

Primary Mathletes – Primary School Mathematics Teaching Aid Application

Final Project Report

DT282

BSc in Computer Science International

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Abstract

This project will be focusing on improving primary school teaching through the use of mobile apps. The project will consist of an app that is going to be developed with Kivy, a Python library used to create GUI elements and using Python programming, that will help primary school teachers by acting as a teaching aid for their students to improve their mathematics abilities.  
  
One issue that commonly occurs in classrooms, especially ones with a lot of students, is that no matter how slow the teacher goes, eventually they will have to move on so that they can appropriately tackle all elements of the curriculum before the end of the year. This project aims to aid the teacher and student by giving them the ability to teach the student more of the curriculum in a fun and interactive way, inside and outside of the classroom so that even if they fall behind there is a way of catching up

without taking up valuable class time.

The app will hopefully improve the grades of students who may be struggling with maths in school and prevent them from giving up once they fall behind.   
  
During the implementation of this project, research into the primary school curriculum through books was conducted as well as conversing with primary school teachers to get an idea of areas where students are struggling with the topics that come up and see if it is possible to make it more accessible to a wider range of students.

Implementation of this project was completed through python programming using Kivy to make an application that uses use the research conducted through books and online resources to create a fun, interactive and informative application that will aid both students and teachers in primary schools.

The project was initially going to be evaluated by getting in contact with a primary school teacher and asking them to use the app during their maths teaching/learning in-class and seeing is there any improvement with the use of the app. There were also other plans to get a small group of primary school students to participate in a study group to try and evaluate its usefulness but due to the sudden outbreak of Covid-19, by the time the application was ready to be tested, neither of these evaluations were possible due to the country being on lock down. Other testing methods were conducted instead, and these are discussed further within the document.

Declaration

I hereby declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

Signed:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Paul Davis

\*\*\*DATE\*\*\*

Acknowledgements

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# 1. Introduction

## Project Background

Many sources state that children, even from young ages, can learn a lot by using technology and can reinforce information already covered in their school curriculums through gamification in apps on phones or tablets. Below are articles and documents about these sources and also includes some research conducted to find what the best programming language would be to write the Primary Mathletes application using:  
  
One paper discusses the different programming environments that are available for mobile platforms such as Python, C#, and Java through Android Studio. The paper mentions *“the flexibility of Python for mobile platforms”.* [1] Originally the Primary Mathletes application was going to be developed using Android Studio which, for a lot of cases is not very user-friendly in comparison to something like Python which lets you do a lot with less code and so this is what was chosen to develop the application of this project.

Another paper discusses how the use of mobile devices such as iPads can be used by teachers to make the teaching of maths more efficient and more involved by having data stores with a piece of software on a mobile device. It found that *“pre-service and in-service teachers saw value in integrating iPads into Maths education as a tool to promote student learning”* [2] and it also discusses several mobile learning approaches and how they can affect a student’s learning positively or negatively.

Another piece speaks about how in South Africa there is limited access to PC’s in many homes but yet there are *“three million teenagers have Java enabled cell phones”*  [3] which would strongly benefit from mobile learning or m-learning applications due to the inaccessibility of web apps in that region of the world.

The final paper looked at discusses the differences between e-learning (using a PC to teach students) and m-learning (using mobile devices) such as handheld phones and tablets that are internet-enabled and how m-learning is a lot more accessible because there is no hardware limitation of PC’s because almost everyone nowadays already owns a mobile phone. This cuts the cost of textbooks and on building expensive computer rooms for students. [4]

## Project Description

Primary Mathletes is a cross-platform mobile application aimed at primary school students and their teachers to help reinforce their learning of the primary school mathematics curriculum. It provides fun, interactive minigames based off the third class maths curriculum focusing on simple operators: addition, subtraction, multiplication and division, all following the learning outcomes put in place by the Irish Department of Education.

The application is split up into two different modes: a student mode and a teacher mode. In the student mode, students will be able to register, login, play minigames, join teacher-created virtual classrooms and view weekly progress reports showing improvements over previous weeks.  
The teacher mode will allow the same functionality as the student mode but they also have the ability to create a virtual classroom that students then join and the teacher can then view all of their students weekly progress in one place. Both modes allow for progress reports to be sent to a user selected email account so, if parents are concerned with their children’s progress within the application they can be notified at the click of a button.

Following a similar structure to Duolingo (shown in figure \*\*\*\*), an application some primary students may already be familiar with, students will earn experience points for whatever operator they are currently playing in and through these points the student will unlock increasingly more difficult levels relating to the current operator. The students will be unable to play more difficult levels until they have first completed all levels leading up to the one they are attempting to complete to ensure that they don’t accidentally throw themselves into the deep end of learning. This gamification of learning will hopefully keep students engaged with the application and therefore will also increase the student’s retention of information for this operator.

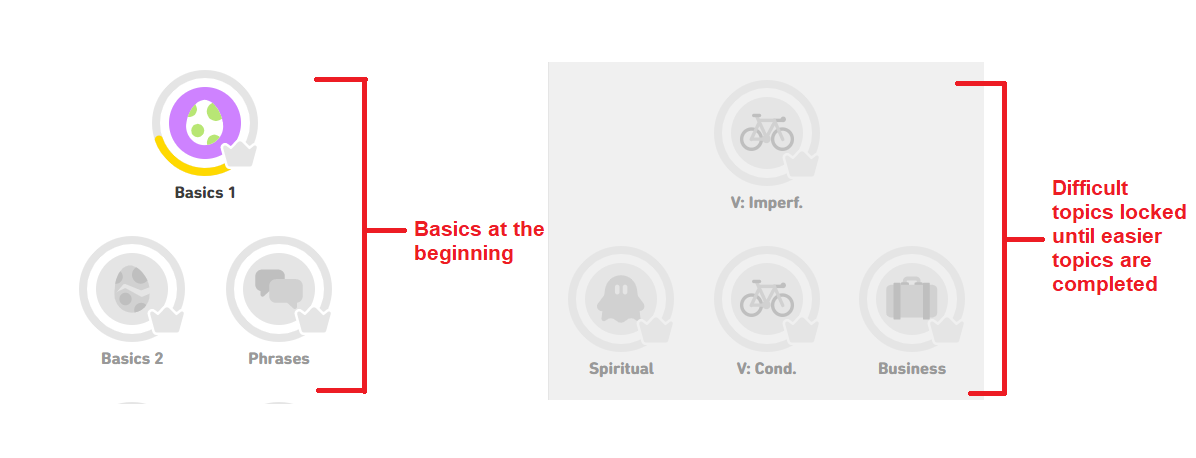


Figure 2 Comparison of easy and difficult topics on Duolingo

The application was originally going to be tested in a few different ways: through black box testing which involved handing over the application to primary school students in a small group and record their thoughts and suggestions before redeveloping the application before the end of the project deadline but this was not possible due to the recent, sudden outbreak of Covid-19. While some black box testing was still possible under the circumstances, the original plan was not executed and so the redevelopment segment of this project fell short of what was planned. The other form of testing, white box testing, was conducted throughout development by myself to ensure that all individual parts of the application worked separately before being integrated into the full app. Unfortunately for reasons expanded upon later in the document, it is currently only possible to run the mobile application on both android and iOS emulators and not physically on mobile devices (**see section \*\*\*\***).

## Project Aims and Objectives

The overall aim of the project is to help aid primary school students and teachers to improve the students understanding of the maths curriculum.

The goal for the project is to create a mobile application that will be used by primary school students that will include minigames and helpful maths-related topics that will improve their overall understanding of the primary school maths curriculum.

Milestones are outlined in the GANTT chart that will be seen later in the report (Section 6). This was created to ensure that targets were set and completed (or at least attempted to be completed) within their given timeframe so that the project would be completed on or before the due date.

The purpose of the project is to see if it is possible to create an application that could be used by primary schools and in turn, would improve the understanding of all students that are studying third class mathematics. The project would be considered a success if the application could be used by these students and when asked of their opinion, had it improved their maths abilities by some amount.

## Project Scope

Maths is one of the most hit or miss subjects that are tackled in any level of schooling whether it be primary, secondary or third-level education. The student either knows the answers or they don’t. So, because of this, there is a market for something that can come away from traditional learning on paper and through verbal teaching and gamify the process of learning to the point where it doesn’t feel like learning anymore. With something like maths where there are definitive answers to everything, some students struggle with finding the right process to arrive at these answers. Some students don’t enjoy traditional methods of learning and they may lose interest in class which will lead to them falling behind. Even though they could be a hyper-intelligent person, the method in which they learn can throw them off reaching their true level of knowledge.

The application could be expanded to include a huge range of information but for the scope of this project the functionality and educational content will be limited to a small sub section of the primary school mathematics curriculum. The app will be aimed towards third class students and focusing on basic operators: addition, subtraction, multiplication and division. The reason for choosing this section of the third class curriculum is because it is the first time students in primary schools actually begin using numbers and operators whereas before this in first and second class the curriculum focused more on basic counting and recognition of shapes and other things not really related to arithmetic so it was decided this would be a good starting point and in future the application could be further expanded to include educational treatment for all of the primary school curriculum.

## Thesis Roadmap

**Research**

This section explores background research conducted on apps similar to the one being developed in this project and also research conducted on papers that outline positive and negative aspects of m-learning (mobile learning) and the benefits of using certain programming languages over others when developing an interactive application for younger students.

**Design**

This section includes use-cases and personas related to the application, a detailed description of the architecture used and testing plans for the application.

**Development**

This section delves deeper into the development process of the system that was outlined in the design chapter and will also include challenges that became apparent throughout the development of the application.

**Testing and Evaluation**

This section describes all of the testing and evaluation of the system that was executed. Each part of the testing is described in detail and will have a detailed report of user feedback received during the user’s evaluation of the application.

**Redevelopment**

This section will outline some of the development steps taken as a result of the feedback gained from the user evaluation. The changes made and the importance of these changes will be examined.

**Conclusions and Future Work**

This section will reflect on the entirety of the project and will discuss the conclusions drawn, personal reflections made, and the future work planned for the project.

# 2. Literature Review

## 2.1. Introduction

In this section, applications and websites that are similar to the application being developed in this project will be explored as well as why these other applications are not the be-all and end-all solution to the problem that this project is trying to solve. Additional research on exactly what students and teachers want and need from an app such as this will be conducted. Technologies researched and also a review of two previous computer science dissertations will be created.

## 2.2. Alternative Existing Solutions to The Problem

**AB maths for Apple iOS:**

This app wasn’t developed specifically for Irish primary school maths students, but it seems to have a lot of general maths content behind paywalls for around 90% of the content.[12] The free content that is available shows a similar structure to one of my original ideas for minigames that can be seen in the image shown below along-side a paper prototype and wireframe created for this specific minigame.

|  |  |  |
| --- | --- | --- |
| Figure AB Maths minigame | Figure Minigame paper prototype | Figure Minigame wireframe |

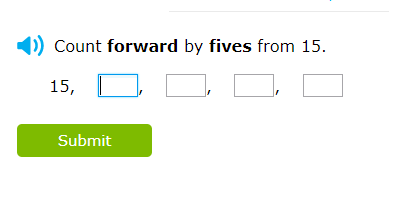
**Mathematics Skill Builder Primary for iOS:**

Opposite to AB Maths mentioned above, this app actually was developed for primary school maths students, but it is very outdated and cartoonish.[13] It also seems to deal with topics that could be deemed too easy for primary school students. Examples of this are challenges where a student needs to pick which number is bigger than the other, pick what shape is mentioned etc. Examples of this can be seen in the images below.

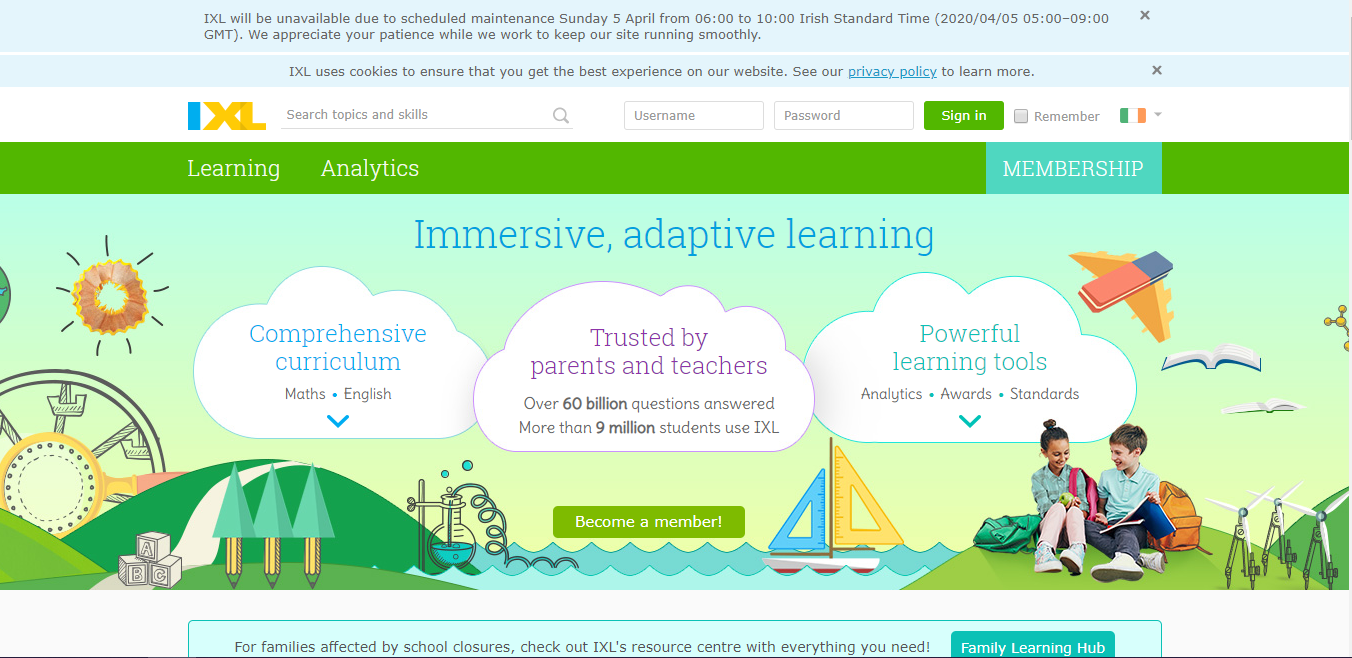
|  |  |
| --- | --- |
|  |  |
| *Figure #: Mathematics skill builders primary homepage* | *Figure #: Skill builder primary basic question example* |

**ixl.ie website:**

This website has hundreds of different quizzes that are developed around the different years of curriculum for Irish primary school students.[14] The screenshot in figure **\*\*FIND FIGURE NUMBER\*** shows a nice, clean minigame found on the website but looking at the screenshot in figure **\*FIND FIGURE NUMBER \*** can seem like a bit of a sensory overload with all of the text which may be off putting to students visiting the website for the first time. The application created for the Primary Mathletes project has a clean and simple design with few options so that younger students don’t get confused when interacting with it, especially for the first time.



*Figure #: ixl example question*



*Figure #: IXL Home Page*

All of the apps and websites mentioned above are definitely in the same vein as the Primary Mathletes application created for this project. Whether these apps are too basic, outdated or too cluttered, there seems to be room for improvement in many aspects such as content and user experience through sound, imagery, simplicity and interactability.

## 2.3. Technologies Researched

Quite a few programming languages were looked at in addition to all the programs and languages that were studied throughout the last three years of computer science.

Firstly, some research went into web-based applications using HTML, CSS, PHP and JavaScript but in the end, this was ruled out because after some conversations with primary school students and teachers it became clear that there is almost never enough working desktop computers available for primary school students in their schools but most schools nowadays have access to tablets whether they’re Android or iOS.[15][16][17][18]

Some research also went into using Java [19] and the Android Studios IDE [20] because in 3rd year of computer science there is a module on mobile app development using both of these and creating an application using something already studied would be easier than learning a new programming language and IDE but after completing this module with a low grade it was evident that Android Studios would not be the ideal choice for this project. It is difficult to use and is not very forgiving when something goes wrong. Hard to understand error messages also makes the IDE difficult to work with.  
In the 4th year of the computer science course, there are many modules that use Python. Researching Python led to the discovery of a plethora of resources for the language and this is where the Kivy library for Python was discovered. The Kivy library can be used to create GUIs based on Python code which is great because Python is very easy to use and there is a lot of great resources online for Kivy as well. Kivy also allows for cross-platform development which is perfect for this project because not every primary school student has access to predominantly iOS or predominantly Android phones or tablets.

For databases, some research went into using either a local SQL database that would store the user’s data locally but this led to problems such as if a student lost his or her phone then all of their progress would also be lost. [21] There was also an issue of the teacher not being able to access the child’s progress reports without going onto the student’s device manually.

In the end, Google’s Firebase Database System was chosen because this means that any user can access their account just by logging in on any random device, it doesn’t need to be their own personal device and also makes things like progress analytics easier for students.

Some research also went in to what it would take to compile this projects application into a useable APK or API file so that it could be used on mobile devices. The only option currently available to compile Kivy projects is Buildozer which proved to be very difficult to use. Further details on this will be discussed later on in the project document.

## 2.4. Technologies Used

Many pieces of technology were used in combination to create this entire project and these will be discussed briefly below.

**Python**

The Python programming language was chosen because of its easy usability and multitude of resources and tutorials found online.

**Google’s Firebase Database:**

The Firebase system was chosen because of the ability to connect to the Python code using its own Python library and because it allows users to access their accounts no matter what device they are on without having to set up any complicated MySQL databases.

**Kivy library:**

The Kivy library was chosen because it allows for easy-to-setup GUIs and it allows for cross-platform development.

**Various other Python Libraries:**

Other python libraries were used to do various things such as: keep track of the time, allow import of sounds to the project, create popups for errors and displaying other pieces of information, creating an SMTP link to a Gmail account used to send weekly reports to users etc.

**Pycharm IDE:**

Pycharm was chosen because it is easy to use and because it offers suggestions when coding that makes creating readable and concise code more efficient. It also has a built-in virtual device that can be resized to test different screen sizes.[]

**JSFiddle.net:**

After working outside of college on a different project I became quite confident in my JavaScript programming and so I used JSFiddle to create the first draft of the algorithm that I would later use in the minigame portion of the project. After it was tested and I was happy it worked, I converted it into Python code.[]

**Github:**

I used Github to back up my project whenever I implemented anything new in case I needed to revert back to a previous version of the code that I was confident that worked and also in case my laptop crashed and I lost my files I could pull them from Github from another device but thankfully this didn’t happen.[]

**Windows 10:**

General functionality and programs of the operating system I have on my laptop were used daily throughout the development of the application such as: calculator, windows media player etc.

**Airtable:**

Late in the development of the application and before I started testing, I began using Airtable to document any bugs I found or small things I had forgotten to add in that would benefit the app.[]

**Microsoft Office:**

Throughout the development of this project I used different aspects of Microsoft Office for different things, some of these include:

- Using Word to write down any ideas I had whether they were about the dissertation, the application or just thoughts I had that might be useful for me to read later.

- Using Excel to create the GANTT chart seen further on in the document

- Using PowerPoint to create presentations for the interim and final demo of the application and project.

**Trello:**

Throughout development I used Trello to keep track off all of the individual parts of the application that needed to be developed as well as deadlines for certain aspects of the project.

**GIMP (GNU Image Manipulation Program):**

This program was used to create all of the image assets found within the application including: button backgrounds, correct and incorrect answer face images, the logo, back buttons etc.

**Audacity:**

This program was used to edit and change file formats of the sound files for the application.

**Wireframe.cc:**

This website was used to create quick mock-up versions of some of the pages that would eventually be implemented into the application with Kivy.

**StarUML:**

This program was used to create the use case and entity relationship diagrams for the project.

**Draw.io:**

This website was used to create system tier diagrams.

**Python IDLE:**

After finishing the JS version of the minigame diagram I then converted it into Python using the IDLE so that I could test it worked on its own before implementing it with the rest of the application.

**Social Media:**

Initially, social media platforms were used for me to connect with primary school teachers to get their input during the ideation phase of the project to see what was actually necessary for this application to be successful. It was also used later on in the testing phase that will be discussed further on in the document.

**Buildozer:**

Buildozer was used to compile the project into an APK for use on android devices. To use Buildozer it was also necessary to use Virtual Box to set up a virtual version of Linux 18.04 as currently Buildozer is only usable on Linux.

**Gmail:**

An email address was set up with Google to send reports to users on request

## 2.5. Other Research Conducted

Apart from the other research mentioned in this section there was some other research conducted and these are discussed below:

- Twinkl: This website has a lot of resources, both for primary and secondary students as well as teachers. It allows teachers to create plans for their students and children to follow based on the curriculum given. [22]

- Transum Maths: This website has resources for both students and teachers, but it is not tailored to the Irish primary maths curriculum but instead for the British GCSE’s. [23]

- NCCA Maths Development: This website provides information on the development of the new Primary Mathematics Curriculum. [24]

- NRich Maths: This website provides problem-solving questions that help to reinforce things that students have learned after they finish a section of the curriculum. [25]

Below is a short document that I sent to some primary school teachers that contained a revised version of the Abstract and Section 1 of this report just to give an overview of the idea for the project, along with a short questionnaire that can also be seen below:

**Your Input:  
1. [a] Do you think the app could be useful for you as a primary teacher?**  
**[b] Would students use it?  
2. Do you think there are any problems with the idea and if so, what do you think could be done to correct them?  
3. Do you know of any resources (websites, books or both) that I could look into to access the curriculum for primary school maths?  
4. What form of devices are primary school students most comfortable with? (e.g Desktop Computer, Laptop, iPad/Tablet, mobile phone)  
5. Off the top of your head do you think there is any other kind of minigame-Esque questions that would be helpful (and hopefully fun) to engage students more with the app?  
6. [a] Do you think to have a section of the app dedicated to times tables would be worthwhile creating?  
[b] Is there anything else in the same vein as this idea that you think could be essential to have in the app?  
7. Is there a specific age the app should NOT be aimed at (junior, senior, 1st class)? Is there any point in targeting students this young?  
8. Do you have any suggestions for the name of this app?  
9. Can you think of any ideas that would keep the students more engaged in the app?  
10. Are there any common difficulties students have with maths that I could address with the app?  
Other Suggestions & Additional Feedback?**

A few days after this questionnaire was sent to the teachers, responses began coming back and the collective document below was created. It gathers all the key wants and needs that an application like the one developed for this project should have based on the teacher's feedback:  
  
**Things noted after speaking to primary school teachers about the app:  
- Most primary school students nowadays are happy to use tablets/iPads. (steering away from desktop computers and laptops depending on schools)  
- Most primary schools have poor internet connection so the ability to use the app without an internet connection is preferred but not essential.  
- The app could be used for assessment as a group in the classroom after finishing a section of the curriculum. (Work on seeding so every student in the class gets the same exam questions)  
- Primary school curriculum:**

**• Twinkl  
• Transum Maths  
• Curriculum online [26]  
• Haylock maths for primary teachers [27]  
• Folens online [28]  
• SEN [29]  
• NCCA Mathematics curriculum online  
• Mental Maths [30]  
• NZ maths [31]  
• Bee Bots (for teaching directions) [32]**

**- Maths Tables section of the app would be good.  
- Tooltips / Glossary for what certain keywords mean.  
- App should be aimed for 2nd class and over but some have said even junior infants would benefit.  
- To help with engagement:**

**• Bright/contrasting colours  
• Badges  
• Hierarchical system that gets more difficult as you go along  
• Positive praise  
• Good sound design for correct and incorrect answers   
• Pictures  
• Points system  
• Allow them to create their own avatar/upload an image**

**- The app would benefit teachers in terms of more advanced children, the teacher can assign additional work for students that are abler when it comes to maths.  
- It would also allow teachers to assign additional work to students who are struggling so that they could catch up.  
- The addition of an app into the student’s life would be a breath of fresh air and help with engagement in class.  
- Mini-game ideas:**

**• Odd-One-Out  
• Matching Games  
• Time trial mode / Beat the clock  
• NRich maths online (problem-solving questions)  
• ixl.ie (online quizzes for Irish maths curriculum)  
• Word problems**

**- Not every student would be provided an iPad/tablet to use on their own so group activities might be necessary, but this is an issue for the school rather than for the development of the app.  
- Combine all curriculum strands to make quizzes at the end of each section.  
- Users should be able to see a graph of the user's progress at the end of the week/month/year/all time.**

All of this information was taken on board when development began on the application but a lot of the things that the teachers mentioned such as graphs and a multitude of minigames were outside the scope of this project.

## 2.6. Existing Final Year Projects

## 2.7. Conclusions

In this section, some previous final year projects that students had written were reviewed. Some additional research conducted through questionnaires and conversations with current primary school teachers was discussed as well as a few websites that have primary school curriculum information. Applications other people have already created that attempt to help primary school students and other students of similar age with the maths curriculum were discussed. Programming languages, databases and APIs were researched and decided upon that best-suited development of the application and a full list of all programs/technologies used throughout the project were listed along with their functionalities and why they were important to the development of the app and project as a whole.

# 3. Experiment Design

## 3.1 Introduction

In this section, some common software methodologies are discussed, followed by a description of the one finally decided upon and why and how this decision was made. There is also a thorough overview of the system and an explanation of the front, middle and back tier of the three-tier system implemented for the design of this project.

## 3.2. Software Methodology

Scrum –

Scrum [33] is a methodology that is comprised of five values: commitment, courage, focus, openness, and respect. It usually involves someone taking over the role of scrum master who organizes daily stand-ups and points out places in the development team where there may be blockages and see can they be removed in one way or another. It also involves doing weekly or bi-weekly sprints which are fast and efficient pushes of work on one particular task over a short period of time. After this is finished there is a sprint review and retrospective, where lessons are created that, will ensure that sprints that follow the last will always be more efficient than the last. Scrum is a methodology that is usually used when working with a team on a project but due to the fact that this is a solo project, it did not seem like it would really be a suitable choice for this project.

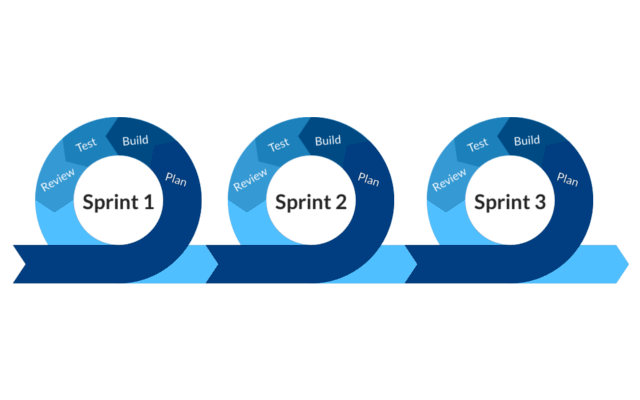


Figure 7 Sprints lifecycle as part of the Scrum Methodology

Agile –

Agile [34] is one of the most famous and recognizable project management methodologies. It was developed by industry leaders that wanted to uncover better ways of developing software by having clear and measurable goals that take into consideration iterative development. It is made up of 4 fundamental values and 12 key principles. Some of the main features include having working code over comprehensive documentation, responding to change over following a set-in-stone plan and being simplistic. I decided not to use Agile but instead opted for a subsection of Agile which can be read below.

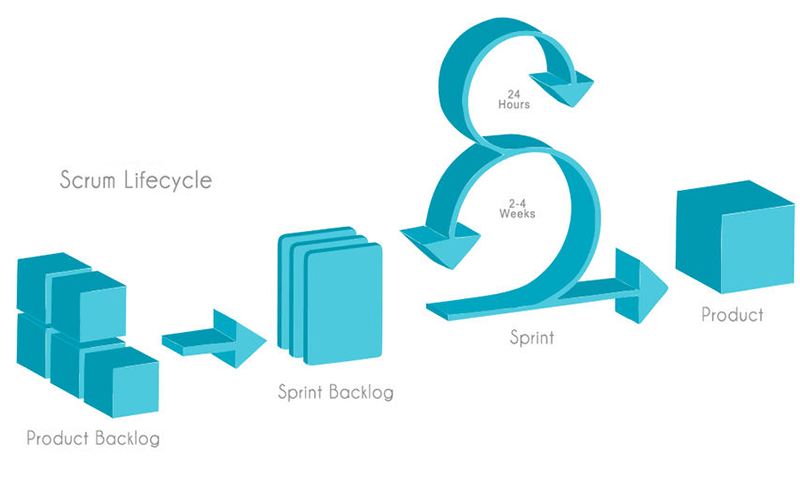


Figure 8 Scrum lifecycle as part of the Agile Methodology

Kanban Methodology –

A Kanban board is one version of the Kanban project management methodology [35] that is used to keep track of tasks to be done during a project. It is a subsection of the Agile approach to project management and they are used to visualize workflow for a given period of time and helped me a lot throughout the progression of the project as it let me add items to the backlog whenever I thought of something that I may have forgotten to add earlier or a new idea that I thought would make a good addition to the project.

**Trello:**  
The image below shows how I used Trello [36] as my Kanban board for the project. Each task is given its own card and was initially placed into the backlog list. The structure of the Trello board allowed me to pick one task at a time and work on it until it was finished, then it was either added to the “testing” list or the “completed” list depending on whether it was a programming task or just a researching or writing task.

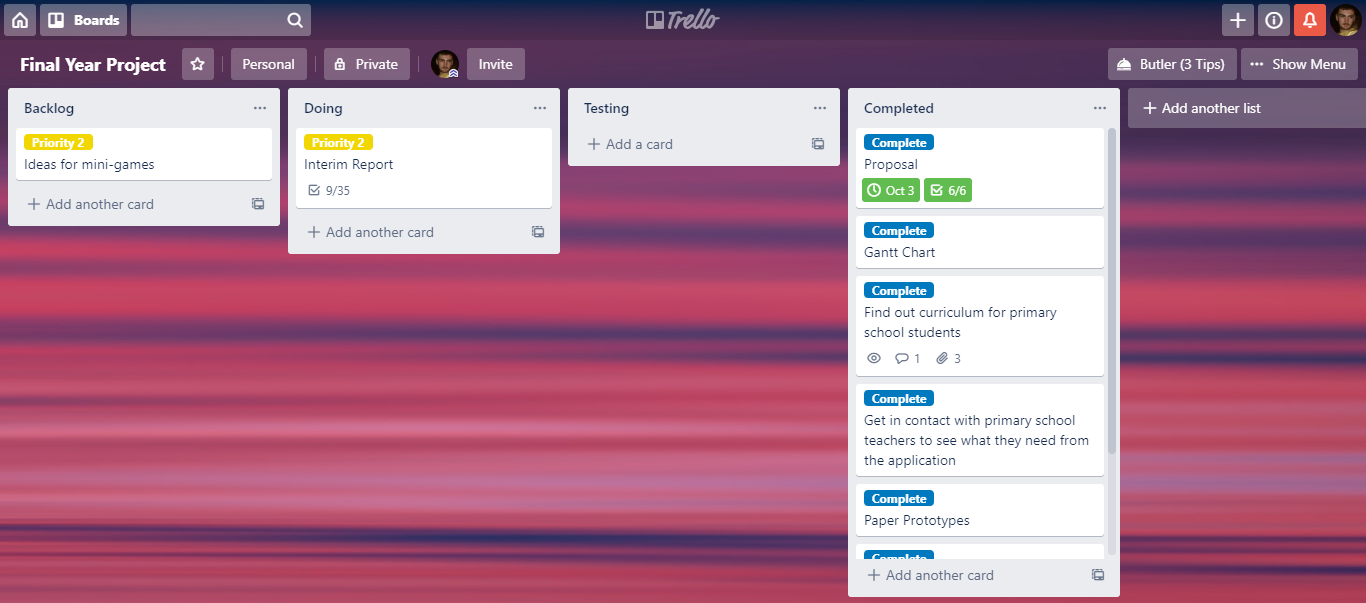


Figure 9 Project Trello board

Below, you can see what is inside of the cards themselves. Usually inside a card there would be a breakdown of all the working parts that need to be completed for the overall task to be finished. Normally I would create a checklist like you see in the image below but I also have cards where I have added useful links to pages I have researched added to the card themselves, as well as comments and descriptions that would aid me in completing the task to the best of my ability.  
By adding comments and checklists to the cards it helped to visualize the tasks that needed to be complete without cluttering the overall Trello board with hundreds of small tasks that could all be grouped into one card anyway.

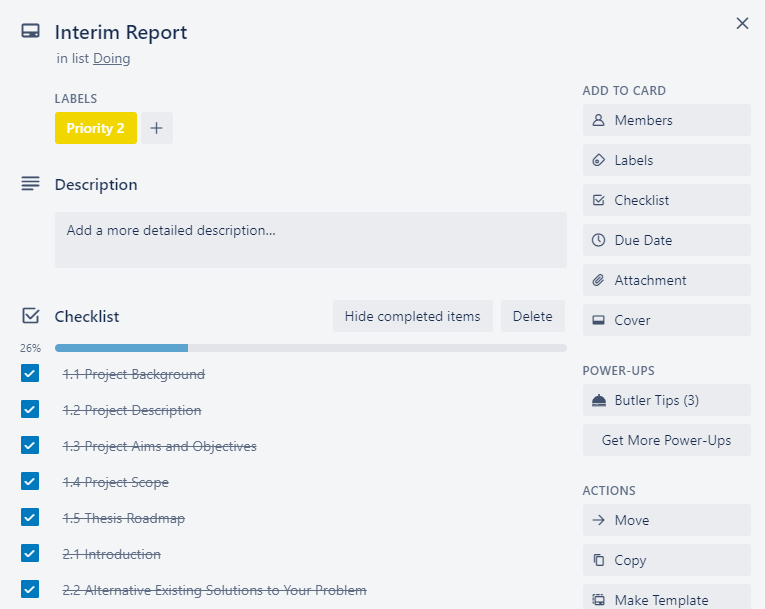
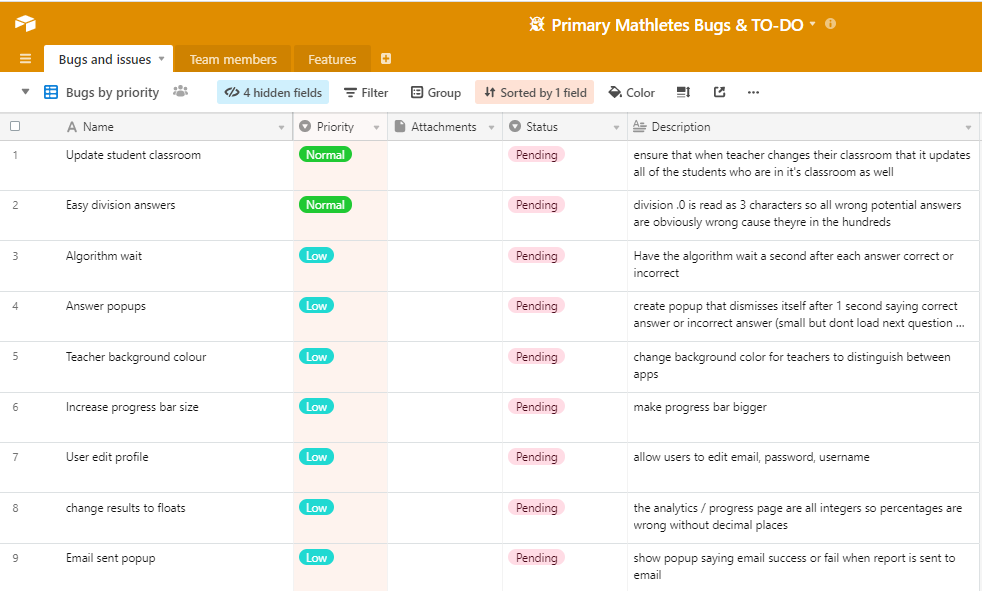


Figure 10 Card details for Interim Report

**Airtable:**

Airtable is another example of a Kanban board and the one seen in Figure \*\*\*\* below shows the one that I used as a bug list while I was personally testing that everything worked after initial development was finished on the app.



After researching these methodologies, it was an easy decision to adopt the Kanban board and use Trello to keep track of the overall project and then to use Airtable as another means of organization to hold all the information I had for bugs and small programming tasks that had not been implemented yet.

## 3.3. Overview of System

In figure \*\*\*\* you can see the proposed three-tier system diagram that was created earlier in the academic year. It includes both android and iOS mobile devices and in figure \*\*\* you can see a simple technical architecture diagram of the application.

Tier one of the system will be everything that the end user sees from the login screen to the minigames, the progress page and everything else shown on the mobile device.  
Tier two of the system is all of the code written in Python that creates these screens that the end user sees as well as the code that connects to the database that holds all of the users information for use within the app.  
Tier three of the system is the database that holds all of the information that can be accessed by any user on any device. It holds a table of all the users including their overall experience points in all of the operators, their login details, whether they are a teacher or not and whether they are in a classroom or not. It also holds information about the classrooms themselves which lets any user anywhere join a classroom.

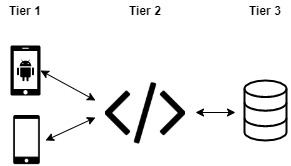


Figure 11 Three-Tier System

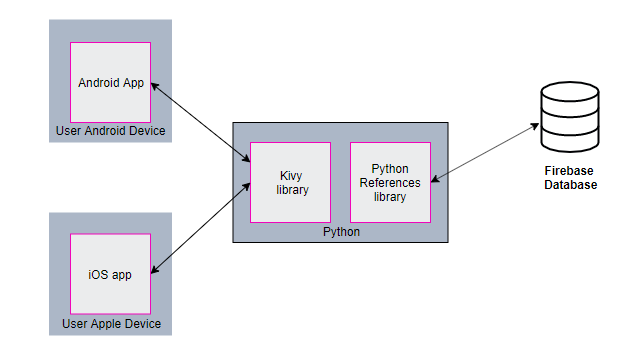


Figure 12 Technical Architecture Diagram

## 3.4. Software Test plan

## 3.5. Front-End

## 3.6. Middle-Tier

## 3.7. Back-End

## 3.8. Conclusions

# 4. Experiment Development

## 4.1. Introduction

## 4.2. Software Development

## 4.3. Front-End

## 4.4. Middle-Tier

## 4.5. Back-End

## 4.6. Conclusions

# 5. Evaluation

## 5.1. Introduction

## 5.2. Software Evaluation

## 5.3. Specific Evaluation

## 5.4. Questionnaires and Interviews Evaluation

## 5.5. Conclusions

# 6. Conclusions and Future Work

## 6.1. Introduction

## 6.2. Conclusions

## 6.3. Future Work

As seen in section ***\*find section with airtable in it \****Airtable was used to document any bugs that were found while testing and there are still a number of low to normal level bugs that were found too late in the testing phase to be fixed. The application still runs with these issues present but they are quality of life fixes that would be beneficial to implement. When providing an application to younger students it would be especially important to integrate aspects such as having the minigame wait a second after each correct or incorrect answer to guard the user from miss-clicking the next answer straight away, which is a possibility in the current state of the application so this would be one of the first things to be fixed in the future.

In the future it would also be necessary to come up with a different system for storing the users data. The firebase database that is used currently in this project works but as seen in the ***\*section where the fact that the app doesn’t compile because of firebase is mentioned\**** section, it was not possible to compile this project into a useable APK for android or IPA for iOS due to the inclusion of the Firebase library which is not supported by Buildozer for some reason. Due to this, turning the application into a web application and developing a Django database using MySQL or Oracle might not be a bad idea in the future because even if this project did compile with the Firebase library, their pricing plans are pretty expensive when scaling up with more and more users using the application.

Creating more minigames would be vital to the future success of this project as only having a single type of question that can be asked gets repetitive quite quickly. The addition of more minigames alongside additional educational content from the curriculum outside of basic operators would not only benefit the users currently targeted by this project (3rd class primary students) but could also be scaled up and down to include the entire curriculum needed to teach all primary school students from 1st to 6th class.

Other smaller and quicker additions to the application could be made, such as an improved experience system. The one implemented at the moment can be exploited easily by spamming any of the potential answer buttons and, if the user is lucky, no matter what questions they answer they will still end up gaining experience points that will eventually unlock all of the levels available in the game without ever actually learning anything. Such exploits could be detrimental to the success of the application in the future. Bringing the minigame system that Duolingo uses into the Primary Mathletes system may be beneficial, this is where if a user gets three questions wrong in any given minigame they are automatically kicked out of the minigame with 0 experience points gained so users are forced to think about the answers they are giving and not just mindlessly pressing buttons until they unlock all of the available levels.

Another small feature that could be implemented but that would be very beneficial to teachers using the application as a supplemental teaching aid is seeding. This would involve giving out a seed for every “random” set of questions that could be copied and sent out to each student so that they would all receive the same set of random questions at the same time so that the teacher could observe whether the majority of their class actually has knowledge about recently studied aspects of the curriculum or whether the teacher needs to revisit these sections again.

With more time and effort, I think that this application could be put out into the world and be used by teachers, parents and students to improve retention of mathematical information. With the recent outbreak of Covid-19, it has become apparent that an application like the one developed for this project could actually be very useful in times where students are unable to attend a physical classroom for whatever reason they might have, whether that be an illness or even a nationwide quarantine. With further input from actual primary school teachers to ensure the implementation of proper educational information is being presented to the students, as well as more development on the minigames to include different aspects of the curriculum, it would be very possible for the application to be used as an alternative to reading numbers from a book and instead turning it into an interactive and fun learning experience that could result in further knowledge being gained overall.

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