Thesis

EXAMINING THE EFFECT OF DIFFERENT TYPES OF TUTORIALS ON NEW PLAYERS OF A COMPUTER SCIENCE TEACHING GAME

by

Vaishnaviben Shah

Submitted in partial fulfillment of the requirements for the degree of Master of Science in Game Science and Design in the Graduate School of the College of Arts, Media and Design of Northeastern University

May, 2018
# Table of Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgement</td>
<td>3</td>
</tr>
<tr>
<td>Abstract</td>
<td>4</td>
</tr>
<tr>
<td>1. Introduction</td>
<td>5</td>
</tr>
<tr>
<td>2. Background</td>
<td>8</td>
</tr>
<tr>
<td>2.1 Types of Tutorials</td>
<td></td>
</tr>
<tr>
<td>2.1.1 Method 01: No Tutorial</td>
<td>8</td>
</tr>
<tr>
<td>2.1.2 Method 02: Non Interactive in game tutorial</td>
<td>10</td>
</tr>
<tr>
<td>2.1.3 Method 03: Interactive In-Game tutorials</td>
<td>11</td>
</tr>
<tr>
<td>2.1.4 Method 04: Background In-Game tutorials</td>
<td>13</td>
</tr>
<tr>
<td>2.2 Eight ways of creating bad tutorials</td>
<td>14</td>
</tr>
<tr>
<td>2.3 GrACE The Game:</td>
<td>16</td>
</tr>
<tr>
<td>2.3.1 Digital versions</td>
<td></td>
</tr>
<tr>
<td>2.3.1.1 Version one</td>
<td>17</td>
</tr>
<tr>
<td>2.3.1.2 Version two (Harteveld, 2015)</td>
<td>18</td>
</tr>
<tr>
<td>2.3.1.3 Version three (2016)</td>
<td>19</td>
</tr>
<tr>
<td>2.3.2 The structure of GrACE</td>
<td>19</td>
</tr>
<tr>
<td>2.3.2.1 Game Architecture Diagram</td>
<td>20</td>
</tr>
<tr>
<td>2.3.2.2 Game Class Diagram</td>
<td>21</td>
</tr>
<tr>
<td>3. Methods</td>
<td>23</td>
</tr>
<tr>
<td>3.1 Tools</td>
<td></td>
</tr>
<tr>
<td>3.1.1 Unity</td>
<td>23</td>
</tr>
<tr>
<td>3.1.2 Eko Studios</td>
<td>25</td>
</tr>
<tr>
<td>3.1.3 Photoshop CC 2016</td>
<td>25</td>
</tr>
<tr>
<td>3.1.4 Lucidchart</td>
<td>25</td>
</tr>
<tr>
<td>3.2 Different kind of tutorials for GrACE</td>
<td>26</td>
</tr>
<tr>
<td>3.2.1 Tutorial 01: Non Interactive In-Game Tutorials</td>
<td>26</td>
</tr>
<tr>
<td>3.2.2 Tutorial 02: Video interactive tutorial</td>
<td>28</td>
</tr>
<tr>
<td>3.2.3 Tutorial 03: Background In-game tutorial</td>
<td>31</td>
</tr>
<tr>
<td>3.3 Playtesting and Survey</td>
<td>33</td>
</tr>
<tr>
<td>4. Result</td>
<td>34</td>
</tr>
<tr>
<td>5. Discussion</td>
<td>38</td>
</tr>
<tr>
<td>6. Conclusion</td>
<td>39</td>
</tr>
</tbody>
</table>
7. Reference

Appendix

Appendix A
1. Limbo,
2. This Is the Only Level,
3. Thomas was Alone,
4. The Swapper,
5. Candy Crush Saga,
6. Infection,
7. Smintheus,
8. VVVVVV,

Appendix B

Appendix C
Acknowledgement

Firstly, I would like to express my sincere gratitude to my thesis committee chairperson and my thesis advisor Dr. Casper Harteveld for allowing me to use GrACE and all previous research work related to the game. I would also like to thank Professor Christopher Barney for motivation, encouragement and useful comments provided during the entire development of my project. Also, I would like to appreciate help from Professor Yetunde Folimiji for supporting my thesis.

I would like to thank Northeastern University Writing Center for help and support they gave me while writing my paper, also to conduct weekly graduate meetings.

I would like to appreciate my classmates for being the constant inspiration for two years of my masters. Last but not the least, I would like to thank my family for supporting and encouraging me to do higher goods.
Abstract

This paper presents three different tutorials for a complex game named GrACE. Tutorials are inspired by a Gamasutra article “4 Ways to Teach Your Players How to Play Your Game” by Darrison J. The first tutorial is the Non-interactive tutorial made by the Northeastern team who also worked on the game. This tutorial uses game design perspective to explain the game. The second tutorial is the video interactive tutorial, made in Eko Studios, an interactive video creation platform. This particular tutorial dives into storytelling perspective of the game. The last tutorial, the background in-game tutorial focuses on giving information while players are engaged in the game. Each tutorial had 15 playtesters who were asked to playtest the tutorial and the game. This paper also discusses pros and cons of each tutorial based on playtests. Results reveal the background in-game tutorial as a superior tutorial among three tutorials for the game. As a result, this paper suggests the game tutorial needs to focus more on teaching players about the mechanics of the game through gameplay.
1. Introduction

The roots of games could be dated long back in the timeline of human existence. The first game to be recorded on paper was in the year 2300 B.C. Games are a way of interaction. They allow players to indulge in the immediate imagination and physical play. Games can take a variety of forms, from competitive sports to a board game and a video game. This paper will focus on video games, mainly to improve the first interaction between a new player and a computer game.

The era of video games, the 1980’s is when video games gained popularity. Games like Tetris (1984), Pac-Man (1980), and Super Mario Brothers (1985) achieved tremendous success. Those games were simple enough to play without any manuals. Most games at that time were simple due to lack of technology. With the dawn of technology, it has become simpler to create intricate games those are graphically beautiful. Mechanics of modern games are a lot more complicated compared to games back in the 80's. Games like World of Warcraft, game developers cannot expect players to learn themselves they have to provide them with proper instructions. In the beginning, gamers had manuals, but nowadays due to competitive nature and experience-oriented industry, game designers do not expect a player to read manuals to teach mechanics and controller instructions (Ray, 2010). Games require much simpler options to guide gamers.

Moreover, regular players are inclined to play PC games, 56% of gamers prefer to play computer games compared to other electronic games (Trends and Statistics, 2017). Over time, PC market has become a huge profit market, around $29.4 billion according to the global game market report. This naturally encourages game developers to create more PC games. However, the game industry is
volatile, an only high-quality game with meaningful experiences can stick around. Developers need to create games that can retain players to earn a massive amount of revenue.

Furthermore, in last ten years game industry changed its perspective when it came to the user experience. On 11 November 2011, the worldwide launch of the first-person shooter video game Call of Duty: Modern Warfare 3 developed by Activision Blizzard, set a new record for the biggest-ever entertainment launch in any format. The game attracted new players; they used Game Audio Tutorial (Richard & Raybould, 2011) so that they can teach novice users. Proper instruction and guiding were one of the reasons behind game’s hit. To retain a player and make their game success, Game designers need to motivate the player to play a game. It is not just to maintain players but to have fun while playing a game. In one of the paper, Raph Koster(2005) mentioned, much of the fun of a game comes from learning to master the game. Instead of throwing a player into deep ends, a game designer should be able to guide players to solve the game. Ernest Adams (2011) mentions that designers need to make players aware of the mechanics and the rules of a game and make them master the essence of a game. To make sure player is mindful of the skills and rules, developers try to teach through gameplay like tutorial and demos.

A tutorial is the first impression of the actual game. Spending a valuable amount of time on the tutorial, a developer can develop a tutorial that can engage and retain the attention of gamer in a game. A study suggests that the 1-Day abandon rate is around 77% (Emarketer, 2015). Thus, it is uttermost essential to increase the training during the first communication and learning phase. Player perspective decides the game complexity. Learnability of given game could be more difficult to a casual gamer than a hardcore gamer (Katelynn A. Kapalo, Alexis R. Dewar, Michael A. Rupp,
James L. Szalma, 2016). It requires game tutorials not just to teach how to play a game but should retain player's attention.

Another reason to take a tutorial as a serious part of game is player experience, 29% of chances of playtime is increased (Andersen, E., O’Rourke E., Liu, Y.-E., Snider, R., Lowdermilk, J., Truong, D., Cooper, S. & Popovic, Z. 2012). A study made 45,000 players play games and examined on HCI factors like the presence of tutorials, the context-sensitivity of tutorial instructions, the freedom to users during the tutorial, and the availability of additional help on demand was used to measure the study plays a significant role while designing the tutorial. Game complexity was decided on bases of players learnability of games (Grossman, T., Fitzmaurice, G., & Attar, R., 2009). A proper guide to a game can make player involved in the game. As above experiment on complex games, this paper will also decide complexity through learnability of a player while playing game.

This thesis aims to examine the new players experience with the different kind tutorials for a complicated game. Also, to analyse whether a tutorial perceive new players to continue the game. Complex mechanics of a game fails to explain to a player what is the aim of the game. One such game is GrAce. It is an educational game with more than three important mechanics of the game. In playtest, session held between 2016 and 2017 showed players losing interest to play the game due to lack of understanding of the game.
2. Background

2.1 Types of Tutorials

Darran Jamieson, an indie game developer, categorizes tutorials into the following subcategories: 

*No Tutorial, Non-Interactive In-Game Tutorials, Interactive In-Game Tutorials and Background In-Game Tutorials.* Also, to get a better understanding of different kind of tutorial games uses, this thesis uses pre-existing games and observation on those games that may help to create better tutorial (Appendix A). Each style has different pros and cons and is discussed below:

2.1.1 Method 01: No Tutorial

*No Tutorial* means not providing any hand-holding tutorials in the game. Giving a player a chance to explore the space, letting them try new options refers to the term, *No Tutorial*. Games like Mario brothers and Limbo (Appendix A) have used *No Tutorial* method; they send players directly into the first level without instruction or proper explanation.

In 1985, a 2D game which successfully was able to change the landscape of video games forever, Mario Brothers. Mario Brothers does not provide any written instructions, such as messages instructing players to ‘press A to jump’. However, most players can follow the path and explore options like jump, kill and get power-ups without any major problem coming on their way. Players are in a position where there is no harm, at least for level one. This method gives time to a player to experiment with controls. Once game developer of Mario Brothers, Miyamoto said “…we wanted the player to gradually and naturally understand what they are doing. The first course purposely designed for players learn more about the game. However, then after that, we want them to play
more freely. That is the approach we have taken with all of the games that we make” (Eurogamer, 2015). Through the effect of memory, a player can recall from earlier experiences and apply it to navigation and problem-solve in the later parts of the game, which leads to a good state of ‘Preparedness’.

Another example of No Tutorial is Limbo. It is a 2D scroller platform based puzzle game. Limbo does not guide players or give any instruction on how to use the controls. Players begin their journey in an inhabitable environment as a little boy. There are no background details provided what the little boy doing in the jungle is. The game uses punishments like falling into a trap and dying, respawnning to the nearest checkpoint and try again. As name Limbo suggest where children tortured and given punishment, developers of the game intended to teach players about the game by providing various penalties. This technique is a bit risky; not many players can understand the meaning of many penalties, new users can lose their interest in beginning few chapters and may not play the game again. Also, no guidelines may get difficult for a player to understand when introduced to a new mechanic of a game.

Overall, No Tutorial refers to games guiding players without ‘hand-holding’. Regarding an optimal learning experience, what better way to teach than to put players in an immediate situation? The actions and events can maintain a player’s attention to help them learn and adapt. Games’ beginning levels are intentionally made to encourage players to try and learn slowly. However, frequent punishments can be a disappointment to some players.
2.1.2 Method 02: Non Interactive in game tutorial

Jamasion (2015) in his article describes this type of tutorial as a left over of game design of a game. Jamison later on elaborated that this kind of tutorial is static. Because of tutorial static nature, explanation of gameplay is through game designing actions. Games like Candy Crush (Appendix A) and Infection (Appendix A) tutorials have used a Non-interactive method.

Candy Crush tutorial, figure 01, choose to explain only one mechanic on one page. They first divided mechanics into few main parts, and each part has sub-parts. For example, figure 01, shows the mechanic of how to crush the same colour of candy. There are four sub-parts/ways of how to crush candies. A first way is to match three candy. Another way is to add four candies in same row or column. The third is to crush candy in L shape using five candies. Also, the last one is to join six candies in one row or column. Game developers of the game purposely used shapes to explain how to crush the candies. It allows a player to remember without overwhelming them with information on the same page.

Figure 01; Candy Crush’s Non-Interactive tutorial    Figure 02; Infection’s Non-Interactive tutorial
Another game that uses a *Non-Interactive* tutorial is Infection. However, developers of Infection choose to implement the method differently. They decide to show a player all mechanics on just one page. Developer Jamasion (2015) confessed that tutorial had a significant design issue, they observed that player would hit the screen, briefly glaze over the tutorial and start to play the game. Curiosity to play lead players wonder how to play the game. Briefly glazing the document did not give players better idea. Most of the players of the game had to go back to the tutorial to refresh the rules of the game.

Overall, a *Non-Interactive* tutorial can be an excellent choice to give the instructions. Developers while implementing *Non-Interactive* tutorial need to remember they do not overwhelm players with much information at the same time. Another pointer to remember is to use symbols instead of text can be a good choice to explain the mechanics of a game.

### 2.1.3 Method 03: Interactive In-Game tutorials

*Interactive In-Game* tutorials allow a player to take a front seat to learn, how to play a game. It involves the player to take action in beginning levels using some guidelines using storytelling mechanics. Two 2D puzzles that implemented *Interactive In-Game* tutorials are Thomas was Alone (Appendix A) and Simtheous(Appendix A).

First, Thomas was Alone has voice over that interact with the player to guide while playing the game. Voiceover helps player guide rectangle looking character to meet other characters. As it shows in following Figure 03, Claire is pink rectangle shape character; voiceover is assisting Thomas giving him clues how to help Claire come out of the problem. It is an exciting way to
implement a tutorial. Since a voice over is an essential part of the game they are non-skippable. Players who want to solve a puzzle without any guidelines may not like this type of play.

Figure 03; Thomas was Alone

Figure 04; Simtheous

Smintheus is another Interactive In-Game tutorial example. The game begins with Lanky the cat forcing the rat to leave his village. In the beginning, the game does not provide any tutorial, but as player precedes the game, an interactive tutorial appears on a screen. It does two things. First, it interacts player with the help of dialogue box. Second, to show them cutscenes, they guide player how to interact with doors.

Overall, an Interactive In-Game tutorial is an excellent way to guide players using storytelling. However, while creating a tutorial one should keep in mind, tutorials should not be mandatory for players. Players who are well aware of the puzzle may not need any instructions; unrequired guideline may not help retain players attention.
2.1.4 Method 04: *Background In-Game tutorials*

Ideal choice to get access to a game is a *background in-game* tutorial. This tutorial expects players to progress through the game. Games like VVVVVV (Appendix A) and Swapper (Appendix A) set an example of a background in-game tutorial.

The game ‘VVVVVV’ used a *background in-game* tutorial to avoid overwhelming their players with information. The message box shows as a player enters the game. VVVVVV displays message stepwise when players start a game, and message visible is left or right move. As a player increments in the game, new information will appear. The game’s tutorial services the purpose of learning slowly and gradually.

![Swapper](image1)

**Figure 04; Swapper**

![VVVVVV](image2)

**Figure 05; VVVVVV**

Another game that uses a *background in-game* tutorial is Swapper. The game uses the unique mechanic to clone a player. To explain this, they use an in-game background tutorial; tutorial carefully shows how to use clone gun. However, the tutorial does not say what the purpose of the
gun or what are limitations of the weapon. How many clones can be made by a gun? What does a clone do? These are few questions that player won’t get from a tutorial.

Overall, a background in-game tutorial is used to teach players slowly and gradually. Their primary focus is to not overwhelm with the information. They give a player to continue or discontinue a tutorial. Most importantly tutorial becomes part of gameplay.

2.2 Eight ways of creating bad tutorials

Veteran game designer, Ernest Adams suggest a few things to avoid while creating tutorials (Adams, 2011). In his designer’s notebook, he wrote down a recipe to create a bad tutorial. According to him, game designers are not natural teachers. Following are eight things not to do while building tutorial.

1. Force the Player to play the tutorial: Trying to overdo the explanation partly in a game kills the user’s curiosity before going to actual fun part of the game. Players may not like to go through a tutorial, every time they make a mistake. Sometimes letting players figure out themselves what they need to do to win a level/a game could be more satisfactory to players. There is no harm to give a tutorial for beginning levels, but option to turn off the tutorial should be included. All players are different; some like to experience and learn the game before looking at the tutorial. It also could be that a player is already aware of the information, overwhelming them with same details may irritate new or old players.

2. Make players read a lot: Giving players screen after screen with faux-medieval language full of anachronisms, nothing to do more but press the button to go from one chapter to the other. Game
designer, Jesse Schell (2012) claims “Nobody reads while playing a game” in his book, The Art of Game Design, explaining how players do not like to read while he or she is in a game. Schell meant making players press the ‘Next’ button without meaningful content may result in not understanding or forgetting previously learned things from starting screens.

3. **Describe buttons and menu items badly:** Asking players to press the ‘Y’ button, without clarifying which button on a screen is ‘Y’ can lead to confusion. Tutorials are supposed to teach what action each menu button is supposed to perform. Sometimes, games also require players to remember icons. Image buttons, ideally take less space, is an ideal choice when developers want to help players remember the symbols. Highlighting or flashing the button makes player remember the icon.

4. **Leave steps out:** Making players play the tutorial without proper instruction about which step they are performing next could mislead them. Players can get confused with buttons and menu on the same screen, without proper instructions. An adequate tutorial will not leave the in-between player steps to learn on their own.

5. **Punish the player's inexperience:** A game can give unnecessary details or make them respawn from the start of a game for each mistake performed could be a huge mistake. If a player fails to perform even a simple task, they should be asked to perform the task again, immediately. That way a player will not lose his enthusiasm to play but to perform the failed task again. The immediate task does two things: one, to try and not get too discouraged and two, to get the feedback where they made a mistake.
6. **Patronize or humiliate your player:** Giving players humiliating comments when they perform poorly will not help them understand where they made a wrong move. Nothing could be more disappointing than laughing or message that breaks the player’s heart to try new moves. Also, players do not need to feel four years old everytime they perform new movements. It has to be a balancing act of appreciation and constructive feedback.

7. **Force the player to complete the whole tutorial:** Imagine making a player play the entire tutorial of a long game like Prey, whose tutorial is 2 hours long without the skip button. Tutorials are supposed to give an overview of game functionality. Sometimes, players may get the idea while they are in a tutorial, they do not necessarily need to finish the whole tutorial.

8. **Not giving them tutorial at all:** Ernest Adams argues that there is no such thing as the intuitive user interface. Throwing players into a game world without giving them proper instructions or not providing a HUD may mislead players to perform the next step. Just because developers have used intuitive way of creating a clear and precise structure of their game, does not necessarily mean it is also understandable to players.

From the above, we get that it is hard to create tutorials. There are no guidelines on how an ideal tutorial may look. An FPS game tutorial will be different than a 2D puzzle game. However, while designing tutorials, one must avoid points mentioned above to give a player unique experience.

2.3 **GrACE The Game:**

Developers of GrACE aim is to teach computer science across the middle school students. In middle schools, there is a need to broaden the interest in learning computational skills. In schools
and colleges there is a lot of pressure to learn how to code, but without understanding the concept of computation regarding computer science. Purpose of Gram’s House Project, Stroy Tech and Grace is to teach computer science to girls, according to developer middle school girls interest in a computer is alarming less (Stewart-Gardiner, C., Carmichael, G., Latham, J., Lozano, N. & Greene, J., 2013). The game further tries to explore the effectiveness of both procedural content generation and collaborative learning to teach computational thinking.

2.3.1 Digital versions

Figure 09, Initial design of GrACE, 2014.

2.3.1.1 Version one

Initial data version of the game did not have any narration. Instead it had nodes and edges which connected each other. It is simple created to make MST(minimum spanning tree). This version was very unstable, due to programming glitches.
2.3.1.2 Version two (Harteveld, 2015)

The concept of this version was created in 2015, by the core team and few computer undergraduate students from Northeastern University. The game has a natural-based theme; theme allows middle school students to focus on testing the appeal of a variety of metaphors. In the game, two characters are the centre point of the game— a mouse and a rabbit. Characters aim to collect vegetables. Vegetables (nodes) in the ground are connected by cracks (edges). Developers gave two different tasks to mouse and bunny. The mouse can fit through the edges and rabbit can dig the edges. Edge weight corresponds to the amount of bunny energy needed to dig along a crack. A player is supposed to operate as mouse and flag cracks for the rabbit. A limited amount of information is shown on screen at a time. This kind of design was adapted so that players won’t solve the whole game at the same time. There were two versions created one with the element of PCG (Procedural Content Generation) and other without having an element of PCG (Procedural Content Generation).

The standard version contains 11 difficulty levels, each with a single associated puzzle pre-generated by the computer and the same across all instances of the game. The PCG version allows the possibility at any time to generate a new puzzle with the same difficulty level. 100 puzzles for each level were generated. Total 1,100 puzzles were made. Level one contained two nodes and one edge to demonstrate basic game mechanics. Level 11 contained nine nodes and 16 edges.
2.3.1.3 Version three (2016)

Instead of letting a player use the mouse to move and the rabbit to flag the edges, developers decided to create a design that gave both the rabbit and the mouse to dig the land. No more random levels were generated. Each level like the previous version had a problem related to Minimum Spanning Tree. Minimum Spanning Tree, in the computer science, means calculating the efficient way. Spending minimum number to go from one node to the other node is an aim of the game. For example, a player has two options to go from one node to the other node. He can choose to go from the edge which uses 3 points and the other edge which uses 4 points. If a player decides to go from a corner that has 3 points, it means he used a minimum spanning tree to determine which way to choose. Each turn a player plays as a rat or as a rabbit; a player loses one energy point. This version of the game introduced three different kinds of tools a player can choose while playing the game.

➔ Shovel - Tool is used to digging the land. Land that is fertile (previously excavated) will not be allowed to digged. To drill the area, a player has to use the water droplet, amount of water droplet to be used while digging the land is determined by the number on edge.

➔ Sand Bucket - Tool is used to throwing sand on already dug land. If a player uses the sand bucket, a player gains water droplets.

➔ Walk - Tool is to be used to walk on fertile land without losing any water droplet.

2.3.2 The structure of GrACE

Following is the structure explanation of version 2017. Architecture Diagram and Class Diagram are for GrACE, 2017. It is most recent version of GrACE.
2.3.2.1 Game Architecture Diagram

The game architecture of GrAce is the structure of the system comprises of the externally visible properties. This diagram is the most straightforward representation of how principal elements and concepts of GrACE interact with each other. It also can help developer and designers of GrACE to understand more about how the game communicates with each component. Diagram 01, shows the

![Game Architecture Diagram](Diagram 01, Simplified Game Architecture by Vaishnavi Shah for GrAce, 2017)

Simplified version of the game can be determined by its architecture diagram. Each element of the diagram are discussed below:

1. **Game Engine**: Unity is the game engine. Unity is used to create and run the game GrACE. It interacts dynamically with GrACE logic. It continuously sends signals or input player performs.
2. **Game Logic:** Games code merges the physics of the game, assets of the game and input from the game engine. Script or game logic determines how the physics of the game will work.

3. **Game Physics:** GrACE is 2D game, it doesn’t use Z-axis. Characters gravity are off. Player jumping in the game or running are prefabs. Prefabs comes from Assets.

4. **Game Assets and 2D box:** GrACE uses the 2D assets which are made by artist from Northeastern University.

2.3.2.2 Game Class Diagram

![Diagram 02; Class Diagram by Vaishnavi Shah for GrAce, 2017. (Appendix C)](image-url)
Class Diagram is part of the Unified Modeling Language (UML). It is structure diagram that describes system communication with classes. It also shows system’s classes, attributes/parameter, methods and the relationship among objects. Game Control class derives other classes. Game Control class handles TurnManager, ActionManager, UI and GameState classes. Below is discussion of functionality of important classes. Other classes are abstracted or derived from below classes.

**GameState class** maintains state of current state of the game. Attributes of the class saves current level of the game, Present level and last level of the game. Last level of the game is set and get through binary data log file. Binary data log file saves levels and past score of those levels.

**TurnManager class** maintains action of players, rabbit and rat. Action like walk and dig are maintained. TurnManager class also maintains turn counter and turn indicator. It indicates the which player will take the turn next. Turn counter compares the solution with total turns player played.

**ActionManager class** maintains action of water count and energy slider. Along with water counts and energy count, it also calculates and create edges and create tiles.

At the end, **UI class** (user interface) class maintains the dialogue messages like warning, notify problem and success.
3. Methods

3.1 Tools

This project uses multiple tools, following is the decision on tools those are used to build a project.

3.1.1 Unity

Unity is a free game development tool. Unity was used to create original GrACE module (2014 to 2017). Unity has been proved to be the first choice of game developer for 2D games. Unity provides lots of walkthrough tutorials for the 2D games compared to Unreal Engine and GameMakers, could be the reason why game developers use Unity.

Here are few benefits of using Unity,

➔ Simplified Object creation for hierarchical object structures and dependencies. It helps to simplify the code.

➔ Abstraction of requirements, developers are allowed to specify dependencies at runtime and to manage the cross-cutting directly.

➔ Unity increases flexibility; it defers the component configuration to the container. Flexibility helps to support a hierarchy of containers.

➔ Localizing the services, developers can use one service in the separate application.
Unity can read configuration information from standard configuration systems like XML files.

Unity can implement methods to allow additional object construction and container features, such as caching.

It allows architects and developers to implement universal design patterns often found in modern applications more efficient.

Diagram 03, Unity FrameWork from Unity website

Above is the image of how Unity Framework process. The process begins with the runtime tests works. Runtime tests open the new window to test the application. It sends the data once open to Runtime Tests FrameWork. Runtime Tests Framework process data from runtime and runner, runner handle in-build data of the actual Unity. In the end, all the data collected send to Unity.
3.1.2 Eko Studios

Eko Studios began as Interlude, making interactive music videos. From there they became Eko, the world’s leading interactive entertainment platform. Games like #WarGames are part of Eko studio, the game allows to create user choice tutorial.

Eko Studios are new ways of creating interactive serialised entertainment pieces. Eko is free to use. Eko Studios gives easy to use interactive UI compared to Unity for creating interactive tutorials. From visionary filmmakers and game designers to Hollywood entertainment studios, Eko provides creators with a rich set of authoring tools and tutorials to fuel the development of interactive serial entertainment. Eko studios operate with the simple functionality of linking the videos made by users and creating meaningful stories.

3.1.3 Photoshop CC 2016

Photoshop CC provides a vast number of tools, which includes marquee tool, magic brush and many more. Photoshop CC is an ideal tool to create 2D objects. It has tools like masking, cropping, Pen, etc. that are used to create or modify the present image. Photoshop also has a feature to create 2D videos. Using timeline feature of Photoshop, a user can create, edit and modify their videos with audio editing feature.

3.1.4 Lucidchart

Lucidchart is a tool to create class diagram, architecture diagram, flow chart. This tool is used to explain the nuance of the GrACE or its tutorials.
3.2 Different kind of tutorials for GrACE

This paper won’t examine the effect of No tutorial on the game. In order create No tutorial, the game may require to go to few major level designing changes. From above discussion (Background 2.1.1) the first level of the game has to be basic level, a level that purposefully require to put only one kind of tool/mechanic in one scene/level and other tools on other scene/level.

3.2.1 Tutorial 01: Non Interactive In-Game Tutorials

**Purpose:** Non-Interactive GrACE tutorial purpose is to make sure new player understands the game’s purpose and how to interact with characters of the game.

**Implementation:**

This tutorial was designed by Northeastern GrACE Team. I was part of the team that designed and playtested the game.
Figure 02 is a general structure of the non-interactive tutorial for the GrACE. To make sure a player will give attention to the tutorial, we implemented it in the menu section of the game. The player when enter for the first time, log data will be empty. This empty log data will be open by TurnManager class which will signal GameController class that player is new. While creating Grid class of the game, GameController class will make sure all the level are not open except for the tutorial part.
To create this tutorial we used HUD in which Image Component is used in Section 01. Section 02 uses Text Section of a tutorial. Moreover, the last section uses two buttons. One is to go to the Previous page. It has the address of the previous page. Next button will have an address of next page expect of the last page has an address of Menu scene. While pressing the last page Next button, it will make flag true for a level 01. Moreover, now level 01 can be accessed from the game.

Structure of the tutorial has an image section on each picture highlighted by arrows players attention is needed. Only the highlighted from picture section is discussed in the Text section. We have made sure the player can get the idea from a picture what tutorial is trying to explain them at that point.

3.2.2 Tutorial 02: Video interactive tutorial

The Interactive Video tutorial, is another way of having an Interactive in-game tutorial. Novice players may understand better by looking at videos that interact with them about how things are working.

**Purpose:** Purpose is to create an interactive story, it should relate to players so that they can easily understand the mechanics of the game.
Diagram 05, *The flow chart of Video interactive tutorial by Vaishnavi Shah*

**Implementation:**

GrACE is an educational game; its purpose is to teach computation regarding computer science. The tutorial is supposed to teach mechanics of the game and not the actual solution. GrACE interactive video tutorial purpose is to teach player through storytelling. This tutorial uses a story of an older version. Two characters rat and rabbit are travelling through a desert. They need to grow crops to survive in a desert. They have a limited amount of water. They have to help each other to survive the quest.
The flow of the story (Diagram 02) is to introduce the desert. Players once finish they can continue and learn more about Scout and Hopper. Players are asked to continue the tutorial where they show three different options, which are Shovel, Sand bucket and Walk. To grow crops they need to dig the land. If they want to fill the land, they can use sand. Moreover, if they are going to walk, they can select walking as an action. The tutorial explains mechanics of each tool. Decision at the end will decide which tool will play. A player can decide to dig the land if they say yes, it will play the tutorial which expresses how a shovel works. Also, it also shows repercussion of using a shovel, like using water count and energy point. It follows with another major decision which next tool process they will like to use, bucket or walk. Once they finish the second tool, they have to decide on selecting to continue the playing last tool or to end process. The process is same for other two tools as the process of digging the land goes.

Above described flow was implemented in Eko studios. It is a simplified interactive tool to use. It works just like Scratch. Dragging and dropping nodes. To connect the nodes connectors are used. The tutorial uses a parallel connector. The parallel connector connects nodes; connected nodes will work synchronised with each other. Each screen lasts for at least 20 frames. Each screen gives only one new and essential information. To grab the attention at a particular area of the screen, we have used to highlight and arrow buttons. Each page also has written instruction that highlights the action of that particular scene. George Fan, the creator of Plants vs Zombies, suggest that there should not be more than eight words on a screen. This tutorial follows the same rule. Players are not pressured to play the tutorial. There is an option to discontinue the tutorial. Players should not be forced to play
the tutorial. To create animated videos Photoshop was used. All the assets were part of 2016, however, for video purpose, few of the assets are created in Photoshop.

To implement this tutorial in the game, original developers can simply add a video window, or they can use cutscene to create the video tutorials. First, implementing separate window for may help new players to familiarise the surrounding using rewind and pause button. The second way the cutscene is part of Unity tool. Creating sequence of cutscenes which are to be played every time player click a button. It would be a replica of interactive video created in Eko studios.

Like the game Thomas was Alone (Appendix A) game is trying to interact uniquely. Thomas was Alone used voice narration for interaction whereas GrACE interaction used storytelling video tutorial interacts. A tutorial goal is to involve a player in a game through narration.

3.2.3 Tutorial 03: Background In-game tutorial

*Background In-game tutorial,* guides through each step in-beginning of a game.

**Purpose:** *Background In-game tutorial* for GrACE is created with the purpose to teach players at each step how to perform a task.

**Implementation:**

Structure of the tutorial is created to stepwise teach players how to play the game. Players are shown instruction using dialogue box and highlighting. This tutorial aim is to explain actions of each tool without giving away the central idea of the game, which is to find the shortest path. The tutorial is created to guide players to learn how to use those tools to find the way.
The tutorial is made in Unity using some unity assets and assets from older version 2016 of the game. The animator and animation controller used, the tutorial can create dialogue box. A dialogue box appears on each step. As per the game, the first step is always to dig the nearest edge. Instead of showing which path to choose. The tutorial explains the consequences of selecting the path. As per rules of the game, shovel takes one energy point, and water points depend on the droplet number of the chosen path. Tutorial tries to teach that by using the arrow button and dialogue box popping up that shows how many water droplets are deducting from the water points.

Player attention is restricted using disabling other possibilities. In the beginning to make a more straightforward choice for a player they have only one choice, click shovel. A successful click leads to choosing between two buttons. This pattern is used to make players familiarise with one tool and later on making it little more complicated so that they are not overwhelmed with the information.

Implementing the tutorial should be easy. GameController class (Diagram 02) can have an association with MenuManager. MenuManager extends with Dialogue Manager; dialogue manager will allow showing messages dynamically. GameController at present has an association with TurnManager, which allows interchange change between Hopper and Scout. To create the map they can use Grid and Edge. Once a map has created UIManager can create warning buttons.

Above three tutorials does not use a skip button. For present study a new player has to play the tutorial and than retain the game they are suppose to play for better understanding the effect each tutorial had on a player.
3.3 Playtesting and Survey

Playtesters were invited to playtest the tutorials and the game, afterwards fill the survey form. Players were invited through social media applications like Facebook and Whatsapp. Playtesters were of age between $\geq 18$ and $\leq 35$. Before playtesting the game, players were asked how much time they spend per week on playing games. For this particular playtest we required novice players, who play games less than 20 hours per week. Tutorials are meant to be usually played by novice players to get the idea of the game. Playtest took place in Northeastern Snell library and also online using google drive which the link is attached.

Playtesters, in the beginning, were informed that they are not bound to complete the game. Anytime they can stop playing the game. Also, playtesters were notified no personal data would be collected except for their email id for unique identification, however, notes in-between the game will be taken by a developer. Once we made sure playtesters were comfortable, we asked them to open the word document (Appendix B). Word document had a link to google drive of the game and tutorials. We were able to get 45 people for playtesting. Players were randomly divided into three equal groups to playtest a different kind of tutorial and playtest the GrACE version 2017.

Playtesters once complete playing the game were asked to fill the survey (Appendix B). This paper uses the survey so that it is accessible to analysis the answers of playtesters. The survey uses close and open-ended questions. The survey asked close-ended questions like did you play the game after watching/ playing the tutorial? Close-ended questions in the survey were used to determine the players choice of selection from given choices. Questions asked in the study has used Patton (2017) guidelines for playtesting. Total six close questions were asked to know whether players were able to
understand basic mechanics of the game or not. Out of six questions one question was self-assessment question and remaining five question was about comprehending weather they understood the mechanics of the game. Four open-ended questions were asked at the beginning of the survey to gather the detail when and at what time they start playing the game. Patton (2017) in his guidelines mention that players suggestions are valuable because it allows developers for future improvements. Open-ended questions in the survey were asked at the end of the study to see the improvement a player would like to see in future for the game and for the tutorial they played if the game was supposed to implement the tutorial.

Once the data were gathered, they were compare to determine the relationship between each other. Method ANOVA one-way is used to determine if there is any statistical difference between two independent data. For example, it allows specifying if there were any relationship between the start and the end time of the game with levels played. It could also be used to know if the tutorial had the relationship with the story.

4. Result

Players were randomly divided into three different types of tutorials and then played the game. Overall result, the highest level a player reached was 8. Median levels played is 3, and minimum completed levels are one.

<table>
<thead>
<tr>
<th>Types of Tutorial</th>
<th>Average time and sd spent on the game</th>
<th>Levels played</th>
<th>Number of players</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Start time - end time) minutes</td>
<td>sd(total levels)</td>
<td>who consider story is most important of the game (rated or 5 from scale of to 5)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Non-Interactive In-Game Tutorials</strong></td>
<td>34.6</td>
<td>7.68</td>
<td>1.34</td>
</tr>
<tr>
<td><strong>Video interactive tutorial</strong></td>
<td>10.0</td>
<td>3.394</td>
<td>2.00</td>
</tr>
<tr>
<td><strong>Background In-game tutorial</strong></td>
<td>15.9</td>
<td>6.29</td>
<td>1.16</td>
</tr>
</tbody>
</table>

Table 01: Result

Non - Interactive tutorial: Total 15 players playtested the game and the tutorial. Highest level reach by a player is 6. Minimum level played is one. Average levels played are 2.00 with a standard deviation of 1.34 (Table 01). Median time played is 30.8 minutes (Table 01). Eight players consider story is critical part of the game.

Observation for Non - Interactive tutorial: 12 out of 15 players looked at tutorial more than two times while they were in the game. One player mentioned he did not look at the tutorial properly, but
when he started playing the game, he was not to understand the game and that is when he looked at Non-interactive tutorial again.

*Video Interactive tutorial:* Total 15 players playtested the game and the tutorial. Highest level reach by a player is 6. Minimum level played is two. Average levels played are 3.00 with the variance of 2.00(from Table 01). Average time played is 10.00 minute (Table 01).2 players consider that story in important part of the game.

*Observation for Video Interactive tutorial:* 8 out of 15 novice players while playing the game mentioned that they like watching walkthrough videos and other game related videos compared to playing the game itself. One of the players of Video interactive tutorial mentioned that she could relate to this tutorial mostly because it was interactive and it didn’t reveal the possible solution.

*Background In-game tutorial:* Highest level reach by a player is 8. Minimum level played is one. Average levels played are 4.00 with the variance of 1.16 (from Table 01). Average time played is 15.9 minute (Table 01).Eleven players who played Background In-game tutorial consider story is important part of the game.

*Observation for the In-game tutorial:* Most players spent most of their time on level 3. 5 out of 15 mentioned that they had difficulty playing the game after playing the tutorial. One of playtester said she had trouble in mapping both players movements because she in the tutorial learned about only one player movement.

ANOVA one-way test concluded that there is no significant difference in mean time of levels played, $F (5,13.50) = 2.51, p = ns$. Test was also run on storytelling with how many levels they
played 0.12. There was significant effect on levels played at $p < 0.05$, $F(2,95.06) = 2.39$, $p = .04$ for condition. The post-hoc Tukey's HSD tests showed that Static tutorial-In-game tutorial had lower levels played of group Static tutorial-In-game tutorial than the other two groups at the .04 level suggesting there is no significant difference. All other comparisons are significant (Appendix C).

All the above mentioned tutorials aim to teach players basic mechanic of the game, close-ended comprehension questions focuses on how much player has understood the game. Close-ended comprehension questions from the survey revealed that 38 players correctly answered Mouse who took the first turn while seven-player choose Rabbit (Appendix C, Table 02). Also, it can be identified from question 12 (Appendix C, Table 02) most players answered 1 point would deduct when a character takes first turn in the game. 42 players guessed the shovel is used to dig the land; 2 players guessed water and shovel is used to dig the land in the game, and one player speculated water is used to drill the land. Types of tutorials does not have an effect on comprehending the game. Average time spent on the game is 36 minutes. Most players played 7 minutes on the game. Self-assessment question about how confident players were to play the game without the tutorial, 11 players of Non-Interactive tutorial answered they were not sure they would have played the game without the tutorial. Thirteen players who played the Video interactive tutorial explained they wouldn’t be able to play the game without the tutorial. And 15 players who played Background In-game tutorial mention they won’t be able to play with the tutorial.
5. Discussion

From survey results and observation, our findings show that types of tutorials are closely related to the number of levels played. ANOVA test suggests that there is a significant difference in the total number of levels played for different types of tutorials. In addition, from results highest level players played by Background In-game tutorial players played higher levels with compared to Interactive Video tutorial and Non-interactive tutorial. It means that most players who first played background in-game tutorial were able to play more levels compared to other levels.

Interestingly from the start time and the end time of the survey, we learn that players who took Interactive Video tutorial and in-game background tutorial played less than half an hour which is less than requested playtime. As per observation reasons for lesser playtime in the background, the tutorial was not able to understand the play of characters, because in-game background tutorial has not implemented how characters play together.

This paper aims to create tutorials those can teach players basic mechanics of the game from close-ended questions in the survey to know whether players comprehend the basic mechanics of the game suggest that 85% of players were able to understand the use of tools whereas 15% were not able to understand basic knowledge of the tools used in the game. Results suggest that most players can understand the basic mechanics from the tutorials. However, survey results show no significant difference between types of tutorials played with the necessary learning rules of the game.
6. Conclusion

It is clear from the data that tutorials are able to teach basic mechanics of the game. Among all three tutorials, most players of *Background In-game* tutorial are able to complete higher number of tutorials compared to *Non Interactive* tutorial and *Interactive Video* tutorial. But, it lacks to teach how characters can play with each other which may have been reason for players not retaining to play the game for longer period of time.

Tutorials were able to retain players to play starting levels of the game. But, tutorials were not able to retain players for longer period of time.

College students playtest the tutorials with the game, but they were separately present to players. Tutorial was not part of the game. It is yet to test how the middle school students perform from a different culture. Another immediate thing to implement in a tutorial would be to add skip button. An ideal background in-game tutorial for GrACE might have an interactive visual that highlights the important information of the game while a player is in a beginning stage of the game.
7. Reference


Appendix

Appendix A

I would like to discuss 2D scroller puzzle games. Written points are based on my observation.

Popular puzzle games:

1. Limbo,

![Picture 1, Limbo.](image)

- Independent studio Playdead attempt to create puzzle-based platform named Limbo in 2010. It is a 2D side-scroller game first released in Xbox Arcade.
- The ultimate goal is limbo guy wants to find his sister in an unfriendly environment.
- The game is taking place from a third-person perspective. It is a story puzzle game.
- The game begins with a player in unknown place in what looks from silhouette as forest.
2. **This Is the Only Level,**

- This 2D side-scroller free to play game is puzzle solving game.
- Each level requires some kind of out-of-box approach. Players are expected to play as a blue elephant.
- It is mobile game.
- In beginning of each level, game gives some kind of clue.

3. **Thomas was Alone,**

Picture 03, Thomas was Alone, narration of the game and character who’s turn it is are shown in picture. Thomas was Alone is an award-winning game created by Mike Bithell.

- The game that must have broken lots of moulds, characters which represented just by different shapes and coloured of rectangles.
- Thomas is pink rectangle trying to understand world surround him. He takes help of narration. The game narration is by Danny Wallace which creates nuance and depth.
The simplicity of character and their representation are easy to understand. Every level demands the player to place Thomas in a difficult situation.

As Thomas surpasses the situation, he meets new rectangle-shape characters. Each character is unique in the way of narration. All the character have to find their own portal, but before that help each other to find the portal.

Narrative encourages to think positively, is what touch the most.

To watch the playthrough of the game, go to https://www.youtube.com/watch?v=LKa75JB0PoE&t=141s.

Better understand go to Thomas Was Alone Changed My Life - analysis by Ryan Hollinger.

4. The Swapper,

The Swapper is platform-puzzle game.

The game opens in space, with following scene building how a player had to crashland in an alienated planet.
A player is left with no choice but to go into building that looks like an old civilization.

Player find a gun. It is a clone gun. As name suggests it creates clones of a player. But player has to remember clone are dummy clones. And will follow player’s move.

But death of clone can affect a player.

For walkthrough please visit, https://www.youtube.com/watch?v=ZSkyKPlzttE.

5. Candy Crush Saga,

People's choice puzzle game, Candy Crush is 3d puzzle game. I included this game in the list because They were able to create two tutorials in one game. One static tutorial is includes three main mechanic which they have included in menu bar. At any stage of the game, player can see the basic mechanic. This is where players are shown static page, which illustrates picture of mechanic with following with text explaining how to crush the candies. One is static tutorial other is in-game tutorial. When some different power-up or other candy is included it show the in-game tutorial which includes purpose of the candy. But important part is this is only shown once, due to different levels it is not necessary these different candies will be repeated in other game. My personal
experience while playing this game, I experienced the problem where I forgot the use. Since I didn’t know the use I lost 2 lives just to know what cotton candy does. I feel why giving away so many different mechanics to different kind of candies they should give option of in game description what candy does.

6. Infection,

2d online game created by Indie developers www.spiffinggames.com. It is a multiplayer game.

7. Smintheus,

Smintheus is 2D platform puzzle game. Main character, Gerald, the mouse is forced to leave the village due to danger. Local dweller, Lanky the cat is trying to destroy the village. Goal of the game is to destroy the cat. Game uses storytelling to interact with player to explain mechanics of the game.

8. VVVVVV,

➔ A player with fellow scientist phases some trouble. They are forced to leave the place. In that situation, Violate(player) loses the signal and all crew member. She gets to know that few crewmembers were successfully able to get out of the facility and in two days they will abound that place.

➔ She has to rescue five crew member. The game set-up is more like the 70s-80s game, which looks like pixel characters. The player can reserve jump on the wall and walk on ceilings are few mechanics are encouraged to use in a process to win the levels.
Appendix B

Survey Questions

1. Enter the email address:

2. Enter the start time of the game

3. Enter the end time of the game

4. Date when you played the game

5. How many levels did you play?

6. Which Kind of tutorial did you play?
   - Static tutorial
   - Interactive Video Tutorial
   - In game tutorial
   - None of the above

7. Which button used while digging the land?

8. How much importance a story is to you while playing the game?

9. Who took the first turn? Rabbit or Mouse
   - Rabbit
   - Rat
   - None of the above

10. If the ground is dug correctly, but there is no water drop left. What will you do?

11. According to you without proper instruction would you have been able to play the game?

12. How much of energy in total used if the rabbit took his first time?
13. Please describe your experience with regards to the game?

14. Changes you think should be implemented for next version of the tutorial?

<table>
<thead>
<tr>
<th>Types of Tutorial</th>
<th>Next step after dig (Water/Use the sand)</th>
<th>Players choice shove</th>
<th>First turn (Mouse)</th>
<th>Without instruction would not have been able to play</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Interactive tutorial</td>
<td>14</td>
<td>15</td>
<td>11</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>Interactive video tutorial</td>
<td>15</td>
<td>15</td>
<td>13</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Background In game</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td></td>
<td>45</td>
</tr>
</tbody>
</table>

Table 02, Comprehended questions and self-interpreting question

Appendix C

Screenshot from Google Analytics form

![Pie Chart](image)

Did you play the game?
46 responses

Number of Players who played the game after playing tutorial.
Which button to be use while digging the land

<table>
<thead>
<tr>
<th>Button</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above</td>
<td>45 (57%)</td>
</tr>
<tr>
<td>Water Scout bar</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Bucket</td>
<td>4 (5%)</td>
</tr>
</tbody>
</table>

Button to use dig the land

Who took the first turn? Rabbit or Rat

- Rabbit: 73.9%
- Rat: 26.1%
- None of the above: 0%

How much importance story is to you while playing game

- 0 (0%)
- 1 (2.2%)
- 2 (4.4%)
- 3 (17.1%)
- 4 (44.4%)
- 5 (8.9%)
According to you, without proper instruction would you have been able to play the game?

46 responses

If ground is dig properly, but there is no water drop left. What will you do?

<5 responses
Copy of class diagram
Difference between different types of tutorials and levels played.

Fit: aov(formula = data_Tutorial$How.many.levels.were.you.able.to.play.the.game ~
     data_Tutorial$Which.kind.of.tutorial.you.played, data = data_Tutorial)

$`data_Tutorial$Which.kind.of.tutorial.you.played`

         diff   lwr      upr    p adj
In-game tutorial tutorial-Interactive video tutorial 1.2541667 -0.07656534 2.5848987 0.0682700
Static tutorial-Interactive video tutorial 0.2205128 -1.18254990 1.6235755 0.9228019
Static tutorial-In-game tutorial -1.0336538 -2.41620977 0.3489021 0.1764127