

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:

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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

## 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 4 AB Maths minigame | Figure 5 Minigame paper prototype | Figure 6 Minigame wireframe |

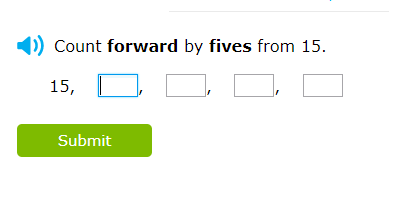
**Mathematics Skill Builder Primary for iOS:**

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.

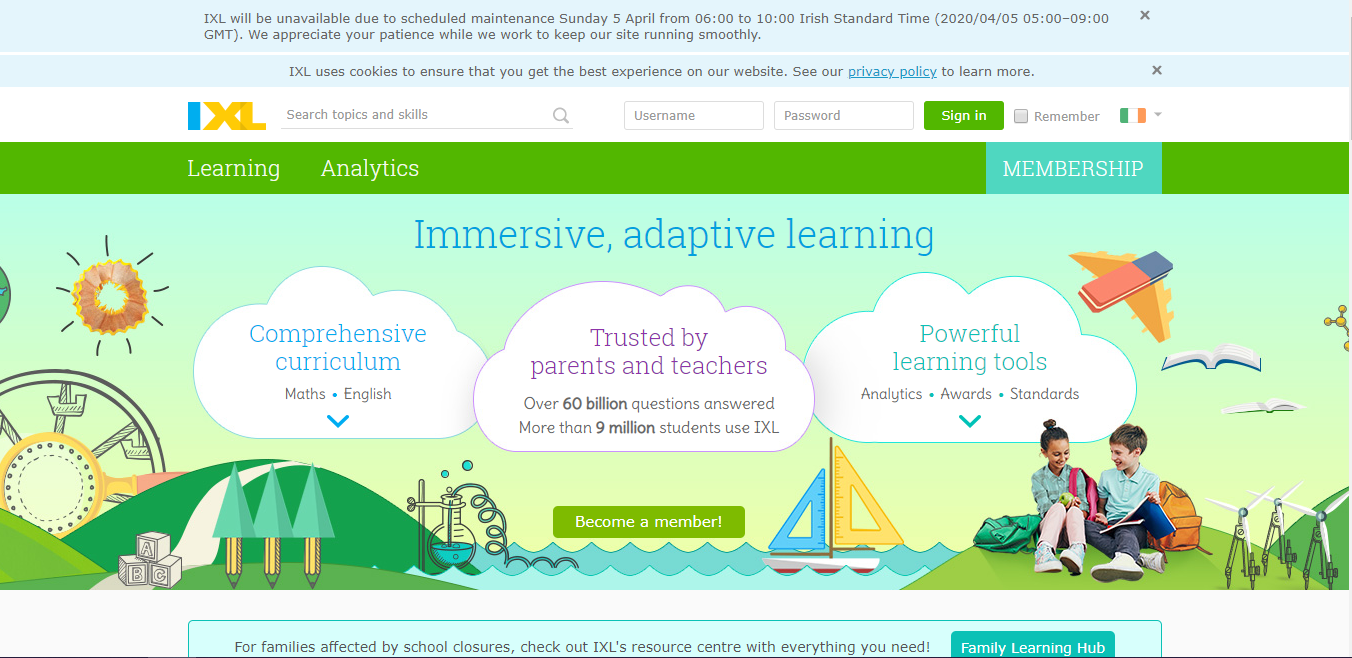
|  |  |
| --- | --- |
|  |  |
| *Figure #: Mathematics skill builders primary homepage* | *Figure #: Skill builder primary basic question example* |

**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

## 2.5. Existing Final Year Projects

## 2.6. Conclusions

# 3. Experiment Design

## 3.1 Introduction

## 3.2. Software Design

## 3.3. Software Test plan

## 3.4. Front-End

## 3.5. Middle-Tier

## 3.6. Back-End

## 3.7. Conclusions

# 4. Experiment Development

## 4.1. Introduction

## 4.2. Software Development

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## 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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