
The Art of Computer Programming – A difficult book to understand

Donald Knuth

Dennis Ritchie

B.Sc.(Hons) in Software Development

APRIL 15, 2016

Final Year Project

Advised by: Dr Alan Turing

Department of Computer Science and Applied Physics
Galway-Mayo Institute of Technology (GMIT)



Contents

1	Introduction	5
2	Context	6
2.1	OBJECTIVES	6
2.2	SECTIONS OF THE PROJECT	6
2.2.1	Explore	6
2.2.2	Learn Irish	7
2.2.3	Create and Play	7
2.2.4	Ocean Facts	7
2.3	URL- LINK TO GITHUB	7
3	Methodology	8
3.1	APPROACH (AGILE)	8
3.2	TESTING AND VALIDATION	9
3.2.1	Downloaded the android SDK:	9
3.2.2	Testing the database	10
3.3	SELECTION OF PLATFORM, LANGUAGE, TECHNOLOGIES	10
3.3.1	Ionic	10
3.3.2	Unity	11
3.4	USING GIT	11
4	Technology Review	13
4.1	XML	13
5	System Design	14
5.1	Create and Play	14
5.2	Learn Irish	15
5.3	Ocean Facts	15
5.4	Explore	17
5.5	Database and uploading software/Additional Diagrams	17

<i>CONTENTS</i>	3
6 System Evaluation	18
6.1 TESTING AND ROBUSTNESS	19
6.2 PERFORMANCE BENCHMARKS	20
6.2.1 Determine what to Benchmark	20
6.2.2 Defining the Measures and Solutions	20
6.2.3 Comparing – Outcomes against Objectives	21
6.2.4 Limitations	24
6.2.5 Opportunities	24
7 Conclusion	26
7.1 PERSONAL THOUGHTS/HOW THIS PROJECT HELPED IS PERSONALLY	27
7.1.1 ALINA Danci	27
7.1.2 Diarmuid Byrne	28
7.1.3 John Lavin	28

About this project

Abstract A brief description of what the project is, in about two-hundred and fifty words.

Authors Alina Danci, Diarmuid Byrne, John Lavin.

Chapter 1

Introduction

“Captain Cillian” is a standalone mobile application based on a series of children’s books of the same name. The application is comprised of interactive, educational pages for children to enjoy. The app should be free to download from the corresponding Application Store. The software is designed to be used with both touch devices and keyboard/mouse to maximize user base and ease-of-use for its audience. This is an ongoing project. This project was recently managed and created by Alina Danci and Dennis O’Neill. Dennis decided to move courses in forth year and therefore was taken of the project. Alina continued this project onto forth year with two new co-workers John Lavin and Diarmuid Byrne. [1]

Chapter 2

Context

2.1 OBJECTIVES

- The project was put back into production due to some requests the client had for the application and were not met:
- The previous application was created on a Windows phone platform. Therefore not reaching the clients needs.
- The client wants an application that can be cross platform that would be able to reach more audience.
- The client also wants more quality and less quantity.
- The client changed her mind about displaying content of the books in the app and now wants the image of the books displayed with a link to her website where they can be purchased.
- The client changed the main headings of the application. These have to be updated from Create to Create and Play, from Fun to Ocean Facts, from Learn to Learn Irish and Explore remains at the same heading.

2.2 SECTIONS OF THE PROJECT

2.2.1 Explore

The explore section will draw heavily from content within the books, as selecting explore from the main menu will provide another menu displaying the different book covers. Clicking each cover will bring you to the website where you can buy the books online.

2.2.2 Learn Irish

This section will focus on familiarizing the users with common Irish words and phrases. It will consist of a “match-up” game where multiple Irish words or short phrases are given on a grid layout, and must be matched to a corresponding pictures/icons. The grids are 4x4, or 4x5 but are shown below as 3x3 for easier illustrative purposes.

2.2.3 Create and Play

Write a story allows the user to create their own storyboards, by supplying them with a background scene and sprites on a navigation bar at the side of the screen. You can drag and drop icons, zoom them in or out as you please, you can also type in a little story about what you have created.

2.2.4 Ocean Facts

The Ocean Facts section draws from the theme of sailing with Captain Cillian. The scenes contains a puzzle game Pick and place the puzzle piece. On the side of the puzzle there will be a fact displayed about puzzle you just created. This is a new way of learning facts while also having fun.

2.3 URL- LINK TO GITHUB

1 <https://github.com/AliLigi/ProjectDocumentation> - This link will bring you to the place where our documentation is stored. We decided to create two different repositories because the amount of information was too large to fit into one github repository. This repository holds the Specification that we did at the start of the year for the client, it also holds the previous documentation from 3rd year and other planning documents and information that was important to add to the project.

2 <https://github.com/DiarmuidByrne/Captain-Cillian> - This repository stores the code that we put together, this will display the final code. Each team member forked this project and updated on the section they were working on.

Chapter 3

Methodology

This section contains the choices we have made as a group to make this project to the best of our abilities. It will clearly articulate the reasons why we chose the particular procedures or techniques below.

3.1 APPROACH (AGILE)

How did we choose this approach? How did we envision this agile approach?

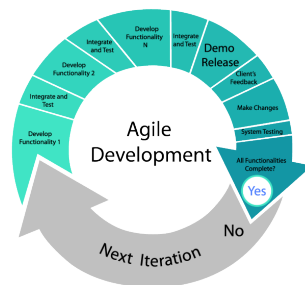


Figure 3.1: Agile process diagram.

“Agile development methodology provides opportunities to assess the direction of a project throughout the development life-cycle. This is achieved through regular cadences of work, known as sprints or iterations, at the end of which members of team must present a potentially shippable product increment. By focusing on

the repetition of abbreviated work cycles as well as the functional product they yield, agile methodology is described as iterative and incremental. “ Since this was an ongoing project from last year Alina had to sit down with the other team members John and Diarmuid and explain the previous approach taken to create the application. After this meeting we had come to the conclusion of dividing the project equally giving each team member a section of the project to work on. Here is where the agile approach kicked in. Each week we would go and work on the section we were responsible for and at the end of the week we would have meetings to show the progress we have done. By having these meetings as often as we could, we came up with solutions for problems arising.

Meetings with the supervisor and the client were done when we had something working to show. Meeting with our supervisor put things into perspective with us. The supervisor guided us to an idea we didn't think about at the start of the project. Creating a database and an uploading software that the client can use to upload more data to the application. This idea was brought up in a later stage of the project therefore we had to meet again with the team and divide ourselves to create this back-end section of the project. With this methodology, the “Product Owner”, client worked closely with the team to identify and prioritize system functionality. The team met with the client whenever was needed to be done in order to successfully deliver a working software system. Agile emphasizes on the speed and efficiency of development work-flow, and relies on rapid and reliable feedback between programmers (us) and customers (our client).

3.2 TESTING AND VALIDATION

For testing and validating our code we used two major ways. First placing the application on the android phone, then testing the database and the uploading software.

3.2.1 Downloaded the android SDK:

The Android SDK is composed of modular packages that you can download separately using the Android SDK Manager. For example, when the SDK Tools are updated or a new version of the Android platform is released, you can use the SDK Manager to quickly download them to your environment. Simply follow the procedures described in Adding Platforms and Packages. Android studio provides the fastest tools for building apps on every type of Android device. The Android SDK provides all the necessary developer tools

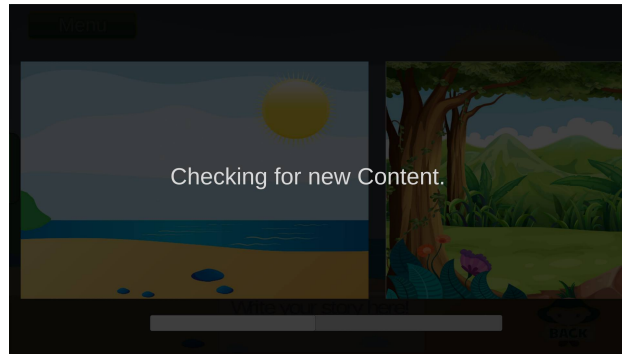


Figure 3.2: This is the application running on an android phone. Showing how its serching the database.

to build, test, and debug applications for Android in Windows, Mac or Linux. We have tested our front-end and back-end code on this. We downloaded the Android SDK and built the project onto it. This allowed us to see the application working on a phone, how it behaved and how it looked. Because the database was connected to one of the sections of the application at that stage we could also see the database in action. Few images were pulled from the database and were running as expected.

3.2.2 Testing the database

Connected the database to the application allowing sample images to show up in the section where this was connected. TO BE CONTINUED. ADD IMAGES OF IT WORKING

3.3 SELECTION OF PLATFORM, LANGUAGE, TECHNOLOGIES

Due to the clients requirements we had to create a cross platform application, so there was only a few software options to choose from. We came up with advantages and disadvantages to each of the software so it will make the process of choosing much easier. The process in choosing the right software:

3.3.1 Ionic

Advantages:

- Cross platform

- Main development in html, css and js
- And being able to use great frameworks like angular, which is embedded in ionic by default.

Disadvantages:

- No experience with this piece of software
- It will take a bit of time to get used to using it
- It's been described as being slow, tricky

3.3.2 Unity

Advantages:

- Easy to use
- We have all used it before
- Cross platform
- Has a free version
- Allows for rapid prototyping
- Asset store
- Collision detection without mathematics

Disadvantages:

- Using the engine requires you to agree with their policies
- Expensive if you need all features.

In the end considering all of our options and all of our skill sets we decided to use Unity. Most recommended software for creating quality games. Also allows team work. Due to the software we decided to use we were limited in our language choice. C sharp is the language Unity works best with. This is also a language we have used over the years in this Course therefore it was a win for us.

3.4 USING GIT

In our journey to get the project finished we have adopted a smart way of keeping our code safe, while also allowing us to contribute to the project together. We have chosen the cloud software called GitHub. GitHub can keep Open Source projects open, so anyone can view and contribute, while private projects get the same features but are only visible when you're signed in. Our team could use GitHub to manage the project, pull in customized versions of open source code, and share our own open source libraries and tools with the world all in one place. In GitHub there is an option on GitHub called fork. A fork is a copy of a repository. Forking a repository allows you to freely experiment with changes without affecting the original project. In our case each team member forked the repository that was created for the project. This repository in the beginning held the skeleton for our project. Each of us then worked individually and committed changes. All these changes didn't affect the skeleton. In the end to pull the project together we merged the forked project and created a final complete project.

Chapter 4

Technology Review

About seven to ten pages.

- Describe each of the technologies you used at a conceptual level. Standards, Database Model (e.g. MongoDB, CouchDB), XML, WSDL, JSON, JAXP.
- Use references (IEEE format, e.g. [1]), Books, Papers, URLs (timestamp) – sources should be authoritative.

4.1 XML

Here's some nicely formatted XML:

```
<this>
  <looks lookswat="good">
    Good
  </looks>
</this>
```

Chapter 5

System Design

5.1 Create and Play

Figure 5.1

- This is in the Create and play section.
- This screen-shot shows that the game is connecting to the database we have running in the background.
- It checks if new input was added.

Figure 5.2

- In this screen-shot you can see a few images.
- These are the scenes you can choose to create your story.
- We are using many new features that we haven't used before.

Figure 5.3

- This screen-shot shows the game in action.
- As you can see a few of the icons were added to the scene



5.2 Learn Irish

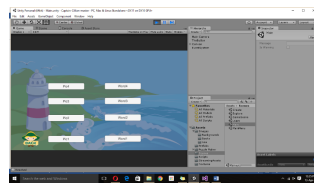


Figure 5.1: Learn Irish Section.

Figure 5.4

- In this section we added a match the word and picture game.
- After researching this we found that it would be the most effective way for children to visualize and also learn Irish words.
- It will be useful for using in the classrooms as our client is visualizing this to be used in schools.

5.3 Ocean Facts

Figure 5.5

- This is the Pick and place puzzle game which displays one fact about one of the books.

- Smart approach in getting children to have fun and enjoy playing a game while also learning.
- This section implements sound .When the puzzle is completed.

Figure 5.6

- Added three different puzzles for each book.
- This is a sliding puzzle.
- At the bottom I decided to add a button that will bring you to one of the books.

Figure 5.7

- This is a Join the pieces puzzle.
- That also contains one fact about another book.
- Decided to add only one fact per book since the customer is using this as a promotion software.
- So in the button “For more fact...” customers will be brought to the website where they can buy the book to find out more facts.

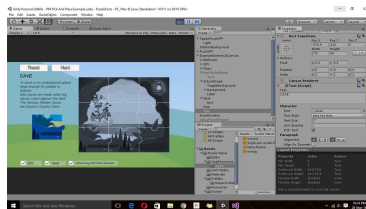


Figure 5.2: Puzzle 1

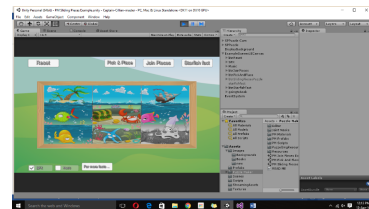


Figure 5.3: Puzzel 2

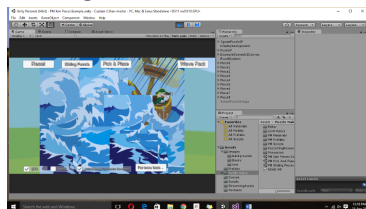


Figure 5.4: Puzzel 3

5.4 Explore

Figure 5.8

- The explore section will only contain the selection of books that have been made.
- Each book will be linked to a website there the book can be bought.
- This is the best way we can promote the clients books and also the clients website.



Figure 5.5: Explore section.

5.5 Database and uploading software/Additional Diagrams

The following screenshots show our database and how the database functions. We chose to use this particular database because it has a free trial for one year. Our client wasn't sure she wanted to use a database to upload more information on this application. She initially wanted to create a new app for each batch of books she created. But since we had to add a level of complexity to our project we decided to give her this option. After the year passes she has the choice of continuing to use this or to leave it aside.

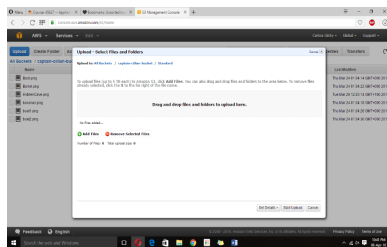


Figure 5.6: Second step

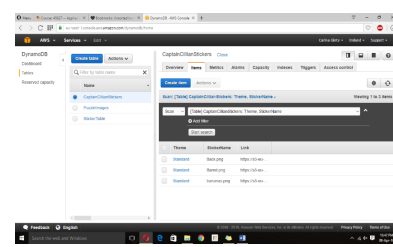


Figure 5.7: Forth step

Chapter 6

System Evaluation

The PDCA Cycle- PDCA (plan-do-check-act or plan-do-check-adjust) is an iterative four-step management method used in business/teams for the control and continuous improvement of processes and products.

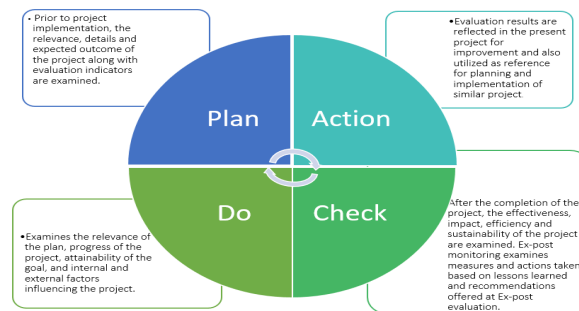


Figure 6.1: PDCA - Plan-do-check-action. More information about this diagram below.

- **PLAN:** Establish the objectives and processes necessary to deliver results in accordance with the expected output (the target or goals). By establishing output expectations, the completeness and accuracy of the spec is also a part of the targeted improvement. When possible start on a small scale to test possible effects.
- **DO:** Implement the plan, execute the process and make the product. Collect data for charting and analysis in the following "CHECK" and "ACT" steps.
- **CHECK:** Study the actual results (measured and collected in "DO" above) and compare against the expected results (targets or goals from

the "PLAN") to ascertain any differences. Look for deviation in implementation from the plan and also look for the appropriateness and completeness of the plan to enable the execution, i.e., "Do". Charting data can make this much easier to see trends over several PDCA cycles and in order to convert the collected data into information. Information is what you need for the next step "ACT".

- ACT: If the CHECK shows that the PLAN that was implemented in DO is an improvement to the prior standard (baseline), then that becomes the new standard (baseline) for how the organization should ACT going forward (new standards are enacted). If the CHECK shows that the PLAN that was implemented in DO is not an improvement, then the existing standard (baseline) will remain in place. In either case, if the CHECK showed something different than expected (whether better or worse), then there is some more learning to be done... and that will suggest potential future PDCA cycles. Note that some who teach PDCA assert that the ACT involves making adjustments or corrective actions... but generally it would be counter to PDCA thinking to propose and decide upon alternative changes without using a proper PLAN phase, or to make them the new standard (baseline) without going through DO and CHECK steps.

6.1 TESTING AND ROBUSTNESS

—CONTINUING FROM METHODOLOGY ON THE TESTING

-
-
-
-
-
-
-
-

6.2 PERFORMANCE BENCHMARKS

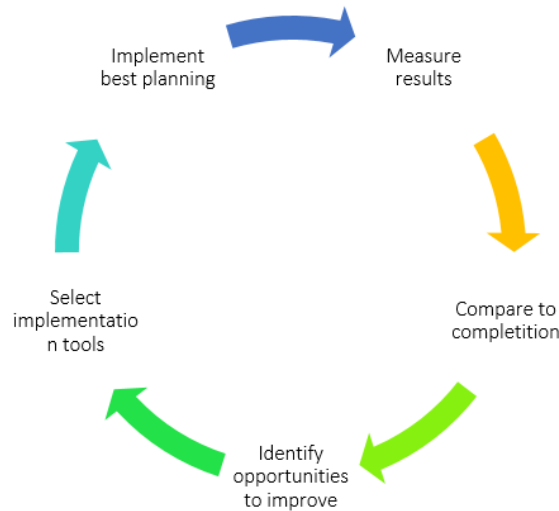


Figure 6.2: Performance Benchmarking Diagram

“Benchmarking is the systematic process of measuring one’s performance against recognized leaders for the purpose of determining best practices that lead to superior performance when adapted and utilized.”

6.2.1 Determine what to Benchmark

What we are benchmarking is the performance of our application that was created in Unity. The method that we approached was placing our application on the android phone. This showed that our application was running. This process allowed us to see where the project was having loading problems. When approaching the section that connected to the database there was a long loading time, where the application was checking if new input was added to the database. The rest of the application had great loading time.

6.2.2 Defining the Measures and Solutions

To define the time that the application was taking to run when connecting to the database we ran the application on the phone. The loading time

was about 20 seconds. It took the application 20 seconds to connect to the database add all the new input and play the game chosen. After researching how to fix this problem, Diarmuid decided to add a timer. The timer basically added a time limit on the loading time of the section. A 10 second limit was set, if the application didn't pull the data added in these 10 seconds the application starts the game without pulling the new assets added.

6.2.3 Comparing – Outcomes against Objectives

This section will hold the process of comparing the outcomes against the objectives we have set in the beginning. Every section of the application will undergo this procedure individually. This is in order to explain fully what each part was actually meant to do and what it came out in the end doing. The purpose of this section is to see all the solutions that were tried, all the work that went into doing each section and the end product. There were only three sections where games were added, therefore only these three sections will be explained in this section.

Create and Play

.....

Learn Irish

.....

Ocean Facts

What this section was describes as in the specification: The Ocean Facts section draws from the theme of sailing with Captain Cillian. It contains multiple scenes (Currently just an aquarium scene) which can be navigated through like a slideshow. The scenes contains pictures of relevant animals and facts about each.

Objectives from the Introduction overall to be implemented:

- More quality and less quantity.
- Cross platform.
- Overall publishing clients books.

Objectives specifically for this section:

- Having one working puzzle called Pick and place with different facts.
- Making this section fun as well as adding facts.

Process of getting the final outcome:

1 Created a template page in unity with facts and images of sea creatures- The page looked somewhat like the picture below. To make sure I was going for what the client wanted, I set up a meeting and displayed this template to her. She was not very happy with just having information with a few images. This is because she was imagining the application to be used in a classroom. Therefore she asked for a word search, or a hand man that the children could play in classes.

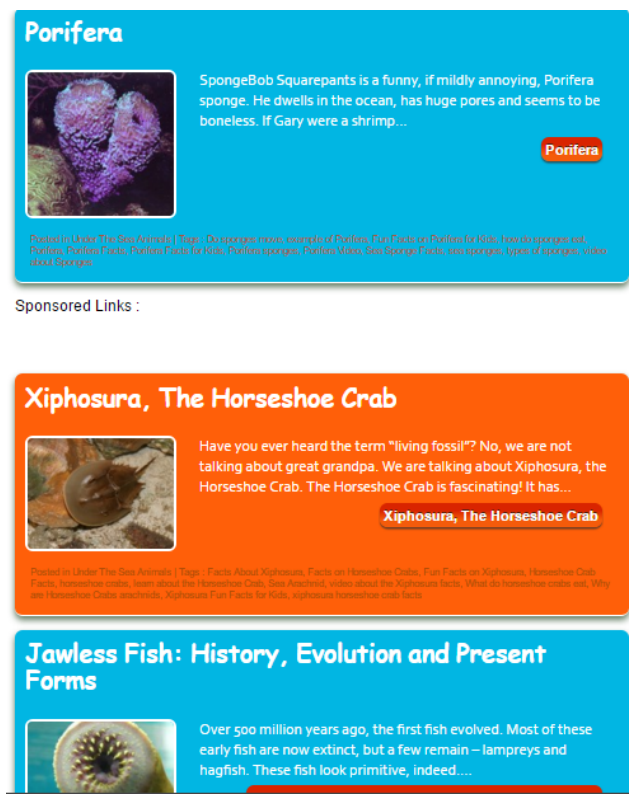


Figure 6.3: First attempt at this section. Basic information with images.

2 Made a word search: - after the meeting, I decided to make a word search and try to implement this to fit the application. But by making a word search there was no way I could add the facts she wanted to display. Therefore I had to go and research on more children's applications and games, where I could also implement some facts.

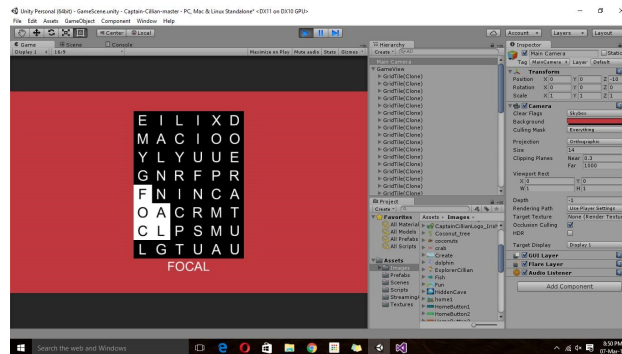


Figure 6.4: Second attempt at this section. Created a Word Game.

3 Puzzle Idea – after doing a few more days of research I found a great unity asset store package. This package contained a puzzle game. This brought me to the idea of creating one puzzle game and adding facts to it that the user can show and hide to their preference. This was a great idea and considering the time I had left to finish this project it was the idea I decided to implement in the end.

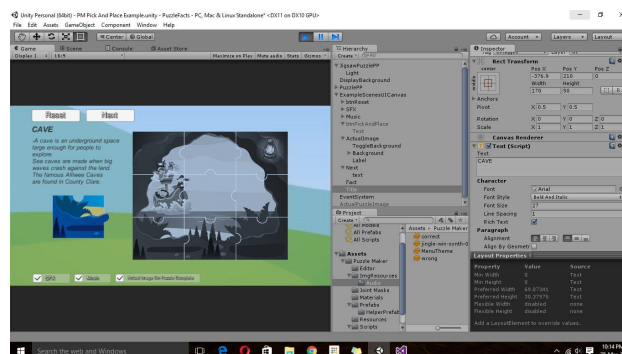


Figure 6.5: Final game choice. A puzzle game that also displays facts.

Outcomes:

- Choosing to do this puzzle was the best Idea in my case.

- It shows educational facts.
- It's fun and appropriate for children to play in classrooms as well as at home.
- Level of complexity is appropriate for the group of children we are targeting.
- Its cross platform.
- It has a really good quality because I used the unity assets package, so the game was basically done when I got it, it had sound and the movements were perfectly functioning. Therefore meeting the client's objectives.
- - Took a lot of trial and error but in the end it was worth all the research and time spent on it.

6.2.4 Limitations

- Time frame limitation: we were limited to the time we had to spend on the project. The first few weeks for us were more of getting the team members on bored with the project since it was ongoing from last year. A lot of research was done to see what the client didn't like about the last project and what we had to change. In our case we had to start the project again since we decided to use unity and to make the project cross platform. Some of the team members were not used to using Unity so that took extra work and extra time spent to understand how the software worked. Also the deadline 18th April.
- Software Limitations: since we had to do a cross platform application we were limited to what software we could choose. There is only a few amount of software that actually allow cross platform. We had a choice between Unity, Ionic and PhoneGap.

6.2.5 Opportunities

- Hardware/software evolution: we had the opportunity of working with new software that is in demand. These new software allowed us to create a more quality application, also a wonderful war to test this code by adding it to the phone and not changing the code. The new online databases are very useful for projects created at the minute. Fee

for a year it gives the clients you develop for an opportunity to try something new they perhaps never considered before.

- Using code that is already there and making it better: For example unity asset store , this gives opportunity to use code that is already made and that are very well made that are high in quality giving your application a polished look. Also GitHub had a lot of code samples you could take and change to suit your project.

Chapter 7

Conclusion

Since we are getting to the end I would like to point out the differences in the project this year and last year. This year we have achieved more of what the client wanted. We made an application that has more quality, unity in itself made this step possible. Also we have achieved to make the application cross platform which was a big objective for this application. We also added two extra features that were not even thought about the year before. We have added a back-end to the project, a fully working database which will allow more information to go into the application. Also created a very simple uploading page at the end. This uploading page is used to make the clients work easier to upload assets onto the database.

1 We also had a better perspective of what the client wanted the application to look like since we had actual hard copies of the books she published and also a website. Reading these books and meditating on them made us come up with better ideas, better facts over all a more robust project.

2 This project challenged us to use new software. To adapt new things we have learned over the years. The amount of research that went into the project this year was definitely much more than last year. In the same time we pulled knowledge from other modules to achieve a better application. A few modules we have used knowledge from are: Research Methods, Semantic Web Development, and Mobile Application in c sharp, Database Management system and Distributed Systems.

3 Last year's project was mostly using software we have used in the three years, was not cross platform, it didn't look very professional and in the end it wasn't finished. Code wasn't used to its fullest potential. We wasn't any

back-end to the project at that stage. There was an emphasis to get more games than quality and that was not the objective to be met. Overall the team from this year made a better effort of meeting the client's objective and actually completing what was said would be done. We have used the technologies to the best of our abilities taking into consideration the opportunities we had. Taking into consideration all the ideas and opportunities given to us, we created a fully working project that is perfect for children to use.

7.1 PERSONAL THOUGHTS/HOW THIS PROJECT HELPED IS PERSONALLY

7.1.1 ALINA Danci

- Personally this was the most stressful project up to date. A lot of work, research, time, meditating was put into getting this project finished to a quality standard. I feel like I have improved my team work skills during this project which will definitely help me in a real life job. I have also learned how to use existing code and adapting it to make a quality project. For me this was a huge research project. Finding out what games work for children, how I can adapt information to it since it is an edutainment application. I also focused on writing most of the documentation since my coworkers were better at coding then me. This way I discovered that I can write pages and pages and not get tired. This showed me I have a passion for writing. Enhancing my writing and research skills will also help me with writing on my developer blog, expanding ideas and maybe work with other developers to create some great work in the future. Every little thing I did this year prepared me for the real work environment outside of this college. I have worked on this project two years therefore I have gotten to see a lot of trial and error and a lot of frustration when code doesn't work the way it's meant to. That didn't take away from the satisfaction of finishing the project this year. Feeling like I did everything to make this client happy and meet her objectives. There were a lot of times I wanted to give up, I was pessimistic at the start thinking we can't make this project work. Perseverance was the key. As the time progressed and we kept getting things checked of the list and made me realize that everything is possible with time and research.

7.1.2 Diarmuid Byrne

7.1.3 John Lavin

Bibliography

- [1] A. Einstein, “Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies],” *Annalen der Physik*, vol. 322, no. 10, pp. 891–921, 1905.