. It must be ensured that there is at least 5 GB of empty space in the hard disk. Then create a new folder in the Development folder and name it as 'Android'. Next step is to create a new folder in the Android folder and name it as 'sdk'. Preparation of all these folders are important as they will be used in the next step. By clicking on My Computer, how the partition of hard disk on the working computer is divided can be seen. As in the figure below there are 2 partitions of the hard disk, C and D.

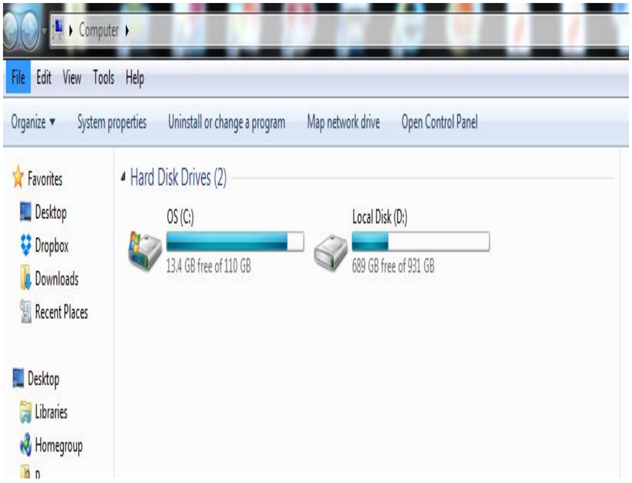


Fig 11 : Hard disk partitions

Installing Notepad

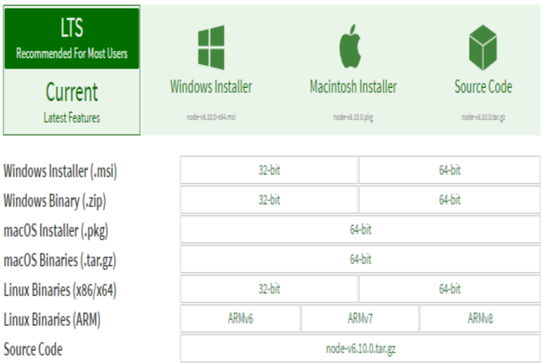
The next tool to be installed is the Notepad ++ The link to download this tool is http://notepad-plus-plus.org/. After completion of the download, the tool can be installed.

Fig 12 : Notepad++ Installer

It is quite easy to install Notepad ++.Without having to change anything, just press the Next button until installation is completed. This software is different with ordinary Notepad in Windows. Notepad ++ is usually used to examine the programming code in apps development.

Installing Node.js

The next step is to download node.js at its link at http: // nodejs.org/.

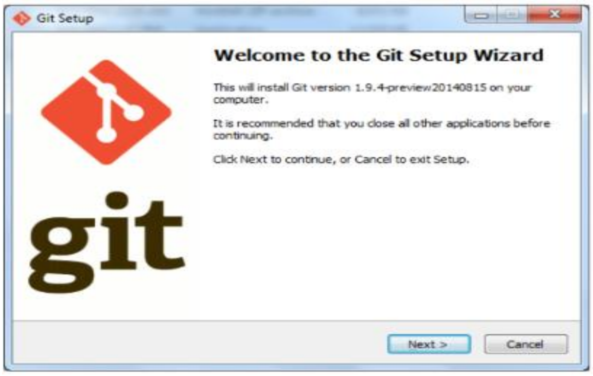


Windows Installer (.msi)	32-bit	64-bit	
Windows Binary (.zip)	32-bit	64-bit	
macOS Installer (.pkg)	64-bit		
macOS Binaries (.tar.gz)	64-bit		
Linux Binaries (x86/x64)	32-bit	64-bit	
Linux Binaries (ARM)	ARMv6	ARMv7	ARMv8
Source Code	node-v6.10.0.tar.gz		

Fig 13 : Node.js installer

Installing Git

Git tool can be downloaded and installed from http://git·scm.com/, but there are some specific settings that need to be considered before installing Git.



Git Setup

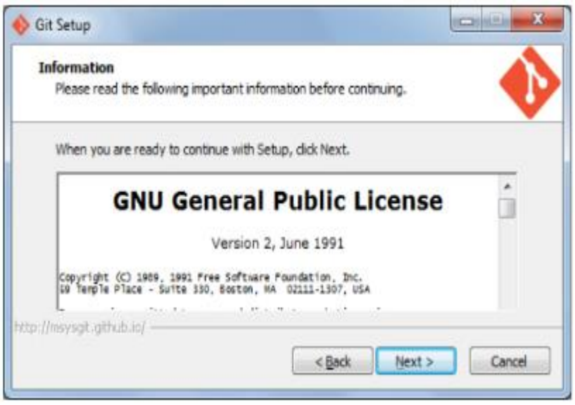
Welcome to the Git Setup Wizard

This will install Git version 1.9.4-preview20140815 on your computer.

It is recommended that you close all other applications before continuing.

Click Next to continue, or Cancel to exit Setup.

Fig 14 : The first step of Git setup



Git Setup

Information

Please read the following important information before continuing.

When you are ready to continue with Setup, click Next.

GNU General Public License

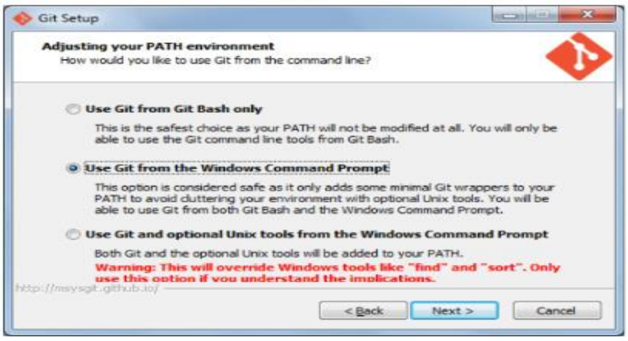
Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc.
59 Temple Place - Suite 330, Boston, MA 02111-1307, USA

http://msysgit.github.io/

Fig 15 : The second step to download and install Git

For the first and second steps of downloading and installing Git, just press the next button, but for the next step, select Use Git from Windows Command Prompt.as in the figure below.


Git Setup

Adjusting your PATH environment
How would you like to use Git from the command line?

○ **Use Git from Git Bash only**
This is the safest choice as your PATH will not be modified at all. You will only be able to use the Git command line tools from Git Bash.

● **Use Git from the Windows Command Prompt**
This option is considered safe as it only adds some minimal Git wrappers to your PATH to avoid cluttering your environment with optional Unix tools. You will be able to use Git from both Git Bash and the Windows Command Prompt.

○ **Use Git and optional Unix tools from the Windows Command Prompt**
Both Git and the optional Unix tools will be added to your PATH.
Warning: This will override Windows tools like "find" and "sort". Only use this option if you understand the implications.

http://msysgit.github.io/

Fig 16 : Selecting the correct option

Setting Ant Folder

After completing the installation of all the necessary tools, some important settings should be done. Firstly, download the Apache Ant file at its link: http: //ant.apache.org/bindownload.cgi. When this is done, copy and paste the file to the Development folder which was created earlier. Then extract the files there and rename the new folder as Ant. Delete the ZIP file that had been derived. There is no need to install anything for this Apache Ant tool.

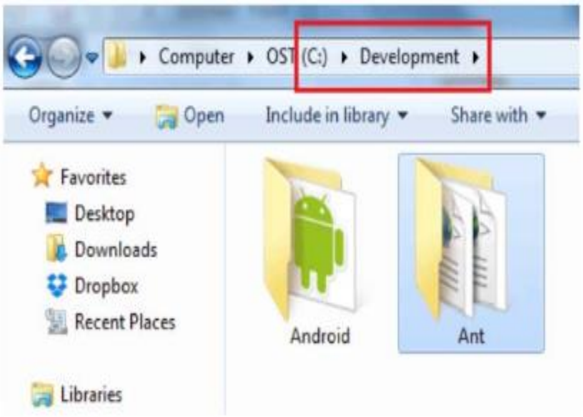
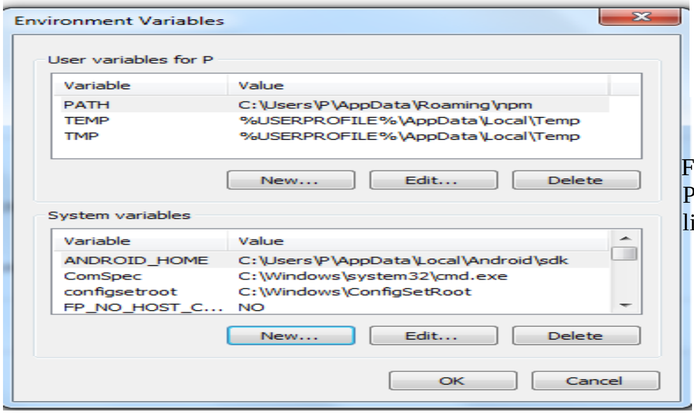


Fig 17 : New Ant folder in the development folder created earlier

Setting Up the System Environment

The next step is to set up the system environment properly so that there will be no problem to start the programming of GRAMMROOM later. To do this, click at My Computer, go to properties and choose advanced setting. Next, click at the Environment Variables.


Environment Variables

User variables for P

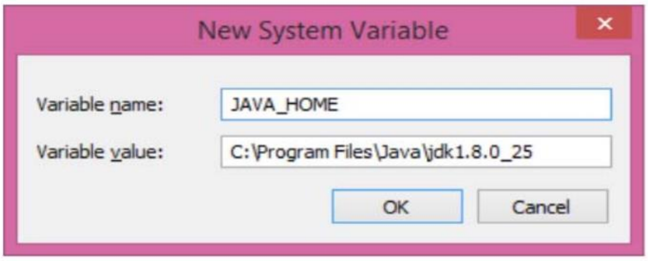
Variable	Value
PATH	C:\Users\P\AppData\Roaming\npm
TEMP	%USERPROFILE%\AppData\Local\Temp
TMP	%USERPROFILE%\AppData\Local\Temp

System variables

Variable	Value
ANDROID_HOME	C:\Users\P\AppData\Local\Android\sdk
ComSpec	C:\Windows\system32\cmd.exe
configsetroot	C:\Windows\ConfigSetRoot
FP_NO_HOST_C...	NO

Fig 18 : Setting the system variables

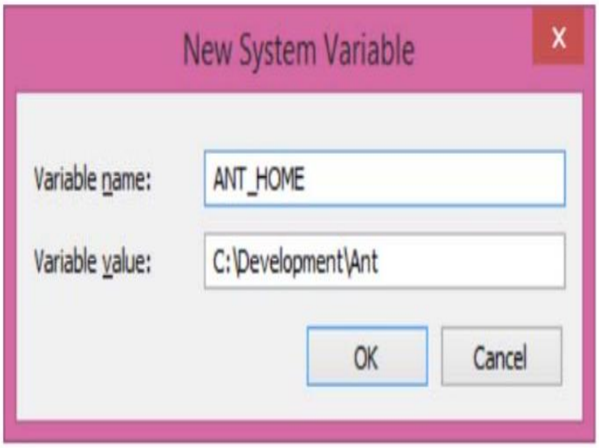
At the system variables option, click New button. Enter JAVA_HOME to the Variable Name, and C: \ Program Files (X86) \ Java \ jdk1.8.0 for Variable Value. For Variable value it can be changed according to the position of the folder where we install the particular tool. Usually all the tools are installed in the Program Files or Program Files (x86) folder. Just click ok after its completion.


New System Variable

Variable name: JAVA_HOME
Variable value: C:\Program Files\Java\jdk1.8.0_25

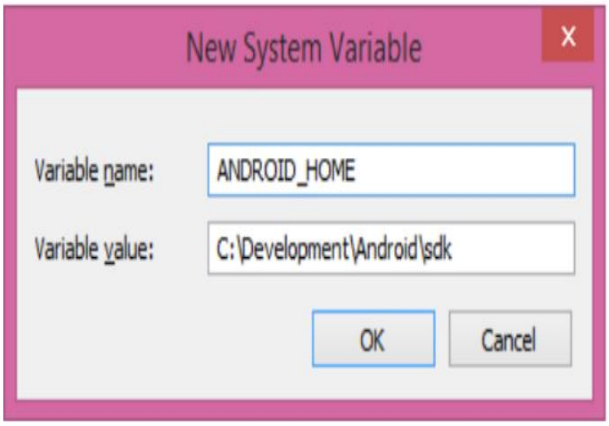
Fig 19 : Setting Java system variable

Repeat the above step for the variable name ANT_HOME and Android_HOME. For Ant type C:\Developrnent\Ant for variable value and for Android type C:\Development\Android\ sdk for variable value.


New System Variable

Variable name: ANT_HOME
Variable value: C:\Development\Ant

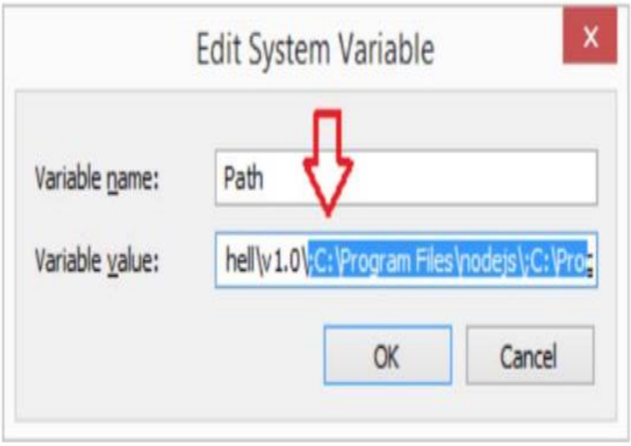
Fig 20 : Setting new system variable for Ant Tool


New System Variable

Variable name: ANDROID_HOME
Variable value: C:\Development\Android\sdk

Fig 21: Setting new system variable for Android_Home

Finally in setting the system environment, look for Variable named Path and click Edit. Insert Path for variable name and add location link for two tools, nodejs and cmd folder.



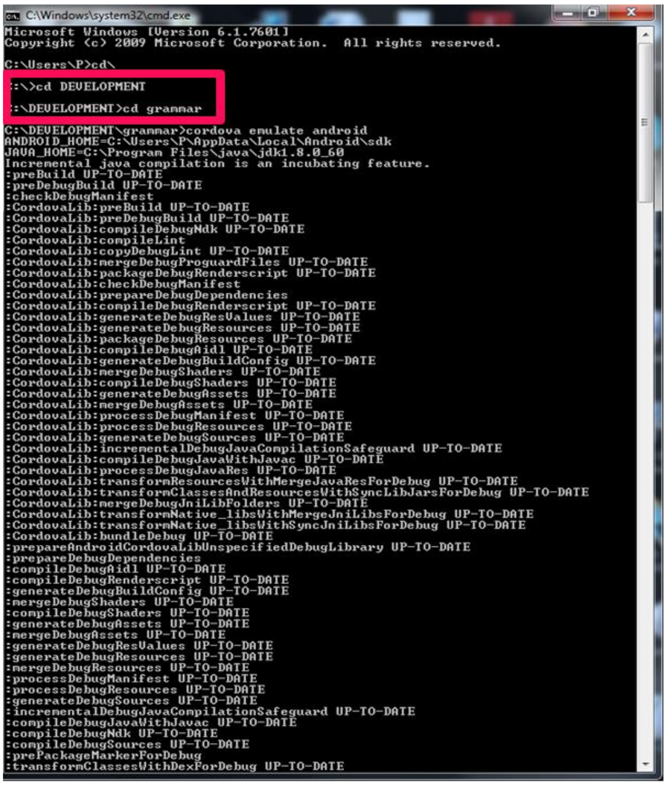
Variable name: Path

Variable value: hell\v1.0\;C:\Program Files\nodejs\;C:\Pro

Fig 22 : Editing system variable

Developing Grammroom

Since all the neccessary tools and environment have been set up successfully, the next main task of developing GRAMMROOM can be executed.



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\P>cd\

:\>cd DEVELOPMENT

:\DEVELOPMENT>cd grammar

C:\DEVELOPMENT\grammar>cordova emulate android
ANDROID_HOME=C:\Users\P\AppData\Local\Android\sdk
JAVA_HOME=C:\Program Files\java\jdk1.8.0_60
Incremental java compilation is an incubating feature.
:preBuild UP-TO-DATE
:preDebugBuild UP-TO-DATE
:checkDebugManifest
:CordovaLib:preBuild UP-TO-DATE
:CordovaLib:preDebugBuild UP-TO-DATE
:CordovaLib:compileDebugNdk UP-TO-DATE
:CordovaLib:compileLint
:CordovaLib:copyDebugLint UP-TO-DATE
:CordovaLib:mergeDebugProguardFiles UP-TO-DATE
:CordovaLib:packageDebugRenderscript UP-TO-DATE
:CordovaLib:checkDebugManifest
:CordovaLib:prepareDebugDependencies
:CordovaLib:compileDebugRenderscript UP-TO-DATE
:CordovaLib:generateDebugResValues UP-TO-DATE
:CordovaLib:generateDebugResources UP-TO-DATE
:CordovaLib:packageDebugResources UP-TO-DATE
:CordovaLib:compileDebugAidl UP-TO-DATE
:CordovaLib:generateDebugBuildConfig UP-TO-DATE
:CordovaLib:mergeDebugShaders UP-TO-DATE
:CordovaLib:compileDebugShaders UP-TO-DATE
:CordovaLib:generateDebugAssets UP-TO-DATE
:CordovaLib:mergeDebugAssets UP-TO-DATE
:CordovaLib:processDebugManifest UP-TO-DATE
:CordovaLib:processDebugResources UP-TO-DATE
:CordovaLib:generateDebugSources UP-TO-DATE
:CordovaLib:incrementalDebugJavaCompilationSafeguard UP-TO-DATE
:CordovaLib:compileDebugJavaWithJavac UP-TO-DATE
:CordovaLib:processDebugJavaRes UP-TO-DATE
:CordovaLib:transformResourcesWithMergeJavaResForDebug UP-TO-DATE
:CordovaLib:transformClassesAndResourcesWithSyncLibJarsForDebug UP-TO-DATE
:CordovaLib:mergeDebugJniLibFolders UP-TO-DATE
:CordovaLib:transformNative_libsWithMergeJniLibsForDebug UP-TO-DATE
:CordovaLib:transformNative_libsWithSyncJniLibsForDebug UP-TO-DATE
:CordovaLib:bundleDebug UP-TO-DATE
:prepareAndroidCordovaLibUnspecifiedDebugLibrary UP-TO-DATE
:prepareDebugDependencies
:compileDebugAidl UP-TO-DATE
:compileDebugRenderscript UP-TO-DATE
:generateDebugBuildConfig UP-TO-DATE
:mergeDebugShaders UP-TO-DATE
:compileDebugShaders UP-TO-DATE
:generateDebugAssets UP-TO-DATE
:mergeDebugAssets UP-TO-DATE
:generateDebugResValues UP-TO-DATE
:generateDebugResources UP-TO-DATE
:mergeDebugResources UP-TO-DATE
:processDebugManifest UP-TO-DATE
:processDebugResources UP-TO-DATE
:generateDebugSources UP-TO-DATE
:incrementalDebugJavaCompilationSafeguard UP-TO-DATE
:compileDebugJavaWithJavac UP-TO-DATE
:compileDebugNdk UP-TO-DATE
:compileDebugSources UP-TO-DATE
:prePackageMarkerForDebug
:transformClassesWithDexForDebug UP-TO-DATE
```

Fig 23: Building GRAMMROOM application

If the step in figure 23 is successful, a new folder named Grammar will be seen in the Development folder created in the earlier steps. All metadata of GRAMMROOM will be saved in this important folder.

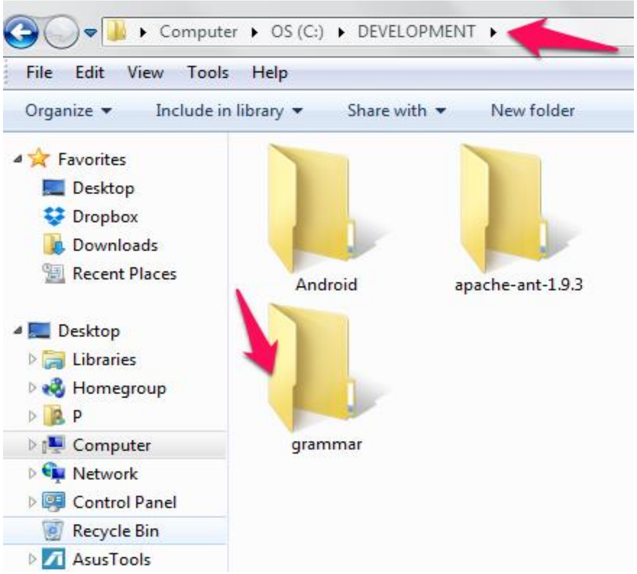
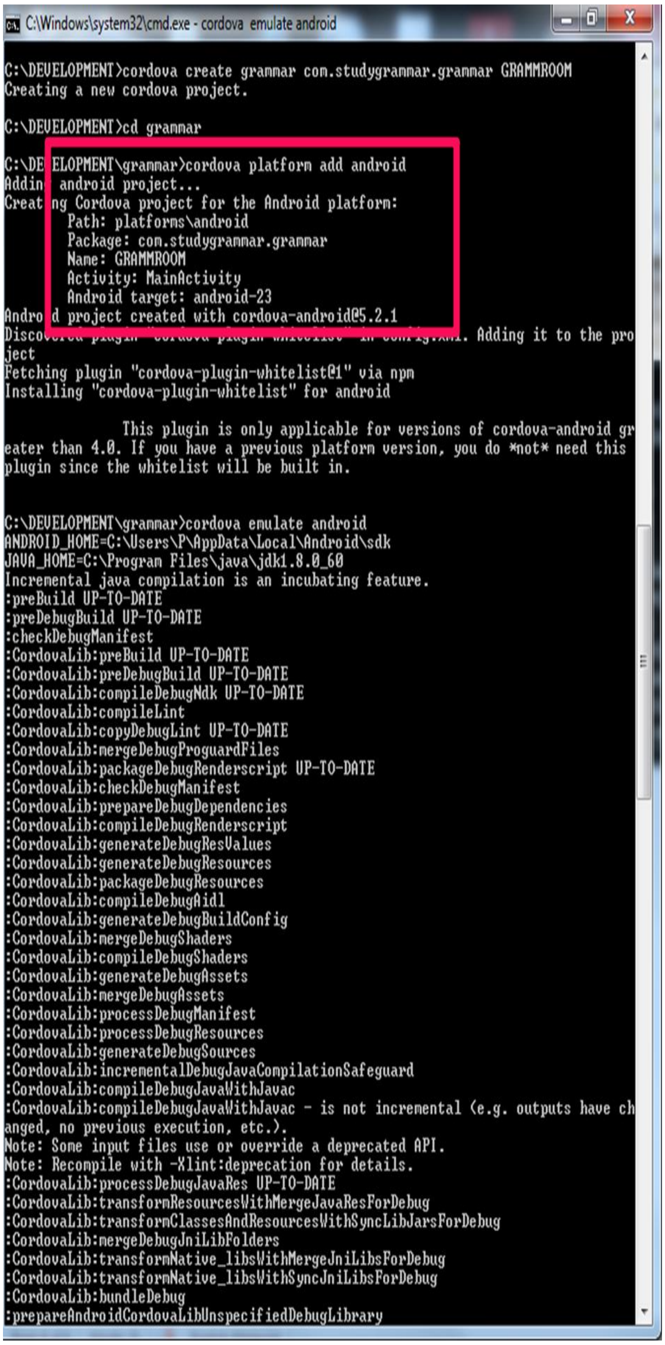


Fig 24 : New grammar folder created in development folder

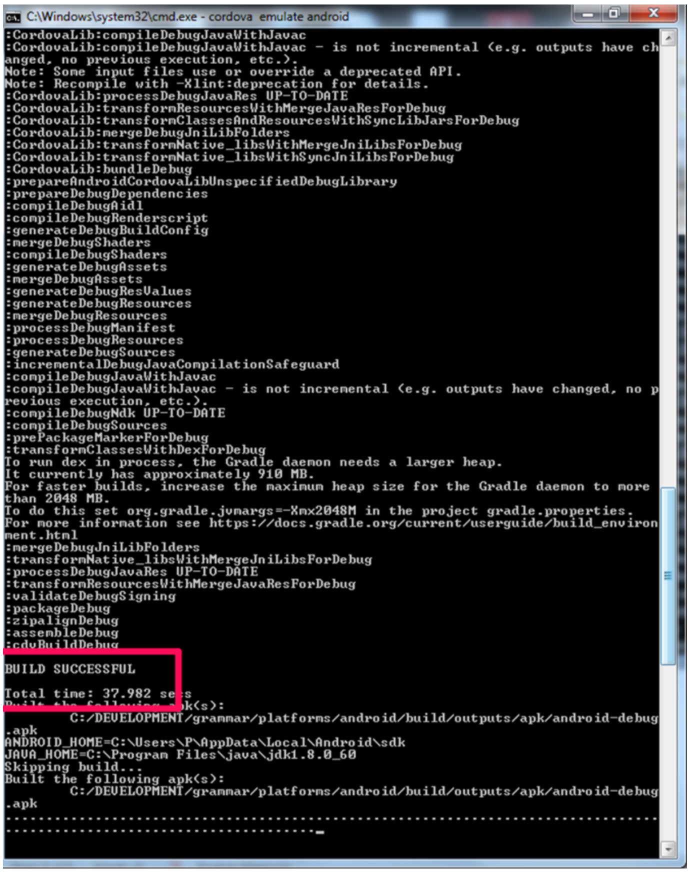
The next step after the grammar folder was successfully created is to proceed with creating the Android platform where GRAMMROOM will be uploaded after the final steps. In the command prompt window, type the instruction “cordova platform add android”. If the step is successful, it will be shown as in the figure below.



```
C:\DEVELOPMENT>cordova create grammar com.studygrammar.grammar GRAMMROOM
Creating a new cordova project.

C:\DEVELOPMENT>cd grammar

C:\DEVELOPMENT\grammar>cordova platform add android
Adding android project...
Creating Cordova project for the Android platform:
        Path: platforms\android
        Package: com.studygrammar.grammar
        Name: GRAMMROOM
        Activity: MainActivity
        Android target: android-23
Android project created with cordova-android@5.2.1
Discovered plugin "cordova-plugin-whitelist" in config.xml. Adding it to the pro
ject
Fetching plugin "cordova-plugin-whitelist@1" via npm
Installing "cordova-plugin-whitelist" for android

               This plugin is only applicable for versions of cordova-android gr
eater than 4.0. If you have a previous platform version, you do *not* need this
plugin since the whitelist will be built in.


C:\DEVELOPMENT\grammar>cordova emulate android
ANDROID_HOME=C:\Users\P\AppData\Local\Android\sdk
JAVA_HOME=C:\Program Files\java\jdk1.8.0_60
Incremental java compilation is an incubating feature.
:preBuild UP-TO-DATE
:preDebugBuild UP-TO-DATE
:checkDebugManifest
:CordovaLib:preBuild UP-TO-DATE
:CordovaLib:preDebugBuild UP-TO-DATE
:CordovaLib:compileDebugNdk UP-TO-DATE
:CordovaLib:compileLint
:CordovaLib:copyDebugLint UP-TO-DATE
:CordovaLib:mergeDebugProguardFiles
:CordovaLib:packageDebugRenderscript UP-TO-DATE
:CordovaLib:checkDebugManifest
:CordovaLib:prepareDebugDependencies
:CordovaLib:compileDebugRenderscript
:CordovaLib:generateDebugResValues
:CordovaLib:generateDebugResources
:CordovaLib:packageDebugResources
:CordovaLib:compileDebugAidl
:CordovaLib:generateDebugBuildConfig
:CordovaLib:mergeDebugShaders
:CordovaLib:compileDebugShaders
:CordovaLib:generateDebugAssets
:CordovaLib:mergeDebugAssets
:CordovaLib:processDebugManifest
:CordovaLib:processDebugResources
:CordovaLib:generateDebugSources
:CordovaLib:incrementalDebugJavaCompilationSafeguard
:CordovaLib:compileDebugJavaWithJavac
:CordovaLib:compileDebugJavaWithJavac - is not incremental (e.g. outputs have ch
anged, no previous execution, etc.).
Note: Some input files use or override a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
:CordovaLib:processDebugJavaRes UP-TO-DATE
:CordovaLib:transformResourcesWithMergeJavaResForDebug
:CordovaLib:transformClassesAndResourcesWithSyncLibJarsForDebug
:CordovaLib:mergeDebugJniLibFolders
:CordovaLib:transformNative_libsWithMergeJniLibsForDebug
:CordovaLib:transformNative_libsWithSyncJniLibsForDebug
:CordovaLib:bundleDebug
:prepareAndroidCordovaLibUnspecifiedDebugLibrary
```

Fig 25 : Building Android platform

The process of building Android platform in the computer will take some time and when the process is successful it will be shown in the command prompt window as in figure 24. The developers faced some technical problems too when proceeding this steps but finally the Android platform was created successfully after trying a few times. .



```
:CordovaLib:compileDebugJavaWithJavac
:CordovaLib:compileDebugJavaWithJavac - is not incremental (e.g. outputs have ch
anged, no previous execution, etc.).
Note: Some input files use or override a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
:CordovaLib:processDebugJavaRes UP-TO-DATE
:CordovaLib:transformResourcesWithMergeJavaResForDebug
:CordovaLib:transformClassesAndResourcesWithSyncLibJarsForDebug
:CordovaLib:mergeDebugJniLibFolders
:CordovaLib:transformNative_libsWithMergeJniLibsForDebug
:CordovaLib:transformNative_libsWithSyncJniLibsForDebug
:CordovaLib:bundleDebug
:prepareAndroidCordovaLibUnspecifiedDebugLibrary
:prepareDebugDependencies
:compileDebugAidl
:compileDebugRenderscript
:generateDebugBuildConfig
:mergeDebugShaders
:compileDebugShaders
:generateDebugAssets
:mergeDebugAssets
:generateDebugResValues
:generateDebugResources
:mergeDebugResources
:processDebugManifest
:processDebugResources
:generateDebugSources
:incrementalDebugJavaCompilationSafeguard
:compileDebugJavaWithJavac
:compileDebugJavaWithJavac - is not incremental (e.g. outputs have changed, no p
revious execution, etc.).
:compileDebugNdk UP-TO-DATE
:compileDebugSources
:prePackageMarkerForDebug
:transformClassesWithDexForDebug
To run dex in process, the Gradle daemon needs a larger heap.
It currently has approximately 910 MB.
For faster builds, increase the maximum heap size for the Gradle daemon to more
than 2048 MB.
To do this set org.gradle.jvmargs=-Xmx2048M in the project gradle.properties.
For more information see https://docs.gradle.org/current/userguide/build_environ
ment.html
:mergeDebugJniLibFolders
:transformNative_libsWithMergeJniLibsForDebug
:processDebugJavaRes UP-TO-DATE
:transformResourcesWithMergeJavaResForDebug
:validateDebugSigning
:packageDebug
:zipalignDebug
:assembleDebug
:cdvBuildDebug

BUILD SUCCESSFUL

Total time: 37.982 secs
Built the following apk(s):
        C:/DEVELOPMENT/grammar/platforms/android/build/outputs/apk/android-debug
.apk
ANDROID_HOME=C:\Users\P\AppData\Local\Android\sdk
JAVA_HOME=C:\Program Files\java\jdk1.8.0_60
Skipping build...
Built the following apk(s):
        C:/DEVELOPMENT/grammar/platforms/android/build/outputs/apk/android-debug
.apk
................................................................................
......................................
```

Fig 26 : Android platform building is successful

Finally, when bluestacks, the application player designed to enable android application to run on windows, is opened, the GRAMMROOM application icon can be seen. This shows that the application was successfully build in the system and the content of GRAMMROOM is now ready to be developed and later uploaded to the android devices.

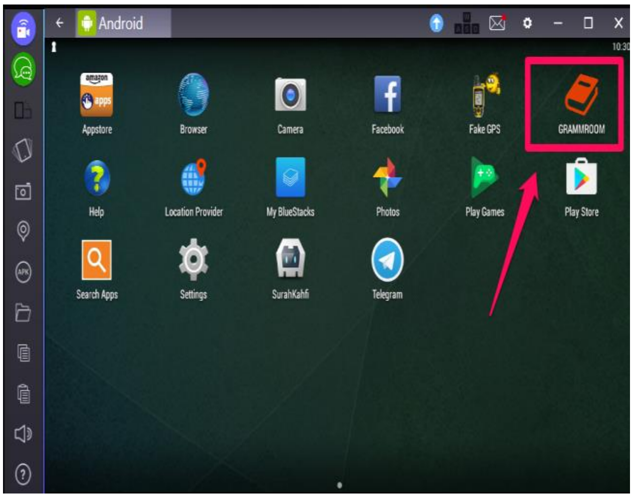
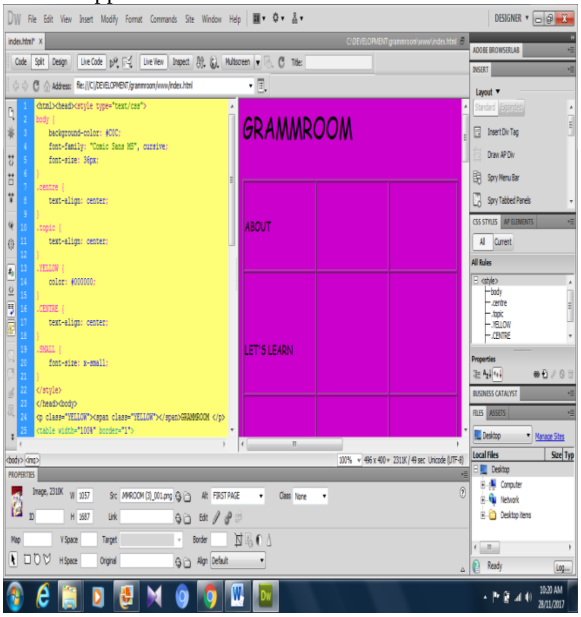


Fig 27 : Bluestacks application player showing GRAMMROOM icon.

Authoring Gramroom

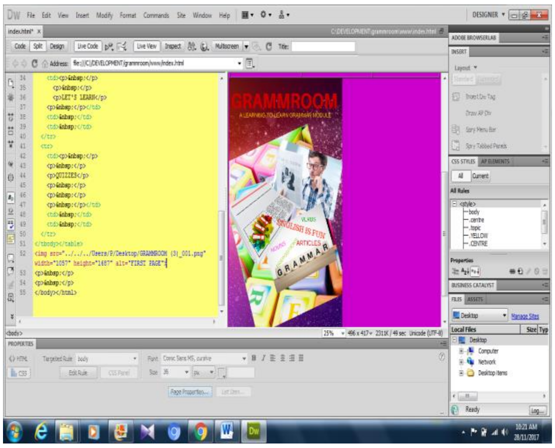
The final steps in developing GRAMMROOM will now proceed by authoring the necessary contents and structures. The researchers use Adobe Dreamweaver , a software program for designing web pages, essentially a more fully featured HTML web and programming editor. The program provides a what-you-see-is-what-you-get (WYSIWYG) interface for users to create and edit web pages in a more user-friendly environment. Dreamweaver supports many markup languages, including HTML, XML, CSS, and JavaScript. As for human languages, it supports English, Spanish, French, German, Japanese, Chinese (both Simplified and

Traditional), Italian, Russian, and many more. The completed web pages that can be re-edited are now ready to be uploaded via Cordova platform that will finally form GRAMMROOM as an android application.


DW File Edit View Insert Modify Format Commands Site Window Help
index.html*
Code Split Design Live Code Live View Inspect Multiscreen
Address: file:///C|/DEVELOPMENT/grammroom/www/index.html
GRAMMROOM
ABOUT
LET'S LEARN
PROPERTIES
Image, 2310K W 1057 H 1687 Src MMROOM (3)_001.png Alt FIRST PAGE

```
<html><head><style type="text/css">
body {
    background-color: #C0C;
    font-family: "Comic Sans MS", cursive;
    font-size: 36px;
}
.centre {
    text-align: center;
}
.topic {
    text-align: center;
}
.YELLOW {
    color: #000000;
}
.CENTRE {
    text-align: center;
}
.SMALL {
    font-size: x-small;
}
</style>
</head><body>
<p class="YELLOW"><span class="YELLOW"></span>GRAMMROOM </p>
<table width="100%" border="1">
```

Fig 28 : Screenshot of one of the pages in Adobe Dreamweaver that is used for authoting GRAMMROOM


DW File Edit View Insert Modify Format Commands Site Window Help
index.html*
Code Split Design Live Code Live View Inspect Multiscreen
Address: file:///C|/DEVELOPMENT/grammroom/www/index.html
GRAMMROOM
PROPERTIES
Targeted Rule body Font Comic Sans MS, cursive Size 36 px
Edit Rule CSS Panel Page Properties...

```
    <td><p>&nbsp;</p>
      <p>&nbsp;</p>
      <p>LET'S LEARN</p>
    <p>&nbsp;</p></td>
    <td>&nbsp;</td>
    <td>&nbsp;</td>
  </tr>
  <tr>
    <td><p>&nbsp;</p>
    <p>&nbsp;</p>
    <p>QUIZZES</p>
    <p>&nbsp;</p>
    <p>&nbsp;</p>
    <p>&nbsp;</p></td>
    <td>&nbsp;</td>
    <td>&nbsp;</td>
  </tr>
</tbody></table>
<img src="../../../Users/P/Desktop/GRAMMROOM (3)_001.png"
width="1057" height="1687" alt="FIRST PAGE">
<p>&nbsp;</p>
<p>&nbsp;</p>
</body></html>
```

Fig 29: Screenshot of Grammroom front page in Adobe Dreamweaver.

For the interactive exercises, the researchers create them by using Hot Potato, a software suite that includes five applications that can create exercises for the World Wide Web. The applications are JCloze, JCross, JMatch, JMix and JQuiz. All the exercise created using Hot Potato will be inserted in the respective units in GRAMMROOM. The exercises will be interactive as students can see their right or wrong answers immediately as hints and clues are also given to aid them while doing the exercises. Hot Potato provides varieties of exercises that can attract the students attention to try and test their knowledge after they finish studying certain topics. The researchers chose this user friendly software as it it easy to utilize and doesn't need any complicated coding to create the exercises.

3. Results and Discussion

After all the necessary authoring step had been completed, GRAMMROOM prototype is now ready to be evaluated and tested by the expert and the hearing impaired students .

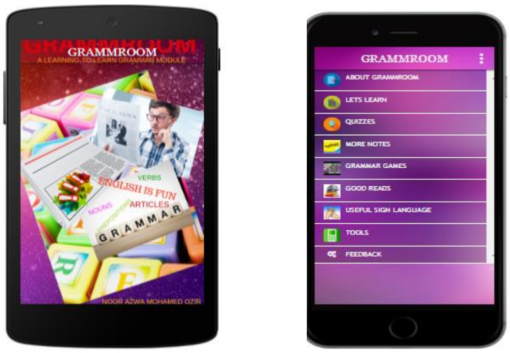
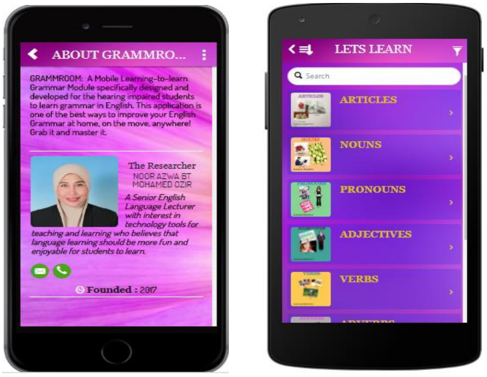


Fig 30 : GRAMMROOM splash screen and menu screen

The splash screen which indicates the researcher's name and also the application's title, GRAMMROOM, will appear when the user click the application's icon on their smartphone screen. The menu page is where users can choose the different sections or pages in GRAMMROOM namely the About Page, Let's Learn , Quizzes, More Notes, Grammar Games, Good Reads, Useful Sign Language, Tools and also the Feedback page.



GRAMMROOM: A Mobile Learning-to-learn Grammar Module specifically designed and developed for the hearing impaired students to learn grammar in English. This application is one of the best ways to improve your English Grammar at home, on the move, anywhere! Grab it and master it.

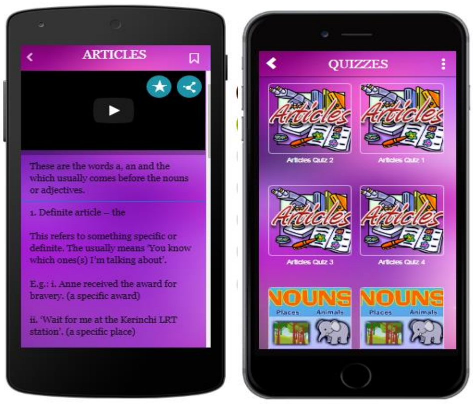
The Researcher
NOOR AZWA BT
MOHAMED OZIR

A Senior English Language Lecturer with interest in technology tools for teaching and learning who believes that language learning should be more fun and enjoyable for students to learn.

Founded : 2017

Fig 31 : GRAMMROOM about page and Let's Learn page

The about page gives a brief descriptions of GRAMMROOM and also the researcher's introduction. In the page it is stated that GRAMMROOM is a Mobile Learning-to learn Grammar Module specifically designed and developed for the hearing impaired students to learn grammar in English. The application is one of the best ways to improve their English Grammar at home, on the move or anywhere. In the Let's Learn Page, users can see all the different topics in GRAMMROOM. There are 8 grammar topics which they can scroll and master such as the Articles, Nouns, Pronouns, Adjectives, Verbs, Adverbs, Conjunctions and Preposition. All the 8 learning units in GRAMMROOM are completed with printed grammar notes and also notes in Sign Language Videos for them to enhance their grammar learning.



These are the words a, an and the which usually comes before the nouns or adjectives.

1. Definite article – the

This refers to something specific or definite. The usually means 'You know which ones(s) I'm talking about'.

E.g.: i. Anne received the award for bravery. (a specific award)

ii. 'Wait for me at the Kerinchi LRT station'. (a specific place)

Fig 32 : GRAMMROOM learning unit and Quizzes pages

Figure 32 shows the Articles topic in GRAMMROOM. Each learning unit have the printed notes where the hearing impaired can read and comprehend. There is also a sign language video pertaining to the notes where they can play and replay as many times as they wish to strengthen their understanding of each grammar topic. This is the significance difference between GRAMMROOM with other grammar applications in the market as there is not only notes but also accompanied by sign language video notes which will enhance the hearing impaired teaching and learning of basic English Grammar.

There are ample quizzes for practice pertaining to all the topics in the Grammar Module. The quizzes are designed by using the Hot Potatoes Software, and later embedded into GRAMMROOM. The Hot Potatoes suite includes six applications, enabling us to create interactive multiple-choice, short-answer, jumbled-sentence, crossword, matching/ordering and gap-fill exercises for the World Wide Web and also mobile phone application. Hot Potatoes is freeware, and we may use it for any purpose or project we like. The researchers choose to incorporate Hot Potatoes quizzes into GRAMMROOM as the quizzes are interactive and this is one of the grammar learning strategies preferred by the hearing impaired students.

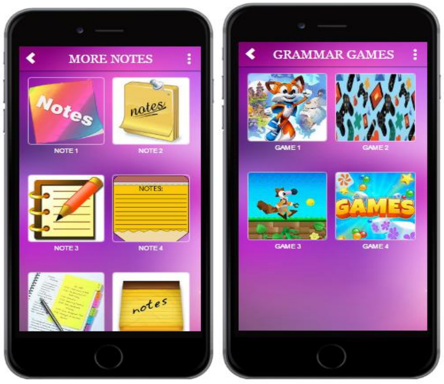


Fig 33 : More Notes and Games pages

In More Notes page, hyperlinks to more grammar notes are accessible for the students to read and comprehend thus mastering all grammar topics. This can be done once they have really understand all the topics and completed the quizzes .The notes chosen are freeware web pages and the students can benefit a lot from all the pages suggested.

In conjunction of the hearing impaired students grammar learning strategies preferred, the author also embedded links to grammar games that might interest the students to learn more grammar via these games. The needs analysis done previously showed that the option of learning grammar through games attracted a majority of 74 students or 67% of the hearing impaired respondents. This is why the researcher decided that one of the suitable contents of this mobile learning-to-learn grammar module must include grammar games.

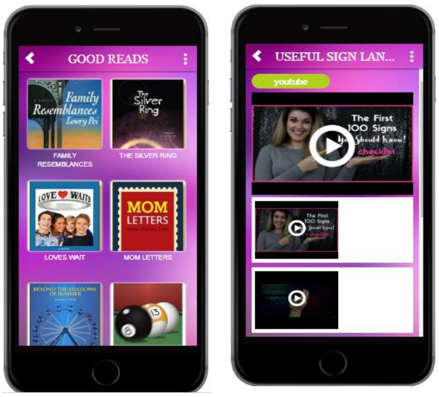


Fig 34 :Good Reads and Useful Sign Language pages

This page suggested good books for the students to read and enrich their vocabularies. The books suggested are Family Resemblances, The Silver Ring., Loves Wait, Mom Letters, Beyond The Shadows Of Summer and Momentum. All these books were selected as they contains good moral values and also average level of grammar to attract the students to read in English and improve their skills.

Those who want to learn more on sign language will benefit much from the Useful Sign Language page. Besides being handy for the hearing impaired students, GRAMMROOM can also be useful for hearing students who want to enhance their grammar too. They can also learn the sign language via all the videos embedded in GRAMMROOM .

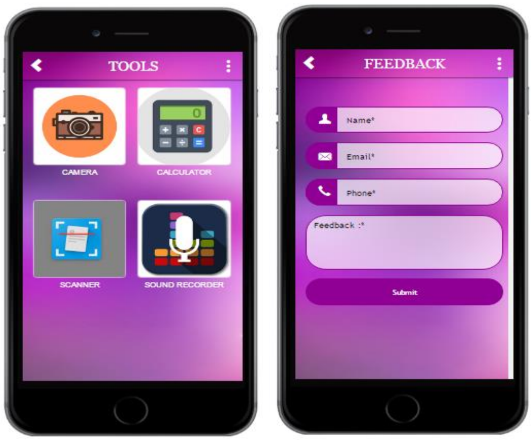


Fig 35 : Useful Tools and Feedback pages

GRAMMROOM is also equipped with some useful tools shortcuts for easy access to tools like camera, calculator, scanner and sound recorder. This can attract more students to use the application and benefit from it.

The last page in GRAMMROOM is the feedback page where the users can write their feedback regarding GRAMMROOM and submit it after filling in the necessary informations. The researcher will later get all the feedbacks via emails and necessary steps to improve GRAMMROOM can be executed from time to time. This is an ongoing evaluation and suggestions for improvement from the real users.

4. Conclusion

This paper details all the crucial steps in designing and developing GRAMMROOM, a mobile application that can be uploaded via Android smartphones for the benefits of the hearing impaired students by using Cordova Framework and all the necessary web technologies. By utilizing GRAMMROOM, the hearing impaired students will be motivated to look at grammar learning in different ways because the application is tailored for them and thus learning process is more focused to each and every individual. As instructional designers, the researchers had taken into account not only the learning objectives, but also a number of other factors, including the needs and characteristics of the learners, in this particular study, the hearing impaired students in Malaysian Polytechnics.

The development of GRAMMROOM has a few important implications for the hearing impaired and also those who are involved in their teaching and learning. The initial findings regarding the grammar learning strategies preferred and used by the hearing impaired students in Malaysian Polytechnics will shed lights to the administrators and educators of the hearing impaired students when designing the curriculum or new syllabus for English, as there will be needs for on-going improvement for these students if we want to see them competing well upon graduation. Therefore, this study is timely as the hearing impaired students in Malaysian polytechnics will have to transform into graduates with mastery of the English language and with the aid of mobile application, it is hoped that they will show improvement in their effort of mastering the language. As for the English Language lecturers in the polytechnics teaching the hearing impaired students, this development will benefit them as they need to vary their teaching materials in order for them to help the students towards the transformation of graduates as mentioned above.

Therefore, in the context of the hearing impaired in Malaysian polytechnics, having the GRAMMROOM integrated in their learning is certainly significance in adding varieties to their learning materials and helping them enhancing their grammar in English Language . However, a further study with more focus on the content of the application is therefore suggested such as adding more interactive games and organizing the notes in infographic forms which will certainly attract more interest among the hearing impaired students.

Acknowledgement

The authors acknowledge the Malaysia Ministry of Education for the Scholarship granted to pursue this study . Special thanks are also dedicated to the supervisors and Universiti Kebangsaan Malaysia (UKM) for the support, advice and guidance for this study.

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