**Flowchart Adventure – gamified application to teach flow chart diagrams**

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11th November 2021

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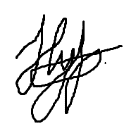
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**Acknowledgement**

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# **Chapter 1: Introduction**

## **Introduction**

This report was the detailed research of an educational gamified application named Flowchart Adventure that was aimed to let a user learn the basics and cores of flowchart diagram development which results an improvement of the user’s computational thinking, critical thinking and problem-solving skills. The application provides flowchart diagram lesson with increasing difficulty on each level, which covers the usage of following symbols: Start/End, Action, Decision and Input/Output, through using game-based learning.

Game-based learning was defined as a system in which the user interacts with rules-based conflict in an artificial story that results a measurable acquisition of specific concepts, ideas, and skills. (Plass, 2020)

A flowchart was defined as a graphical representation of an operation sequence, where it serves as a pictorial means of communicating from one person to another following the time-ordering of events or actions. (Gill G. , 2004)

## **Problem statement**

Modern students grew up with constantly advancing digital technologies; consequently, traditional methods of education became less effective with each succeeding generation. The education system faces a problem in adapting the learning process to the requirements, preferences and demands of modern students. To urge students to be active participants with a strong interest in his/her own learning, professors must employ a variety of instructional techniques and approaches. Pedagogical paradigms and trends in education, bolstered by the use of ICT, create the conditions for the implementation of active learning using innovative approaches and techniques, with gamification as the dominant trend. (Angelova, 2014)

The increased consumption of visual content has resulted in a high number of visual learners; data show that 65% of the world's population was a visual learner; therefore, from a pedagogical aspect, it was vital to employ graphic tools to explain and demonstrate complicated topics, thus a usage of pictorial means of communicating was required. (Jawed, 2019) A flowchart diagram was a useful tool for making a process easier to comprehend and describe by clearly displaying what happens at each stage and how each action affects other decisions and actions. Using flowcharts can help students to learn complex algorithms and improve his/her computational thinking, critical thinking and problem-solving skills. (Gill, 2004)The main issues with flowchart diagram were that learning and mastering it take a long period of time and students might lose interest during long sessions, thus the Flowchart Adventure project was created to make the learning and practicing period entertaining which encourage students to learn and practice flowchart diagram development.

## **Detailed research question**

1. Can user engagement and motivation be enhanced by using any of the currently available game-based learning applications?
2. To what extent may user engagement and motivation be enhanced by arranging game progression in accordance with in-game elements?

## **1.3 Research objectives**

1. To develop a flowchart diagram lesson with increasing difficulty on each level, which covers the usage of following symbols: Start/End, Action, Decision and Input/Output, through using gamification.
2. To provide user knowledge and understanding of flowchart diagrams so user can complete basic flowchart diagram in the project.

## **Keywords**

Flowchart diagram; game-based learning applications; visual learner; user engagement and motivation; interactive;

## **Project Title**

Flowchart Adventure – gamification of flowchart diagrams.

## **Client, Audience and Motivation**

The topic of 1.6 section was about the target audience and what was the motivation research to have the inspiration to develop Flowchart Adventure gamified lesson. The project's audience consist from 2 groups: primary audience were students, software engineers and self-learners who face difficulties in using traditional methods of learning and want to learn/practice flowchart diagram development through gamified method. The project was designed as a beginner friendly game-based lesson which means it did not require any prerequisite knowledge from the user. Simple tutorial videos and direct instructions were embedded in to the project, which makes people without any IT background a secondary audience group. The motivation of the Flowchart Adventure project was to provide user knowledge and understanding of flowchart diagram development and help to raise the student engagement in study material through flowchart diagram lesson with increasing difficulty on each level.

## **Primary Research Plan**

The key idea of the Flowchart Adventure project was to develop an engaging learning environment that motivate user to learn/practice flowchart diagram development, there for the project involved extensive literature review about game development, user motivating and attraction grabbing. The primary research consisted from 3 phases: phase 1 – research, phase 2 – development and phase 3 – testing and deployment, demonstrated by Figure 1.

In order to complete the phase 1, the extensive literature review was conducted through searching and reading research papers and journals from 2018 to 2021, which contained needed information about flowchart diagram development and game development. The “Google scholar” was used as the searching engine for acquiring required journals and research papers.

The second phase was systems development, where the detailed requirements were converted into completed detailed systems design, which described how the application needs to be created.

The final phase was system implementation and coding. The Unity game engine using C# language was selected, because Unity was a multi-platform game engine, commercially available and was used for 2d and 3D video games production accompanied by visualizations and non-game interactive simulations. It permits rapid iteration and editing in the cycles of development comprised of smart previews play mode in real-time. (Hussain, 2020) Furthermore, a set of success metrics will be evaluated by the project panelist.

Figure 1 The primary research plan

The waterfall model was the oldest and most straightforward of the structured methodologies. The waterfall model was selected for the Flowchart Adventure project development because the start and finish criteria for the project were well defined and the project did not plan to adopt major changes in requirements in the middle of the development, so the waterfall’s bottleneck problem was not an issue. The waterfall model was simple to understand and manage. It was sequential design process, since the stages were rigid and precise, each stage was executed one at a time, making it easy to maintain and document, alleviating stress, which was important because of the limited time for development and testing. (Kramer, 2018) The strict time limit for the development was one of the main reasons to select the waterfall model, because there was no time for moving back to previous stage and reworking it. The waterfall model ensures the quality and identifies deliverables and milestones, the waterfall model focus was on documentation. The Figure 2 demonstrates the six stages of the waterfall model. The analysis of the gathered materials resulted creation of the mind map demonstrated by Figure 3.

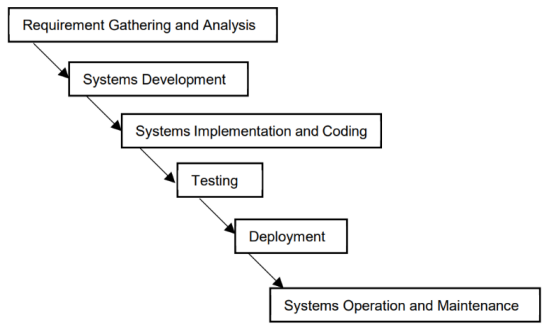


Figure 2 The six stages of the waterfall model

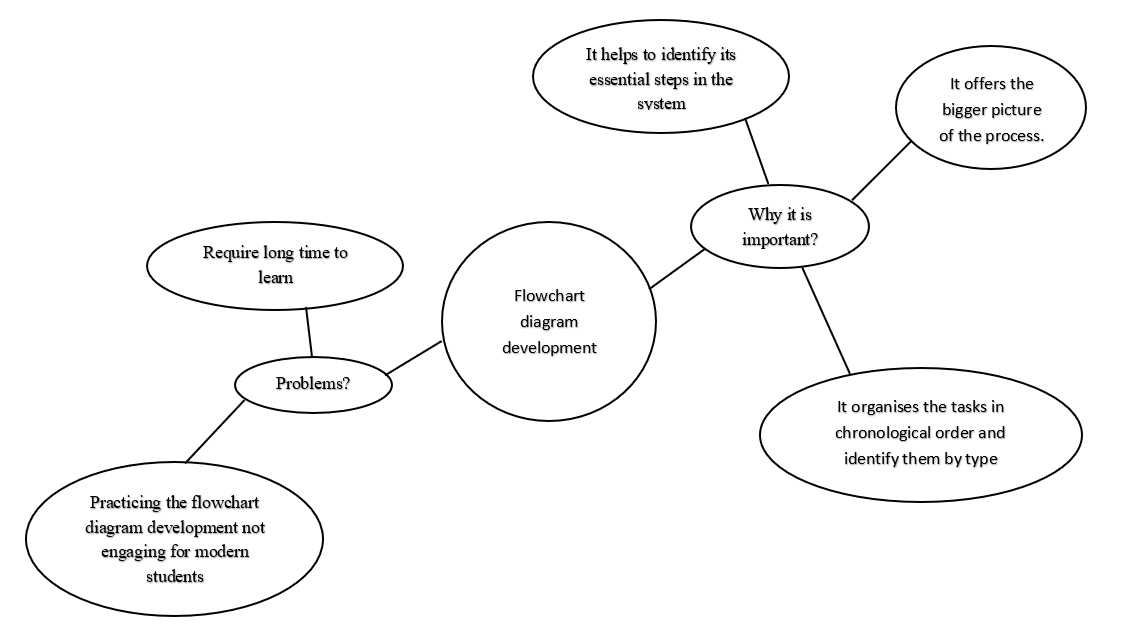


Figure 3 The Mind map for flowchart diagram development

## **Conclusion**

The education industry sees changes as a result of technological advancements. It's possible, for instance, for students to use the Internet as a source of educational resources. The lesson may be taken online, and it provides a fun and interactive way to learn through the use of games. The Flowchart Adventure project incorporates insights gleaned from the research question's investigation of preexisting game-based learning applications, including the latter's framework and elements. Even when the user was not connected to the internet, the software may still guide them through the process of creating a lesson plan that teaches a flowchart diagram. The Flowchart Adventure provided supplementary resources for teaching and studying flowchart diagrams to its primary and secondary audiences. The primary research strategy, which provided an overview of the project's methods. The next section was a literature review and analysis of the current game-based learning applications, which was used to create a game design document and provide an argument for why this particular game development framework was selected.

# **Chapter 2: Literature Review**

## **2.0 Introduction**

In order to provide a solution to the research question that was given for this project, this section contained a comprehensive literature study on how gamification might increase user engagement and motivation. In addition to this, investigate already existing gamification and game-based learning platforms and apps to determine the features of game design that are already in use.

## **2.1 Game-based learning**

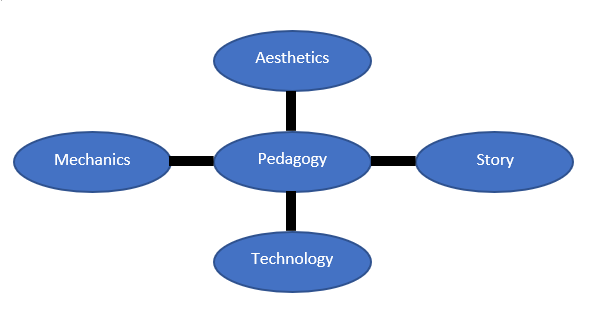
 Game-based learning (GBL) was defined as a system which targets intrinsic motivation, self-reliance/autonomy learning through “fun”, authenticity, and experiential learning. It includes rules, clear nut challenging goals and progressive levels of difficulty with usage of different game elements and mechanics. GBL was designed to teach specific concepts or strengthen competence. Five basic game elements concept was discovered by George Kalmpourtzis – leading game designer, founder, director of several European design studios. He stated that to provide educational experience to a user the game design must focus on five basic game elements, demonstrated by Figure 4. All elements were interrelated with learning aspects that were required to be broken down as educational game design was being implemented. (Ahmad, 2020)

Figure 4 Five basic core game elements

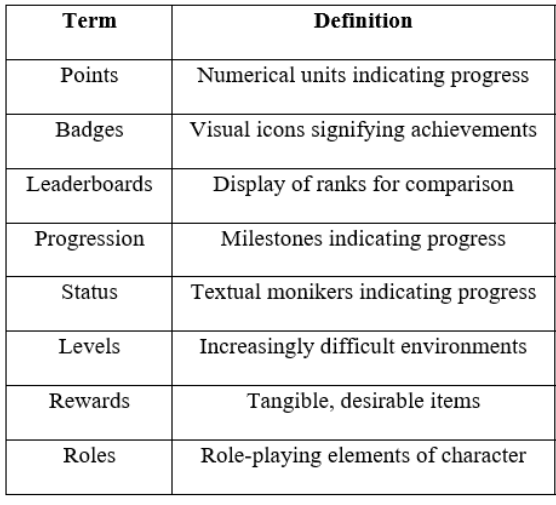
The accomplishment of certain tasks in the game must be awarded and emphasized by providing users with some achievement badges or leaderboard, it was important in maintaining user engagement and motivation. According to students’ behavior studies, students are more interested in educational games when the feeling of achieving self-improvement was enhanced with in-game rewards and trophies. (Li, 2019) Game elements with definitions were demonstrated by Figure 5. The following subchapter provided an analysis of several game-based learning apps in order to gain a thorough understanding of the game-based learning concept.

Figure 5 Game elements and definitions

## **2.3 Game-bases learning platforms and apps**

This section describes existing game-based learning platforms and apps which were used as a tool to improve the learning experience for students. Analysis of the following platforms and applications were important for the Flowchart Adventure project development. The list of five selected examples was demonstrated by Table 1. Existing game-based learning platforms were used to identify similarities and distinct features. All selected examples follow the same goal of providing students and self-learners materials and practice exercises in the form of games. Each of the selected platforms was beginner friendly, with increasing difficulty with progression and motivating users with in-game rewards and trophies, demonstrated by Figures 6 and 7.

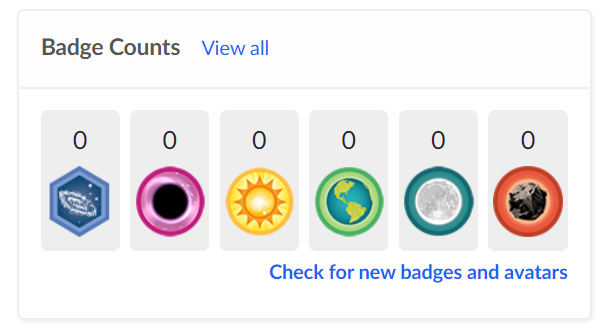
The platforms from Table 1 were tested and analyzed by the researcher, the outcome was an adaptation of several mechanics and features to the Flowchart Adventure project. The way to identify users’ level of understanding of the specific topic, where the user was given several tasks and 3 lives, was demonstrated by Figure 8.

Figure 6 Badges in Khan Academy

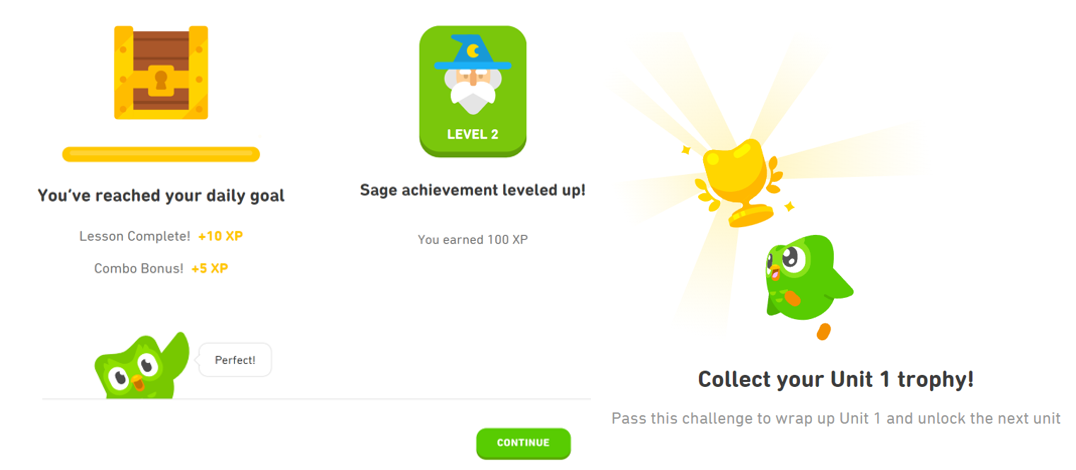


Figure 7 Rewards in Duolingo

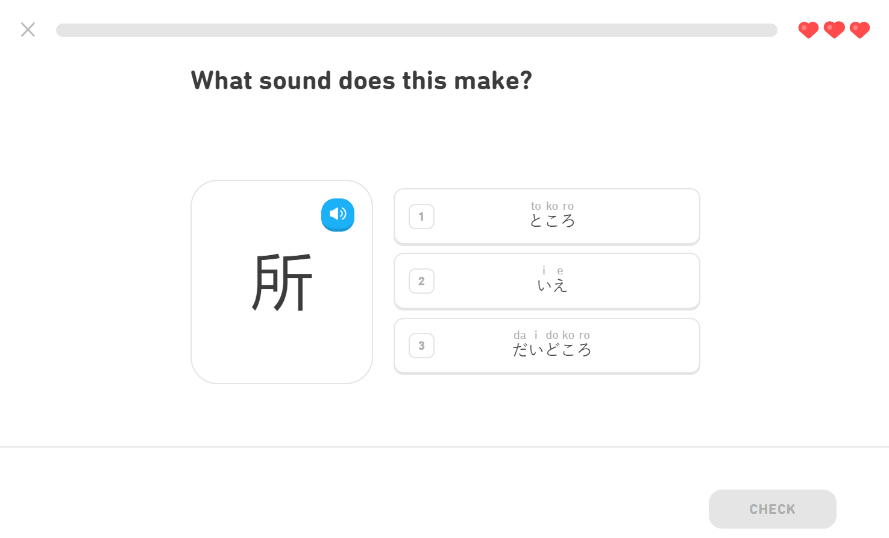


Figure 8 User's knowledge level testing in Duolingo

Table 1 Existing game-based learning platforms

|  |  |
| --- | --- |
| Platform | Description |
|  | Duolingo was a language-learning web application which provides language certification. The user can practice vocabulary, grammar, pronunciation and listening skills using spaced repetition, tutorials and exercises. (Shortt, 2021) |
| Math Widgets | Math Widgets was a not free mobile application which was a collection of four interactive tools for teaching and learning basic math concepts. Where each stage was dedicated for specific mathematical concept (Ahmad A. , 2020) |
| Download Khan Academy Logo in SVG Vector or PNG File Format ... | Khan academy was a set of online tools that help educate students about math, science, computing, history, art, history and economics. It provided short lessons in the form of videos with supplementary materials, practice exercises and tests. (Sahar, 2020) |
| Typing.com | Typing.com was a free website where user was provided with detail tutorials, exercises and tests to learn and practice speed typing, digital literacy and coding. (Typing, 2022) |

## **2.5 Conclusion**

This section of the literature review was a summary of all stated above ideas. The implementation of the game-based learning to modern education can improve existing instructional design and increase student or self-learner interest.

Additionally, the usage, game mechanics and features of each selected platform, presented by Table 1 were analyzed and implemented into the Flowchart Adventure project. Furthermore, the waterfall model was selected due to its documentation simplicity and time limits for the project development.

Lastly the Unity Game engine was selected because it offers a large pool of development tools and a comprehensive knowledge base and a relatively simple start for a new game developer.

The upcoming chapters discussed in-depth the Flowchart Adventure project management, planning and development with focus on the implementation methods and research methodology.

# **Chapter 3: Project Management, Method and Implementation**

### **3.0 Introduction**

Due to the time constraint nature of this project and the start and finish criteria for the project were well defined and the project did not plan to go through major changes in requirements in the middle of the project development the project methodology employed for the Flowchart Adventure was the waterfall model, which has six steps, as described in chapter 1. The clear understanding of the final product was achieved through project preparation and planning phases, which included user and context analysis, paper prototyping and flowchart diagram development for the Flowchart Adventure.

During the planning stage it became clear that flowchart diagram was a large topic to cover thus the objectives of the project were discussed again with the project supervisor. One objective was tweaked to fit the Specific, Measurable, Achievable. Relevant, and Time-Bound goals. During the initial stage of listing out the objective, one of the objectives was “To provide user knowledge and understanding of flowchart diagrams so user can develop basic flowchart diagram in the project”, where it was decided to change the "develop" with more realistic "complete", which fulfilled the "Specific," "Measurable," and "Time-Bound" goals. The result was “To provide user knowledge and understanding of flowchart diagrams so user can complete basic flowchart diagram in the project”. Each stage of the project plan was covered in this section of the report.

### **3.1 User analysis**

The user analysis stage was important for creating user persona which was used to improve the understanding of player engagement and motivation. Obtaining the characterization of the target audience was achieved through survey via Google Forms where the target audience could be separated into user group segmentation for better analysis. All collected information was stored on the personal Google Drive, where it can be easily deleted after the project was complete thus keeping participants' information safe from any third-party.

In order to simplify the access to the survey and increase the number of potential participants it was decided to create a quick response (QR) code for the survey, demonstrated by Figure 9. To keep the survey organized and clean from multiple attempts the “Limit to 1 response” and “Collect email addresses” options were activated in the settings of the survey, demonstrated by Figure 10. When participants tried to open the survey after submitting it, the survey provided a notification that the survey was already done by this person demonstrated by Figure 11.

The survey contained 3 sections, where each section was designed to fulfil a specific goal. Total number of responses collected was equal to 72 but unfortunately 2 users did not agree with the acknowledgment notice thus 70 responses were used for further analysis. Accepting responses was stopped to prevent disrupting the data analysis by new responses. The information about the survey and results were described further in this section of the report.



Figure 9 QR code for the survey

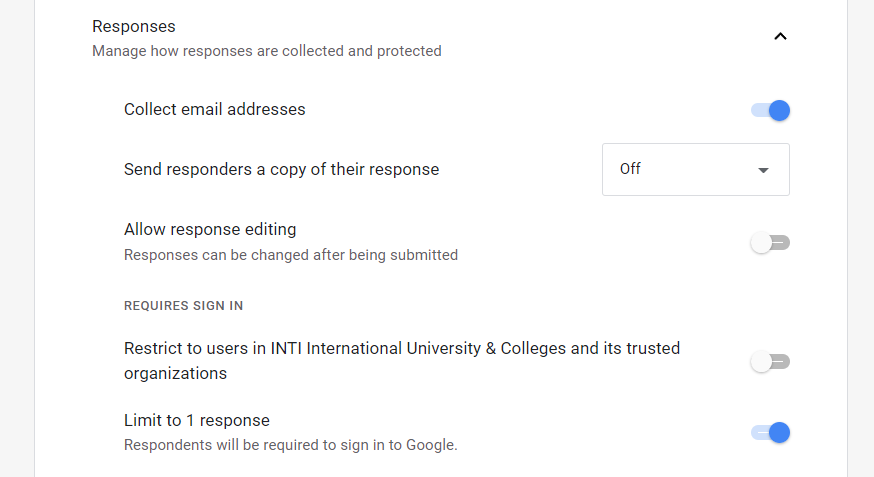
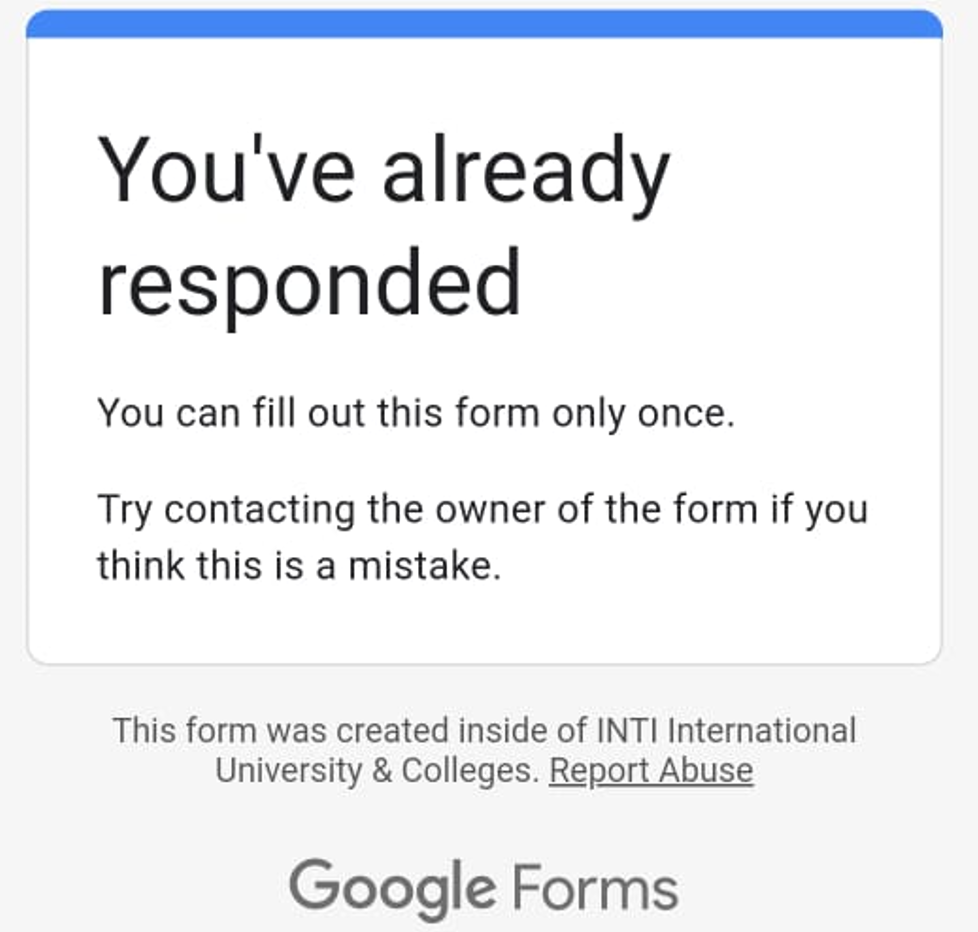


Figure 10 Notification that the survey was already done by this person

Figure 11 Responses settings for the survey

The first section of the survey was an acknowledgment notice with information about the survey and its objective. Providing information about the survey owner, supervisor’s name and relation to the university increased the trust from the participants, demonstrated by Figure 12. To proceed to the next section of the survey participants were required to acknowledge that collected data was used only for this project, demonstrated by Figure 13. If the participant disagrees, they survey ends. It was important to confirm participants' approval to collect information because of the Malaysia Personal Data Protection Act. (Hamzah, 2019)

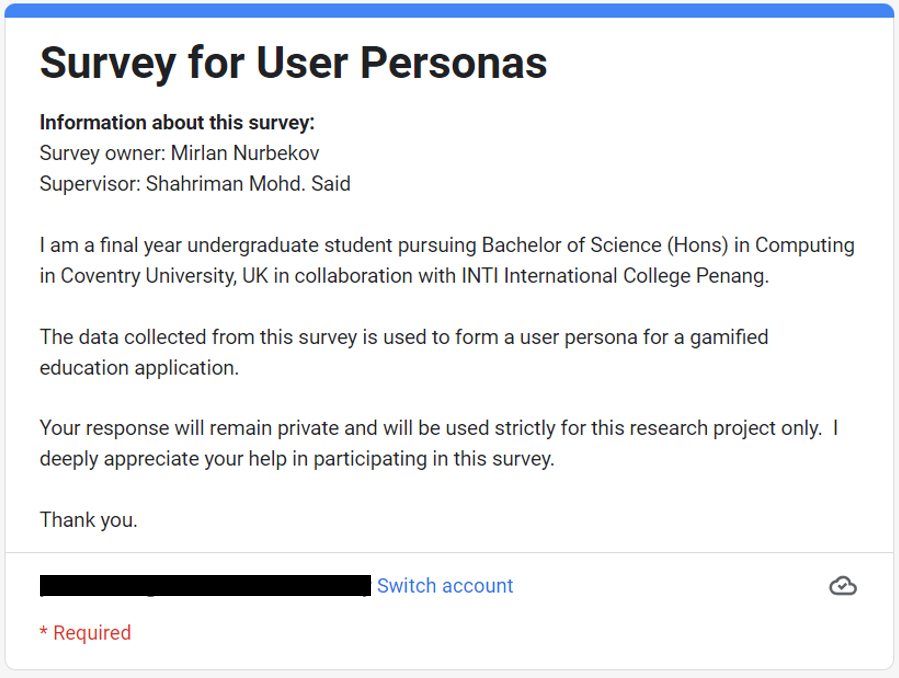


Figure 12 Providing information about the survey

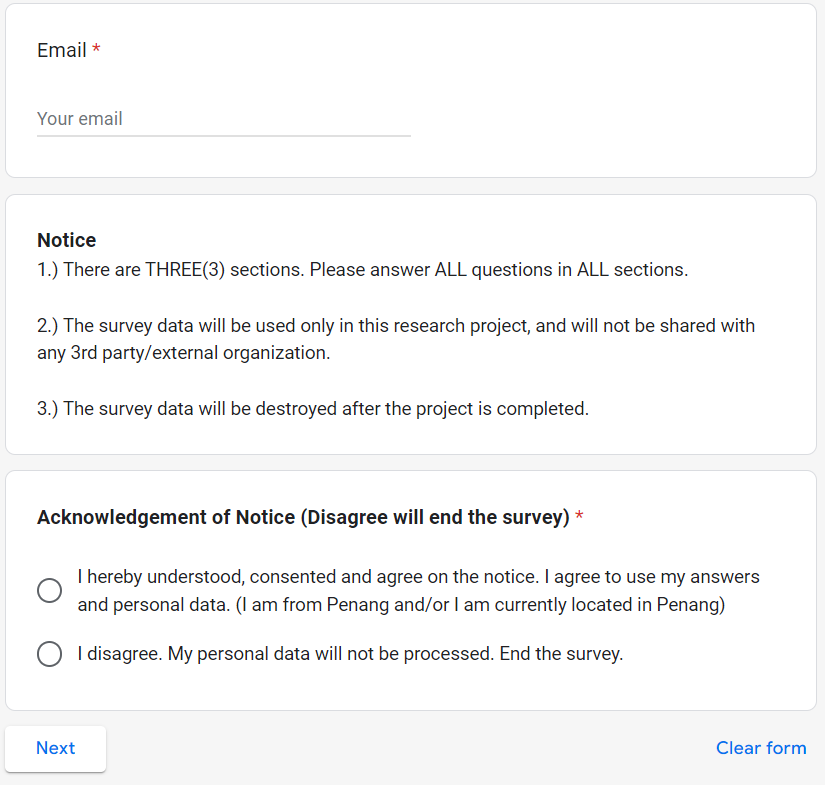


Figure 13 The acknowledgment notice

The second section of the survey was designed to characterize the target user group. It was important to identify the gender of the participant because the gaming preferences of the user can be profoundly influenced by a player's gender, demonstrated by Figure 14. Each generation has different expectations and preferences for game environment thus to see the age categories covered by the survey it was decided to collect age information, demonstrated by Figure 15. The level of education was taken into account because the primary target audience was initially set to be students, demonstrated by Figure 16. It mattered greatly to collect information about employment to identify the relation between hours spent weekly on playing games and employment status, demonstrated by Figure 17.

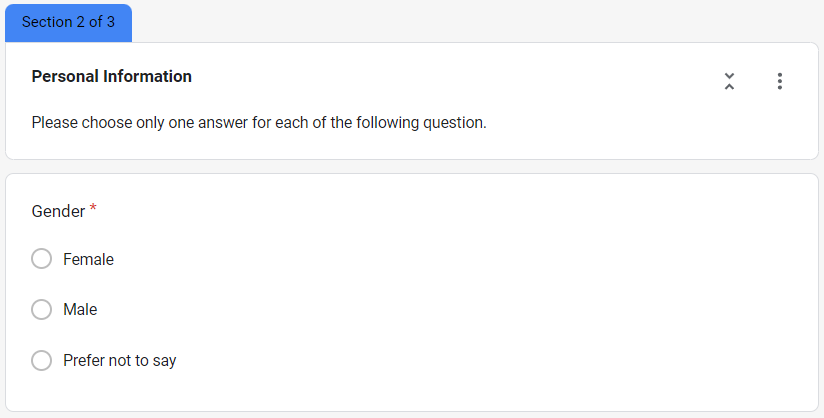


Figure 14 The gender question

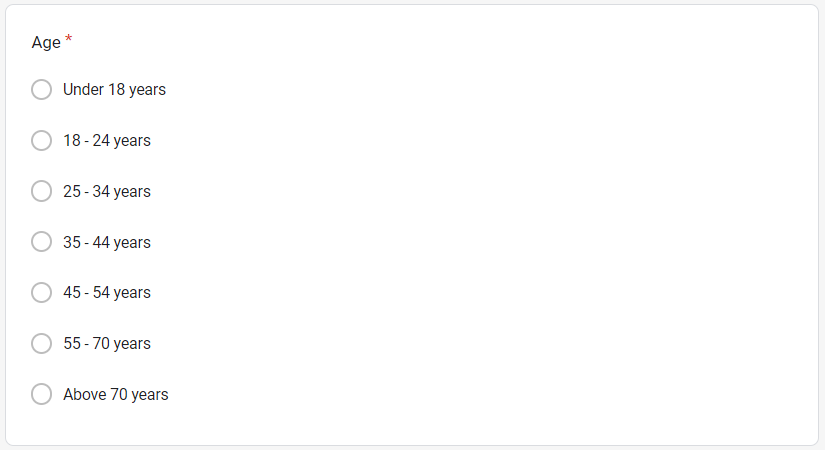


Figure 15 The age question

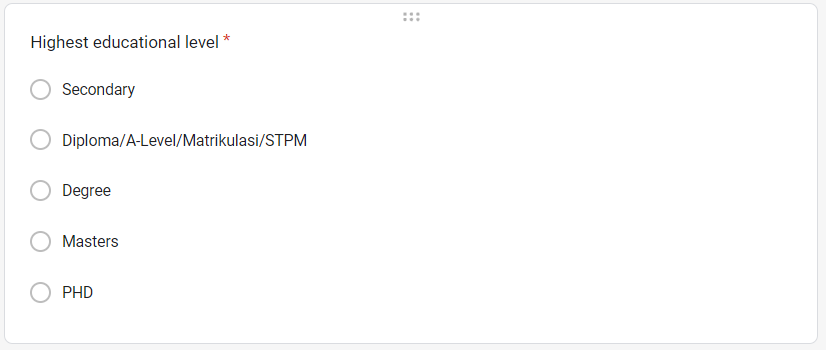


Figure 16 The education level question

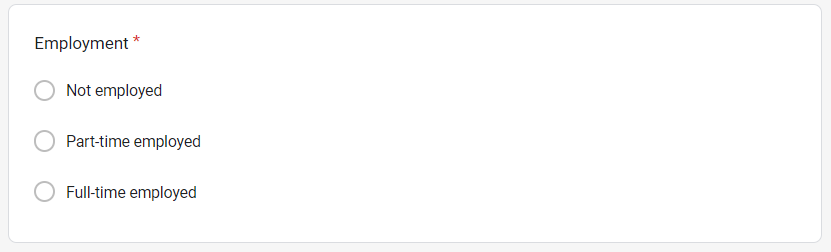
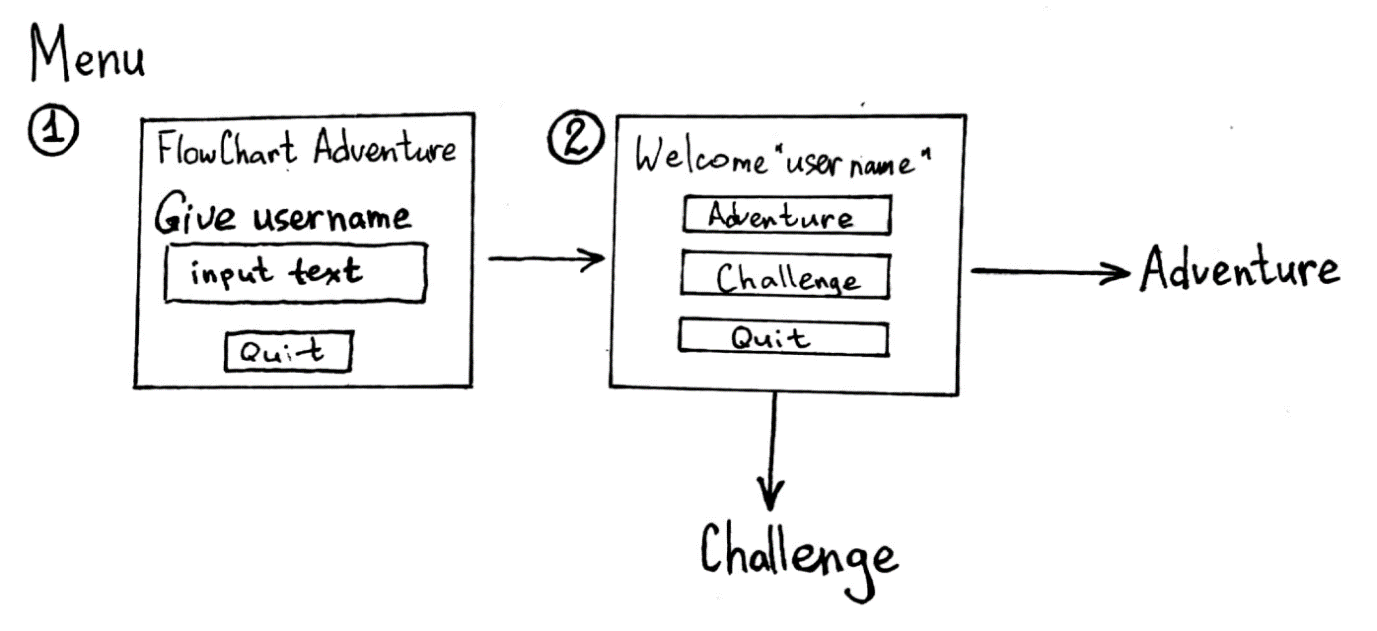


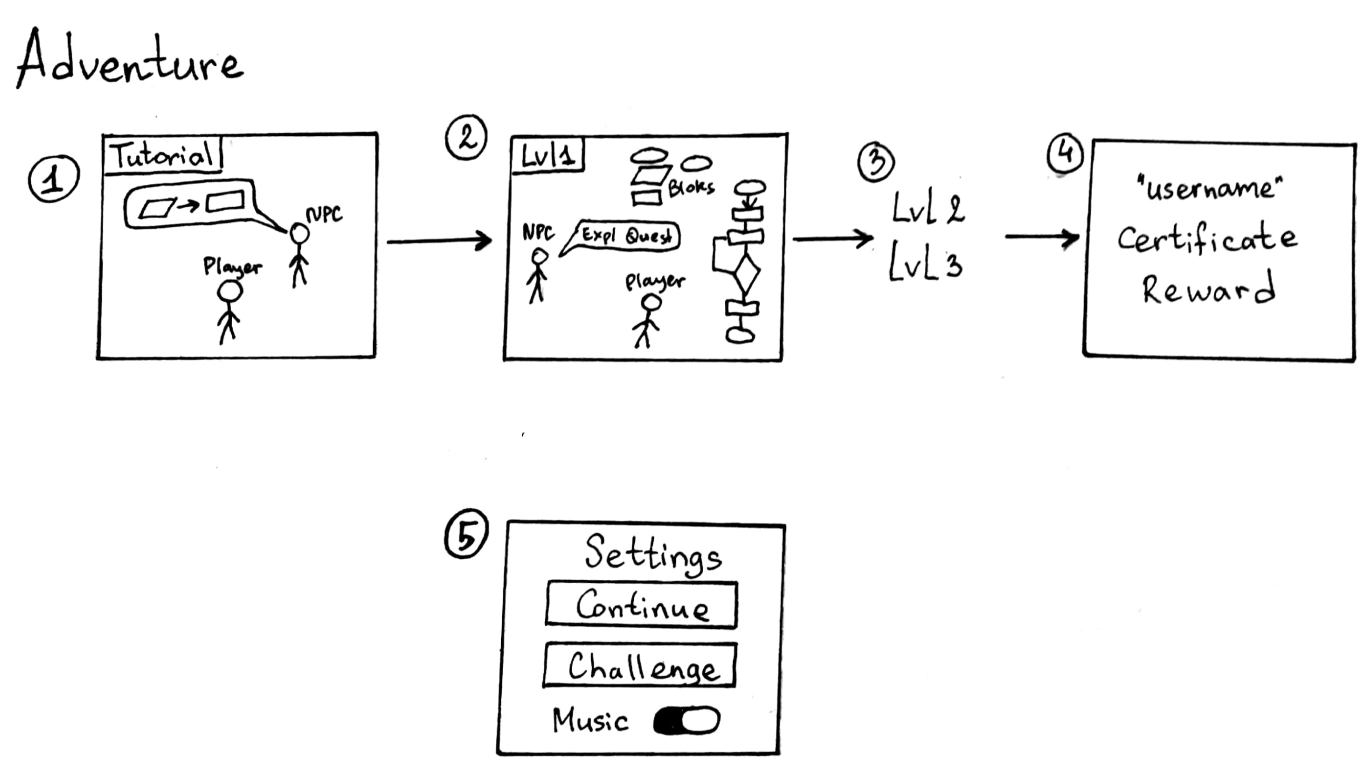
Figure 17 The employment status question

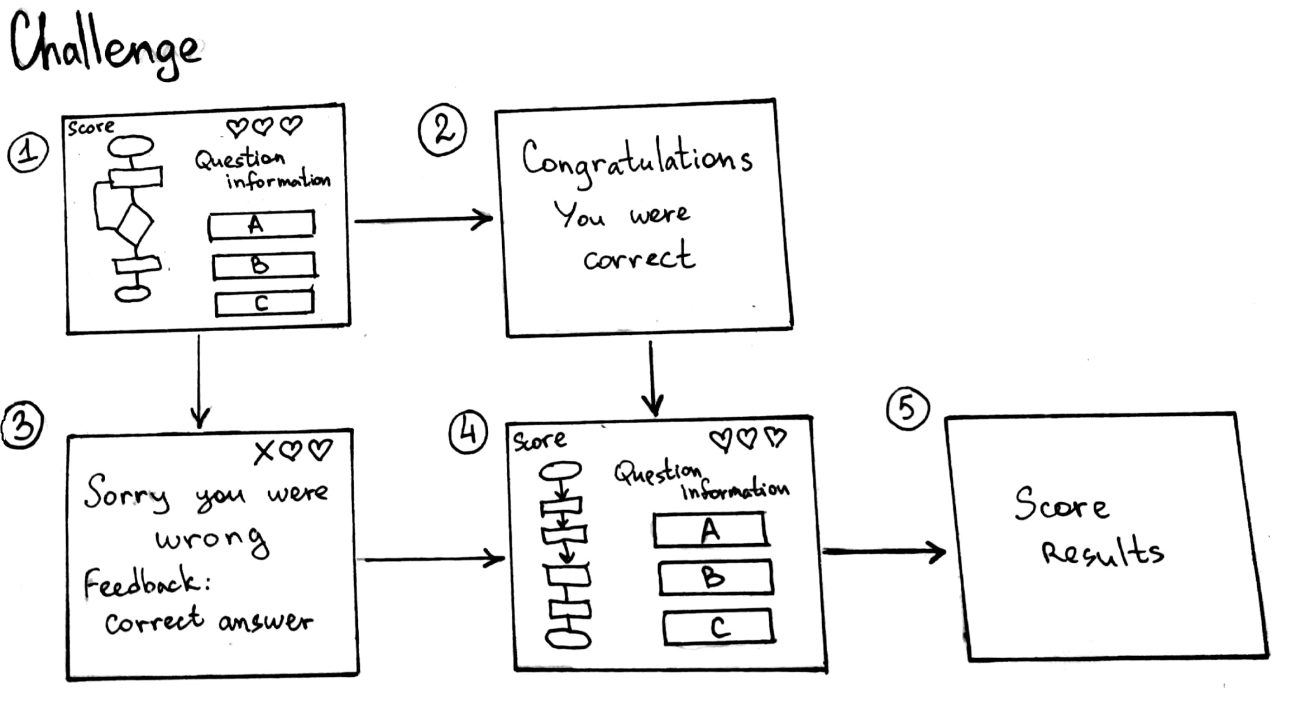
The third section of the survey was aimed to

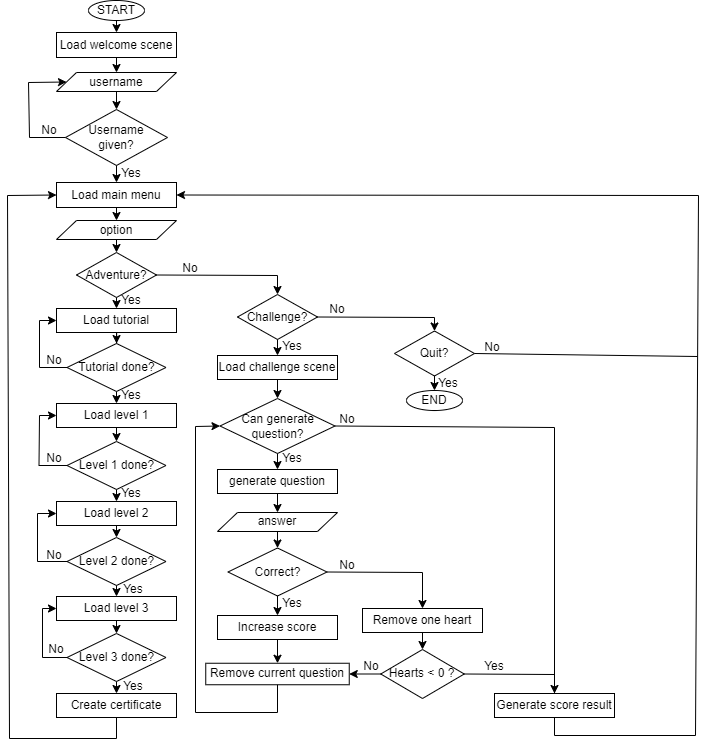
### **3.2 Context analysis**

### **3.3 Design**

Paper prototype







### **3.4 Gantt chart**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No | Task |  | Month | |  |  |
|  |  | August | September | October | | November |
| **1** | **Proposal Phase** |  |  |  | |  |
|  | Finalize project title |  |  |  | |  |
|  | Initial Allocation Form Proposal |  |  |  | |  |
| **2** | **Requirement Analysis phase** |  |  |  | |  |
|  | Gathering data for proposed project |  |  |  | |  |
|  | Literature review |  |  |  | |  |
|  | Context analysis |  |  |  | |  |
|  | User persona survey |  |  |  | |  |
|  | Collected information analysis |  |  |  | |  |
|  | Project success metrics |  |  |  | |  |
| **3** | **Planning phase** |  |  |  | |  |
|  | List of ideas and concepts |  |  |  | |  |
| **4** | **Design phase** |  |  |  | |  |
|  | Create the Gantt chart |  |  |  | |  |
|  | Paper prototype |  |  |  | |  |
|  | Flowchart |  |  |  | |  |
| **5** | **Implementation phase** |  |  |  | |  |
|  | Unity packages and resources |  |  |  | |  |
|  | Development |  |  |  | |  |
|  | Testing |  |  |  | |  |
| **6** | **Evaluation and monitoring** |  |  |  | |  |
|  | Results analysis |  |  |  | |  |
|  | Success evaluation |  |  |  | |  |
| **7** | **Discussion** |  |  |  | |  |
|  | Complete the documentation |  |  |  | |  |
|  | Conclusion for the project |  |  |  | |  |
| **8** | **Complete the FYP thesis** |  |  |  | |  |
| **9** | **Viva presentation session** |  |  |  | |  |

### **3.5 Conclusion**

# **Chapter 4 Project Development**

# **Chapter 5 Evaluation / Results**

# **Chapter 6 Discussion**

# **Chapter 7 Reflection**

# **Chapter 8 Conclusion**

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# **Appendix**