■   3123

Design and Development of Curious Jojo©
A Go-Green 3D Game on Android

Juliana A. Abubakar*[1], Ariffin Abd. Mutalib[2], Dendi Permadi[3]
UUM ViCube Lab, School of Multimedia Technology & Communication Universiti Utara
Malaysia
Corresponding author, e-mail: am.ariffin@uum.edu.my, dendi@gmail.com

Abstract

Various campaigns such as 'Save the Earth', 'Earth Hour', and 'Reduce, Reuse, Recycle' are held to create environmental awareness among the general public. The effort is seen endlessly using any means of presentation and communication medium in order to ensure the intended message reach its audience. Meanwhile, the availability of mobile devices and the advent of natural user interfaces have simplified the interaction in games so that it is intuitive for vast audience at different abilities. Hence, this would possibly provide wider audience an engaging experience while playing games and at the same time absorbing the intended message. This article describes the process of designing and developing a go-green tridimensional (3D) game on a mobile platform. It also discusses educational benefits of games and how the concept of environmental awareness is integrated into the game play in order to educate the general public especially the young ones about their social roles. Initial results on performance assessment reveal that the functionality of interactive elements in the game is excellent and young ones did not have difficulties in playing the game. Future work will focus on how 3D mobile games facilitate informal learning process such as inculcating environmental awareness to the general public.

Keywords: 3D game, mobile, environmental awareness, informal learning.

1. Introduction

The increasing rate of solid waste particularly from domestic is alarming. In Malaysia, apart from high-level authority's effort to manage solid waste and build incineration to curb with the waste, various campaigns on environmental awareness are designed and promoted by using any means of presentation and communication medium in order to reach the general public. Campaigns such as 'Save the Earth', 'Earth Hour', and 'Reduce, Reuse, Recycle' are among big concepts that always associated with the environmental awareness campaign.

In recent years, mobile devices such as smart phones and tablets have been equipped with natural user interfaces. These have made human-computer interaction a lot easier and functions of a mobile device are then become versatile. For instance, people may interact with touch screens by simply using fingers via touch screens and simultaneously asking the directions of a place via speech recognition. These multiple abilities and functions are giving all walks of people the opportunities to get relatively quicker messages across language barriers and cultural boundaries. This study attempts to promote the environmental awareness by translating it into the game play where the final version of the game is available for everyone that has the access to a respective mobile platform.

This article describes the process of designing and developing a go green tridimensional (3D) game on a mobile platform. It provides background of this study by discussing the educational benefits of a game. It explains how this concept is integrated into the game play in order to educate the general public on the environmental awareness. Subsequently, the performance of the 3D game is assessed during technology exhibition by the general public to reveal any usability errors.

2. Background

Game is associated with play where the metaphorical magic circle of play is a voluntary, contractual structure that is limited in time and space. This magic circle separates game from

reality but often the boundary of separation is not clear. Hence, the definition by Salen and Zimmerman [1] of computer or electronic games is considered valuable to game designers as "in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome". Despite of widely cited, this definition of game is considered less friendly towards learning as the emphasis is strictly on conflict, rules, and quantifiable outcome. Thus, game for learning version is defined by Champion as "a challenge that offers up the possibility of temporary or permanent tactical resolution without harmful outcomes to the real world situation of the participant" [2]. The edge of pervasive computing has expanded the magic circle of play socially, spatially, and temporally [3]. As we want to focus learning outcomes specific to creating awareness, we offer an extended definition of a 3D mobile game as "a contextual space in which players engage in doing voluntary tasks that represent their social roles in order to create desired awareness". A game compounds a space that embodies situated play for specific tasks to be accomplished. The change of space requires a set of different tasks which increasingly challenging in parallel to increase on skills. In order for desired outcomes are to be part of learning process (and product), social roles designated should be able to comply with rules for real life situation.

2.1. Educational Benefits of Games

It has been found that interactive games can provide educational benefits such as better memory retention [4, 5, 6] and intensive engagement [7, 8]. Games often mention of task and strategy, provides interaction and, at times, collaborative environment that includes multi-player. Games may provide a sense of being socially embedded, being part of a team, building puzzles or games together, sharing messages or riddles, and instructing new players. Other players or scripted agents may add to a sense of competition or serves as a benchmark. Games are often competitive and destructive due to its emphasis on manipulating objects and solving tasks rather than understanding, recovering and preserving. They tend to train and reward action, motor-coordination, and reflexes. They are designed to create activities for us to enjoy. Interaction in game-like environment, such as 3D jigsaw puzzle, is recommended for learning-by-doing in informal education settings [9, 10, 11].

2.2. Instilling Awareness into the Game Play

Awareness is literally defined as knowledge or consciousness or interest. Inculcating awareness includes informing significant values in a matter of interest. As in environmental awareness, the general public must be informed about the significance of reducing, reusing, and recycling solid waste and how they can contribute doing their social roles so that awareness turns into good habits and at the end of the day, becomes a culture. Table 1 lists the designated social roles and game play in accordance to a particular environmental awareness campaign.

Table 1. Incorporating Environmental Awareness into the Game

Game Level	Campaign	Social Roles	Game Play
1	Reduce, Reuse, Recycle	To know types of solid waste To know recycled and recyclable items	Task: To get collectible items Challenge: Bomb traps and bad people Rewards: Points and extra lives
2	Stop Open Burning	To collect recyclable items To know the harm To identify authority To control open burning	Task: To dissolve an open burning Challenge: Fire traps and culprit Rewards: Points, gadgets and extra lives
3	Save the Earth	To know facts on nature reserves To know illegal hunting To learn to save nature reserves	Task: To save wild animals Challenge: Hanging traps and bad people Rewards: Points, gadgets and extra lives

At the time of writing, Level 2 and 3 are still under construction.

As per the definition, awareness is also knowledge; this means it is associated to some forms of learning. As many seem to agree, games have been proven to provide educational

benefits through its engagement factor. Therefore, it is argued that games are capable to instill the awareness to the general public by deriving knowledge via learning facts and figures embedded across the game play. However, the generic questions remain-how do and how much people learn things from games?

Champion [2] suggests that interaction does not help learning as learning is dynamic and may occur due to many approaches. However, interaction may engage players as it provides affordances and 'hard fun' to keep players still. On the other hand, it is proven that strong visual and audio cues, such as real blood colour and pain sounds as in violent games, do affect the recognition memory [12] where players may remember better the details of arousing events [13, 14, 15, 16] and enhancing presence (engagement) would increase memory effects [12]. This again reflects the significance of using principles of multimedia learning in games where, according to [17], "humans focus on the meaning of presented materials and interpret in light of their prior knowledge". As far as we know, findings on emotional cues are often associated with violence and aggressive thoughts in 3D games. In this study, we attempt to explain the process of learning through games and whether interaction and emotional cues in 3D mobile games are able to provide presence (engagement) and motivation of doing the designated social roles. As part of the objectives that is to achieve the ultimate aim of this study, the rest of the article would describe the technical part of this study particularly on the design and development of the 3D mobile game.

3. Game Design and Development

"Curious Jojo" allows the player to be the main character who has specific missions to save the earth. During the beginner's level, the main character "Jojo" should collect all recycled and reusable items which can be found all over the town and put it into the recycle truck in order to get points. These collected points will bring Jojo up to the next level. However, the challenge is that Jojo fears to traps which appear as bombs which have been planted at various places. Another challenge is The Hunter, a wicked and illegal hunter who is on his way to the nearby forest. The bomb and The Hunter may destruct Jojo and Jojo has to come again to his starting point.

During the first game level, in realizing missions on 'Reduce, Reuse, Recycle (3R), Jojo has to collect 20 recycled items which at the end, are transferred into a recycle truck. This also means the player successfully finishes the first level and entitled to go up another level. Before collecting any game point, there is a pop-up window of 'Do you know?' frequently asked questions with answers that share interesting facts of 3R items. Among others are the facts that major football teams have used recycled materials for their jerseys as well as other facts and figures on solid waste.

In the planning stage, storyboard is used to sketch the main scenes with the description of the events occurred during the game. Decisions regarding this game are also available in storyboard: texture materials; background music or any special effects; and hero interactions that is what the player has to do in order to finish the game. The 3D game was developed using Unity3D, a game engine which, among others, has the ability to model the character, adding in interaction using game scripts, and to publish games in various platforms including mobile platforms such as Android and iPhone.

Based on the game play and the content that we had identified, the development process iteratively includes character definition, scene modeling, game scripting, platform conversion, and performance assessments.

3.1. Character Definition

There are two main characters in this 3D game: Jojo and The Hunter. Jojo is represented by a baby who symbolically will inherit this world in future. Therefore, he is determined to make the earth a better place and always curious in ways of doing so. The Hunter, on the other hand, represents a wicked person that performs illegal hunt of wild animals in nearby forest and is not keen on green initiatives. He keeps wandering to stop Jojo doing his mission.

Once characters have been defined, they were modeled and animated in a 3D modeling software. Character modeling utilizes editable poly function. Biped files are then

attached to these characters in order to animate them. Skin modifier is used to attach biped files to characters as shown in Figure 1.
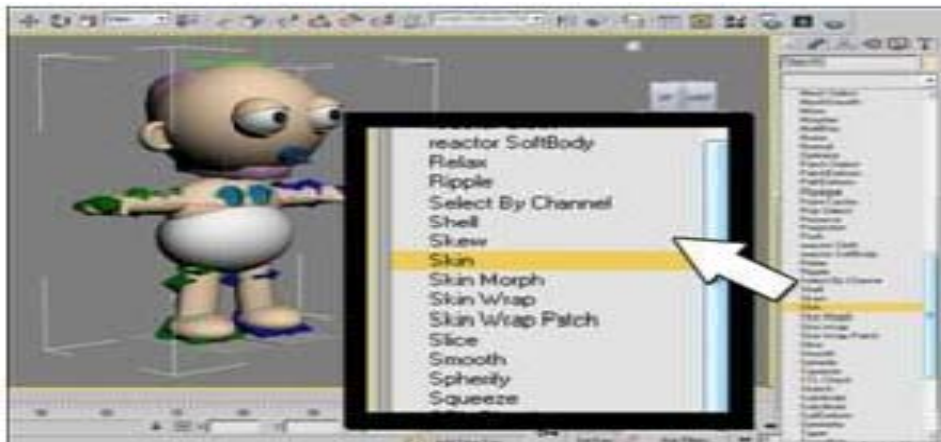

Figure 1. Character Modeling.

These characters were formed using polygon functions and the process of transforming into a new shape requires adding in more polygons onto an object. Upon modeling, the 3D characters were animated according to its predetermined movement.

3.2. Scene Modeling
Scene modeling is performed to develop a screen stage or virtual world where all objects in a specific level of the game should be in place. The virtual world at the Game Level 1 is populated by trees, houses, roads, and collectible items as shown in Figure 2. These items were modeled in the 3D modeling software and were exported to file formats compatible to those of game engines.
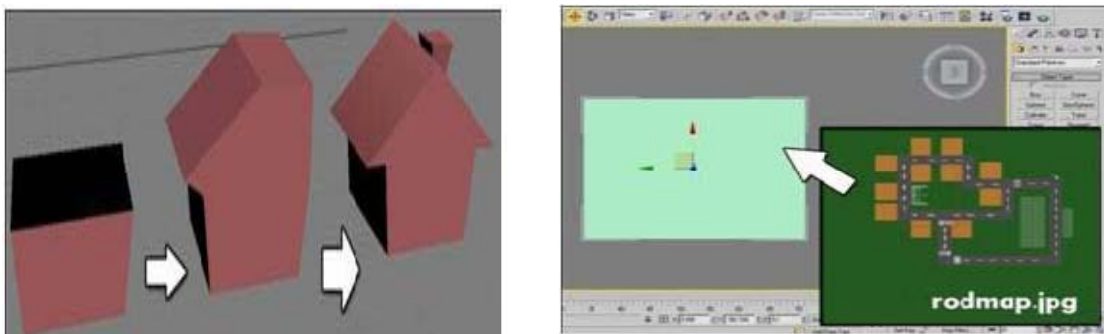

Figure 2. Scene Modeling of House (upper) and Roads

Once these files of 3D objects were imported into game engines, they can be used repeatedly as they were accessible from the software library by means of 'drag and drop' function. This ability makes game development faster and the 3D objects are reusable for future projects.

3.3. Scene Modeling
Game scripting is performed inside the game engine after integrating the 3D game scene, characters and other materials. This process includes setting up cameras, player controller, and adding in collision detection to objects. In this game, third person camera is used

where the camera is set to follow the movements of the main character. The game controller for character movement is designed as virtual buttons similar to gamepad's as depicted in Figure 3.
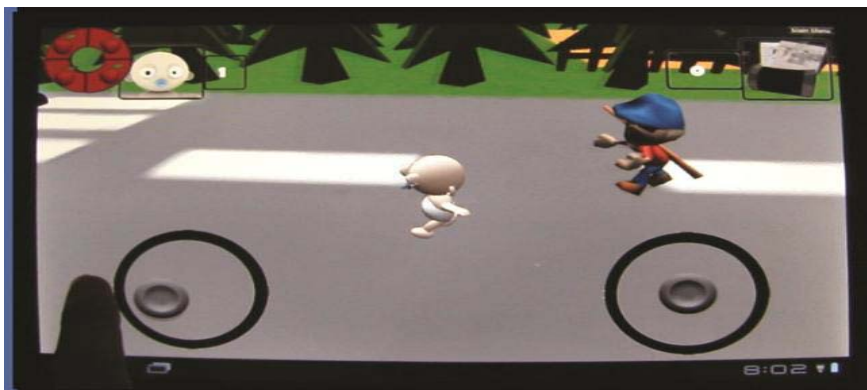

Figure 3. Screenshot of the Game Interface Showing the Use of Third Person Camera and Buttons

Collision detection is added by adding in mesh collider function onto the 3D objects. This function is essential to provide realism of not going through objects that are supposed to be physically solid.

Graphical User Interfaces (GUIs) are important components in a game. GUI in games displayed as menu, options screens and so on. The GUI usually place in a corner, for example the display of score and health status bars. The GUI is created using built-in script from the game engine. The GUI is handled by the Game HUD script, which contains GUI component layout and various elements.

3.4. Platform Conversion

The game engine provides various platform conversions from the personal desktop version that developer normally working on. Mobile platform includes Android and iPhone compatible formats. It also supports older and newer versions of Android such as those versions of Gingerbread and Ice Cream Sandwich. At the moment, Curious Jojo provides compatibility with Android Gingerbread versions.

4. Performance Assessment

The performance assessment of Curious Jojo was conducted in terms of functionality and user assessment. The functionality was done to ensure interactive elements in the game runs perfectly as being expected by its audience. User assessment was carried out during a public exhibition to gauge feedback and recommendations from the general public.

4.1. Functionality

The functionality of icons, buttons, and interactive elements inside this game was assessed once it was installed in tablets and smartphones. At the time of writing, it runs perfectly in Android tablets but further adjustments on graphics and screen resolution need to be done when using smartphones. Subsequent paragraphs describe on the icons, buttons, and interactive elements used in this 3D game.

The game icon is embedded as shortcut in application window as illustrated in Figure 4. Upon launched, the introduction page of the game shows the main character Jojo and the wicked people of The Hunter. The function of virtual button is similar to those in a gamepad device. This similarity may relatively reduce learning time to operate the game.

The first level of the game depicts a housing area where the starting point is fixed. The player is ready to play as the main character Jojo on the mission to collect recyclable items and get rewards that appeared in terms of score at the upper right screen as depicted in Figure 5.

Once all recyclable items are collected, a green truck passes by as shown in and Jojo has to deliver these items to the truck to finish off the first level.

Figure 4. The game Icon (left) and its Introduction Page

Figure 5. Jojo at the Starting Point (left). A Delivery to the Green Truck Marks the end of the Game Level

The second and third level of the game performs similar strategy but differ in context and space. In the second game level, Jojo spends his mission in a paddy field to perform the designated social roles for combating unlimited open burning. Then, he will proceed to the next level at a forest reserve in another mission to combat illegal hunting and logging.

4.2. User Assessment
User assessment was done using an Android tablet during a public exhibition at international level. Public is encouraged to play with the game on their own time. It is observed that users were impressed on the fact that this game embedded social roles to create environmental awareness into its game play.

As most smart phones use touch screens as their natural user interface, virtual 2D buttons are embedded as the game controller. Initial observation shows younger kids (age 4-11) have difficulties in controlling the game but quickly learn how to use it in a short while. However, those who familiar with gamepad did not find any difficulties at all in controlling the game using these 2D buttons.

5. Conclusion and Future Work
This article describes the proof-of-concept on the successful installation of social roles on environmental awareness into the game play. Educational benefits of game have evident in previous literature though its engagement factor. However, such evident is yet not emerged in informal learning such as in instilling social roles games have been proven to provide educational benefits through its engaging factor. Therefore, it is argued that games are capable

to instill the awareness to the general public by deriving knowledge via learning facts and figures embedded across the game play.

The design and development process has undergone character definition, scene modeling, game scripting, and platform conversion from desktop to mobile platforms. Performance of this completed game was assessed during a public exhibition. A quick and simple assessment was made to check its functionality during game execution.

The ultimate aim of this study is to determine the process–and, if possible, product–of informal learning through 3D mobile game. Future work will look into the direction of human-computer interaction which includes the relationship among engagement, motivation, presence, and memory and how these factors affect the process of informal learning such as inculcating environmental awareness to the general public.

References

[1] K Salen, E Zimmerman. *Rules of Play: Game Design Fundamentals*. MIT Press, 2003.
[2] E Champion. Fragging history: Why gamers don´t learn it the old fashioned way, *Journal of International Digital Media and Arts Association*. 2007; 4(1): 11–18.
[3] M Montola. *Exploring the edge of the magic circle: defining pervasive games*. Proceedings of DAC 2005.
[4] C Nelson. Attention and memory: An integrated framework. New York: Oxford University Press. 1995.
[5] M Prensky. Digital game-based learning. McGraw-Hill. 2001.
[6] D Oblinger. The next generation of educational engagement, *Journal of Interactive Media in Education*. 2004; 8: 1–18.
[7] J Randel, B Morris, C Wetzel. The effectiveness of games for educational purposes - a review of recent research, *Simulation & Gaming*. 1992; 23: 261–276.
[8] M Hannafin, S Hooper. Instructional message design: Principles from the behavioral and cognitive sciences. Educational Technology Publications. *Learning principles*. 1993; 191–231.
[9] M Roussou. *Immersive interactive virtual reality and informal education*, Proceedings of User Interfaces for All: Interactive Learning Environments for Children, Athens. 2000.
[10] JA Abubakar, PS Jahnkassim, M Mahmud. *The Effects of Interactive versus Passive Digital Media on Museum Learning*, International Conference on Computing and Informatics ICOCI, Bandung, 2011: 400-406.
[11] L Pujol-Tost, M Economou. Exploring the suitability of virtual reality interactivity for exhibitions through an integrated evaluation: the case of the ename museum. *Online International Museology Journal*. 2007; 4: 84–97.
[12] EJ Jeong, A Biocca, Frank, J. Bohil Corey. *Effects of representational realism in 3d violent games,* Proceedings of the 11th Annual International Workshop on Presence, A. Spagnolli and L. Gamberini, Eds., Padova. 2008; 191–200.
[13] M Bradley. Emotions: Essays on emotion theory. Lawrence Erlbaum Associates, ch. Emotional memory: A dimensional analysis. 1994; 97–134.
[14] R Brown, J Kulik. Flashbulb memories. *Cognition.* 1977; 5: 73–99.
[15] L Cahill, B Prins, M Weber, J McGaugh. Beta-adrenergic activation and memory for emotional events. *Nature*. 1994; 371: 702–704.
[16] F Heuer, DD Reisberg. The handbook of emotion and memory: Research and theory. Lawrence Erlbaum Associates, ch. *Emotion, arousal, and memory for details*. 1992: 151–180.
[17] RE Mayer. *Multimedia learning*. New York: Cambridge University Press, 2001.