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iTrash: Proper Waste Segregation Mobile Game

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Abstract

Objectives: This study developed an educational android game application to engage the young minds of the children with ages 3 years and above to practice proper waste segregation. Through this mobile game application, the user learned the basic segregation processes that are mostly found in the surroundings. **Methods/Statistical Analysis:** Thwack Application was being used in testing the mobile application for its functionality aspect. It was concluded that the application was compatible and can be launched and installed on a device with an operating system of Gingerbread 2.3.1 and as high as the Lollipop 5.0.2 version. The application works well in tablet with a screen resolution of 1024 pixels by 600 pixels. Some of the images and buttons in the application are affected by screen resolutions. They may appear small and difficult to tap when the resolution is small. The mobile application is designed to children age ranges 4 – 5 years of age, because on this range they are very activate in learning lessons especially in terms of educational mobile games. Segregation of waste between what is biodegradable and non-biodegradable. The children who will play this game may need to learn a lot of things before they can get going since this game requires knowledge in terms of classification of waste.

Keywords: Android Application, Digital Game Based, Educational, Educational Game, Proper Waste Segregation

1. Introduction

Way back in the ancient times, solid waste was not a problem since it was mainly organic and the amount of waste was still small. The rapid growth of population and the development in technology have brought astronomical increase in anthropogenic activities along with the contribution of solid waste, thus the need for systematic management of increasing municipal solid waste and the complex waste characteristics has become an urban challenge thereby making waste segregation needed for effective waste management[1].

Another study conducted which cited that environmental problem is a concern of everybody it is either national or international. Solid waste has been scattered everywhere and it should be avoided to have a clean and green environment. To make people aware of it there were some environmental protections needed by means of making it a habit and practice of proper waste segregation and proper waste management[2].

In the year 2012 there was a study that stated at the early stage of the children should be trained to practice proper waste management so that it will be inculcated in their young minds on how to protect the environment and its resources. These are the prerequisite of the so called environmental education[3].

Environmental education is a one of the essential parts that can be integrated in the curriculum of the young children. It should be practiced from elementary level and teacher will be the one who will motivate and instill the mind of the young children for them to be aware of the proper waste management. It can be in the form of games[4].

Digital games are very rampant today that even in the elementary level it has been integrated as a tool for giving lessons it is because it captures the attention of the

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children. Young people will be interested if the lessons are in a form of audio and video presentations. It can be integrated with educational game based with learning. From this aspects, "digital game based learning" as Prensky calls it[6].

With the advent and rapid development of digital games, it has been observed that it becomes a potential learning tool that motivates learners to focus their attention to their lessons[7]. Learners viewed mobile games as entertainment. Some countries introduce this technology to education and schools[8].

Educators using games as an alternative tool in discussing lessons. Today's learners have exposed to the so called educational mobile games. It develops skills in a form of cooperation, collaboration, challenges and developing a skill in problem solving[10]. Based on some research results it was found out that mobile games as instructional tool has a positive result on the level of academic achievement of learners. It opened a wide horizon in the interest of learners, teachers and with the parents[9].

This study developed an educational android game application to engage the young minds of the children with ages 3 years and above to practice proper waste segregation. Through the game, the user will learn the basic segregation processes that are mostly found in the surroundings.

2. Methodology

2.1 Design of the System

2.1.1 Analysis

The researchers have read thoroughly some related studies; it has been analyzed that improper waste management is one of the major contributing factor of the environmental problems. Waste management can be addressed by starting with proper waste segregation. Since environmental education has become crucial, children at their young age must be trained to understand the issue since they are the one to continue what has been started. Waste segregation awareness can be learned through traditional teaching and through the use of technology. Educational games can be used to promote motivation, interest and curiosity of the students as a learning tool. Games can be implemented through variety of platforms; one of those is through android platform. Through mobile devices, the limit in learning inside the four corners of the classroom was broke. Children 2 years old and below should not be exposed to mobile devices due to its harmful effects based on the researches. The proponents then conceived to create an environmentally educational mobile game application that will use as one of the tools to children ranges from age 3 years old and above to practice proper waste segregation.

Figure 1 shows the overview of the trash dash architecture. The data from the user while playing are the inputs and saved it to the applications. The output of the game is directly shown on the Heads Up Display of the application found on the upper part of the application such as the high score, level, money and the current score.

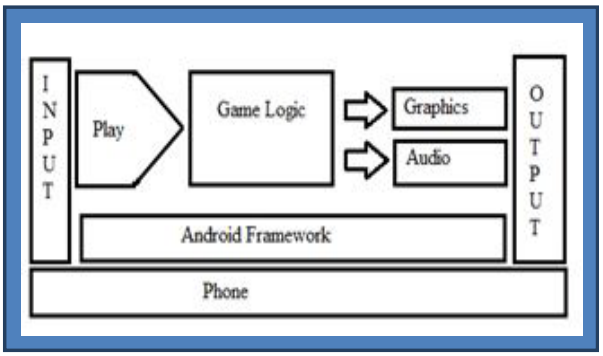


Figure 1. Mobile application architecture.

Figure 2 shows how the game application manipulated. In the main menu, there are three options to choose. These are the play, how to play and about us button. When the play button is tapped, it will redirect to the game map. This game map shows the different places where the players has the options to choose what places to visit- these includes the house, the school, the store and the library. The player can visit these all automatically except for the school place. The school can be visited and played even if the other levels are still locked. The house place includes different levels such as kitchen, dining room, bed room and living room. These four levels were arranged accordingly wherein kitchen comes first. Each level can be played only when the previous level was completed. This place includes one level, the classroom level. The store shows the beach map, coin multiplier and a mini game to be purchased by the player. The library serves as reference to all trash items found in all levels. This can be visited anytime.

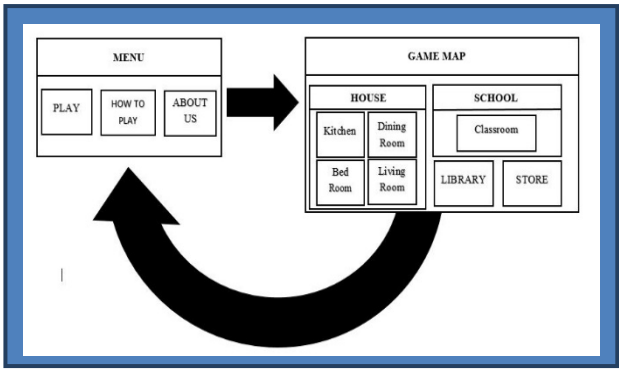


Figure 2. Game flow diagram.

When the how to play button is tapped, it will redirect to the game instructions. Two button options can also be seen, the biodegradable and the non-biodegradable button. Biodegradable button leads to its definition and so with the non-biodegradable button.

2.1.2 Development of the Text File

Here are some snapshots of developing the text file.

Figure 3 shows how fetching and reading the score text file. If the score text file doesn't exist, it will be automatically created. If it exists but is empty, it will be overwritten. Then the read score () function is used to load the text file. The trash items were called as the Sprites. The levels in the application were called Scenes. Box Collider in Physics 2D is the component added to make the items move by itself.

```
public void getscore(){
    score = Normlvl5coring.getScore();

    if(!scoretxtfile.Exists)
    {
        scorew = scoretxtfile.CreateText();
    }
    else
    {
        scoretxtfile.Delete();
        scorew = scoretxtfile.CreateText();
    }

    scorew.WriteLine(score);

    scorew.Close();
}
public static int readscore(){
    scorer = File.OpenText( Application.persistentDataPath +"\\"+ "score.txt");
    tempscore = int.Parse(scorer.ReadToEnd());
    scorer.Close();
    return tempscore;

}
```

Figure 3. Code snippet for fetching and reading the score.

Figure 4 shows the source code for writing and reading the money text file. If the money text file doesn't exist, it will be automatically created. If it exists but is empty, it will be overwritten. Then the read function is used to load the text file.

```
public void write(int money){
    if(!f.Exists)
    {
        w = f.CreateText();
    }
    else
    {
        f.Delete();
        w = f.CreateText();
    }
    w.WriteLine(money);
    w.Close();
}

public void read(){

    r = File.OpenText( Application.persistentDataPath+"/" +"money.txt");
    info = int.Parse(r.ReadToEnd()) ;
    r.Close();
    money = info;

}
public void create(){
    w.WriteLine(writetofile);
    w.Close();



}
void Update () {
    if (Input.GetKeyDown(KeyCode.Escape))
        Application.LoadLevel("map");
}
```

Figure 4. Code snippet for writing and reading the money text file.

2.1.3 Testing and Evaluation

In testing the mobile application functionality, the researchers tested the source codes using the Thwack Application. The code was uploaded to be installed, launched automatically with the application. The proponents also tested the application manually using different devices with different API versions and screen resolutions.

The teacher of the pre-school children issued a certificate of observation of the students about their knowledge in solid waste segregation from June 2014 – February 2015. The researchers deployed the application to the target users who are children that the age ranges start from 3-year-old and above. Respondents were the pre-school children of Macanhan Elementary School. After the demonstration and the actual playing, the proponents launched a test questionnaire with the assistance of the teacher to test whether the children did learn through play.

3. Results and Discussions

3.1 Design

Figure 5 shows snapshot of the first level, the kitchen room

where specific trashes were placed statically. These trashes were considered to be the commonly found trashes in the kitchen area. This level is the first level to be completed inside the house. The score obtained by the player can be seen in the upper-right corner of the screen and below it, is the number of trash left.

Figure 5. Snapshot of the kitchen level.

Figure 6 shows snapshot of the dining room where specific trashes were also placed in random. These trashes were considered to be the commonly found trashes in the dining area. This level comes after the kitchen level. The dining room level is the prerequisite level of the bedroom level. The score obtained by the player can be seen in the upper-right corner of the screen and below it, is the number of trash left.

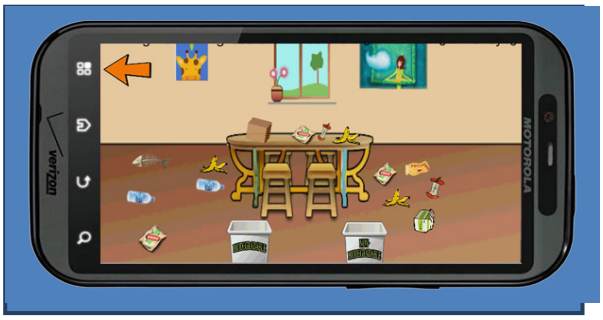


Figure 6. Snapshot of the dining room level.

Figure 7 shows screenshot of the bed room where specific trashes were also placed in random. These trashes were considered to be the commonly found trashes in the bed room regardless of the gender of its player. This level will only be played if the dining room level was completed. This level needs to be completed before proceeding to the next level. The score obtained by the player can be seen in the upper-right corner of the screen and below it, is the number of trash left.

Figure 7. Snapshot of the bed room level.

Figure 8 shows screenshot of the living room level inside the house. This is the level to be played after the bedroom level. It will be the last level inside the house. The score obtained by the player can be seen in the upper-right corner of the screen and below it, is the number of trash left.

Figure 8. Snapshot of the living room level.

Figure 9 shows screenshot of the classroom level. In this level the child will learn to segregate the waste the he has been encountering in their school.

Figure 9. Snapshot of the classroom level.

Figure 10 shows screenshot of the mini game of the application. This can be played when the player has bought this item from the store. There would be leaves that will

fall from the trees and the player has to sweep it using the broom and keep it through the use of the dustpan. The score and coins obtained will be automatically added to the player's previous score and coins.

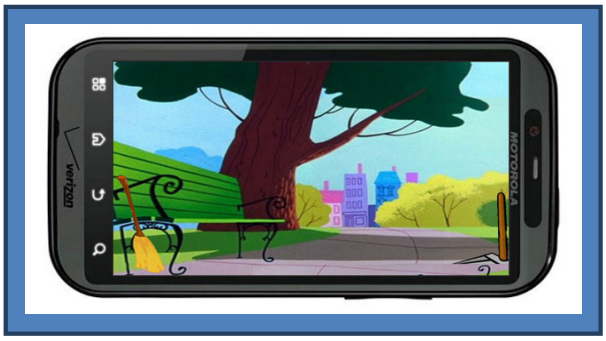


Figure 10. Snapshot of the park level (Mini game).

Figure 11 shows screenshot of the library of the items in the application. It contains the image of the trash, its name and its classification. The items found in the library were the trashes encountered by the user during the game.

Figure 11. Snapshot of the trash library.

Figure 12 shows screenshot the store of the application. It sells the map, the coin multiplier, and the mini game.

Figure 12. Snapshot of the trash store.

3.2 Development of the Text File

Figure 13 shows the screenshot for high score text file created. It determines the highest score attained by the player. It automatically updates as the player plays the game. The figure on the right shows the screenshot for its output which can be seen in the upper-right portion of each level.

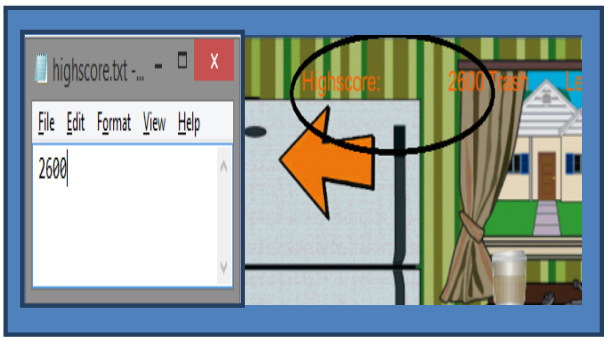


Figure 13. Screenshots of the high score text file and its output.

Figure 14 shows the screenshot for money text file created. It determines the total money earned by the player. It has a default value of 0 and automatically updates as the player plays the game. The figure on the right shows the screenshot for its output which can be seen in the upper-left portion of each level.

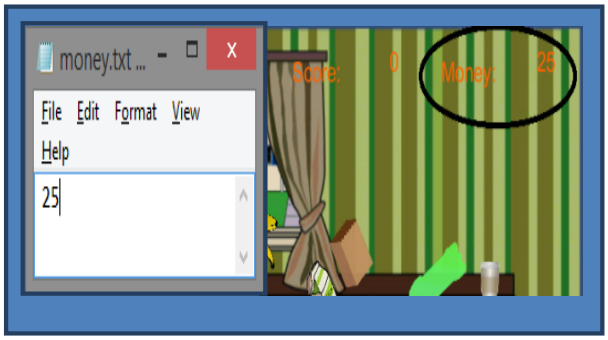


Figure 14. Screenshots of the money text file and its output.

3.3 Evaluation of System Performance and User Interface Design

3.3.1 Performance Evaluation

The proponents tested the source code of the application with Thwack Application. Thwack Application is focused on building automation tools and services particularly

in areas involving complex interactions between distributed devices. The application was tested with 25 devices. The bases of the results are minimum SDK level requirement and CPU architecture. Here are the results for incompatible devices:

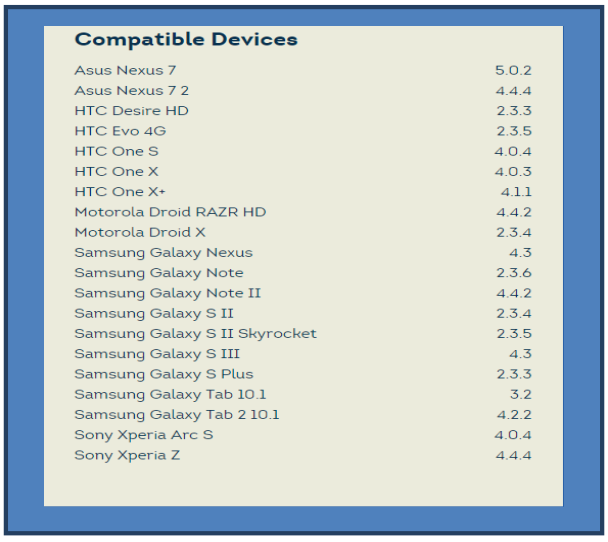
Figure 15 shows the snapshot of the results of the Thwack Application. These results shown are for the incompatible devices of the application. Out of 25 devices 5 devices are not compatible with the application.

Incompatible Devices

HTC Desire	2.1-update1
Minimum SDK level not met	
Samsung Galaxy Ace	2.3.4
Minimum CPU architecture not met	
Samsung Galaxy Mini	2.3.4
Minimum CPU architecture not met	
Samsung Galaxy S	2.1-update1
Minimum SDK level not met	
Samsung Vitality	2.3.4
Minimum CPU architecture not met	

Figure 15. Snapshot of the result for incompatible devices.

Figure 16 shows the snapshot of the results of the Thwack Application. The application was uploaded and was tested automatically by the application whether it can be installed, launched and is fit with the screen resolution. These results are for compatible devices. Based on the result there were 20 devices are compatible out of 25 devices tested.



Compatible Devices

Asus Nexus 7	5.0.2
Asus Nexus 7 2	4.4.4
HTC Desire HD	2.3.3
HTC Evo 4G	2.3.5
HTC One S	4.0.4
HTC One X	4.0.3
HTC One X+	4.1.1
Motorola Droid RAZR HD	4.4.2
Motorola Droid X	2.3.4
Samsung Galaxy Nexus	4.3
Samsung Galaxy Note	2.3.6
Samsung Galaxy Note II	4.4.2
Samsung Galaxy S II	2.3.4
Samsung Galaxy S II Skyrocket	2.3.5
Samsung Galaxy S III	4.3
Samsung Galaxy S Plus	2.3.3
Samsung Galaxy Tab 10.1	3.2
Samsung Galaxy Tab 2 10.1	4.2.2
Sony Xperia Arc S	4.0.4
Sony Xperia Z	4.4.4

Figure 16. Snapshot of the result for compatible devices.

Figure 17 shows the Performance Evaluation of the application by the using Thwack Application. This shows that the average CPU usage of 24.49 %, memory average usage of 37.82 MB, threads average 26.56, frame draw time average of 0.29 ms.

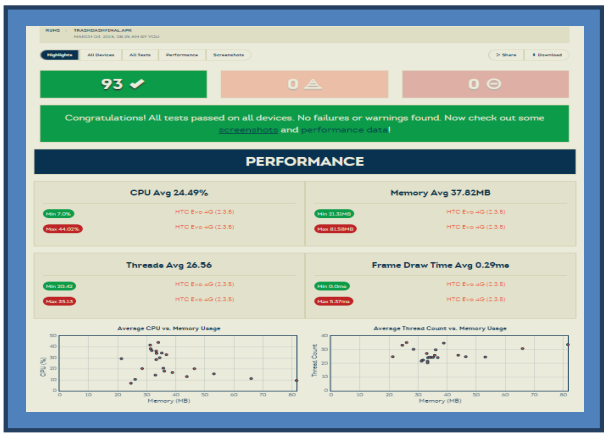


Figure 17. Performance evaluation.

Table 1 shows the result of actual testing done in different devices with different API version and screen resolutions. The application works in Gingerbread API version. This API version was the set minimum API level for the application. The application works well in tablet with a screen resolution of 1280 pixels by 800 pixels. Some of the images and buttons in the application were affected by screen resolutions. They may appear small and difficult to tap when the resolution is small. Some buttons may not work well depending on the device's processor speed.

3.4 Usability Evaluation

3.4.1 Pre-Test Result of K-2 Pupils

Figure 18 shows the screenshot of the observation of the teacher from June 2014 – February 2015. Based on the observation of the teacher, the pupils know how to throw their garbage but they do not know yet how to segregate waste.

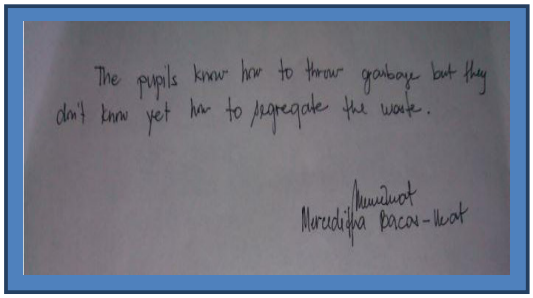


Figure 18. Screenshot of pre-school teacher's observation from June 2014- February 2015.

Table 1. Actual testing results of five different devices

Device Name	Specifications	Remarks
Huawei U8860	Smart Phone OS version: v2.3 (Gingerbread) Processor Speed:1.4 GHz Scorpion RAM:512 MB Screen size: 4 inch Resolution: 854 x 480 pixels Dimensions: 61.5 x 122 x 10.9 mm	The application fits to the screen and the buttons work well. Some buttons may appear small but can still be easily tapped.
Huawei Ascend G510	Smart Phone OS version: v4.1.1 (Jellybean) Processor Speed:1.2GHzdual-core RAM:512 MB Screen size: 4.5 inch Resolution: 854 x 480 pixels Dimensions: 134 x 67 x 9 mm	The application fits to the screen and the buttons work well. Some buttons and images may appear small.
Samsung Galaxy V	Smart Phone OS version: 4.4 (Kitkat) Processor Speed: 1.2GHz Single Core RAM:0.5 GB Screen size: 4.0 inch Resolution: 800 x 480 pixels Dimensions:62.9 x 121.4 x 10.7 mm	The application fits to the screen. Buttons and images appear and work well.
Alcatel OT-4030e	Smart Phone OS version: 4.1 (Jellybean) Processor Speed: 1.0GHz Single Core RAM:512 MB Screen size: 3.5 inch Resolution: 480 x 320 pixels	The application fits to the screen but some images may not appear well. Some buttons may appear small and difficult to tap. The trash items are difficult to tap. The library view may not appear well.
Samsung Galaxy 7.0	Smart Phone OS version: 4.4 (Kitkat) Processor Speed: 1.2GHz RAM:1.5 GB Screen size: 7.0 inch Resolution: 1280 x 800 pixels Dimensions: 186.9 x 107.9 x 9 mm	The application fits to the screen. Buttons and images appear and work well. The trash items can be easily tapped and dragged.

3.4.2 Post-Test Result of K-2 Pupils

Figure 19 shows the post-test results conducted by the researchers at Macanhan Elementary School K-2 pupils. The conducted test consisted 10 items with 5 biodegradable items and 5 non-biodegradable items. The blue bars indicate the number of correct answers where the first blue bar represents the biodegradable items and the second blue bar represents the non-biodegradable items. The orange bars indicate the number of mistakes where the first orange bar represents the biodegradable items and the second orange bar represents the non-biodegradable items. This shows that 84% out of 20 respondents got the right answer regarding the biodegradable segregation. This also shows that 85% out of 20 answered correctly regarding the non-biodegradable segregation.

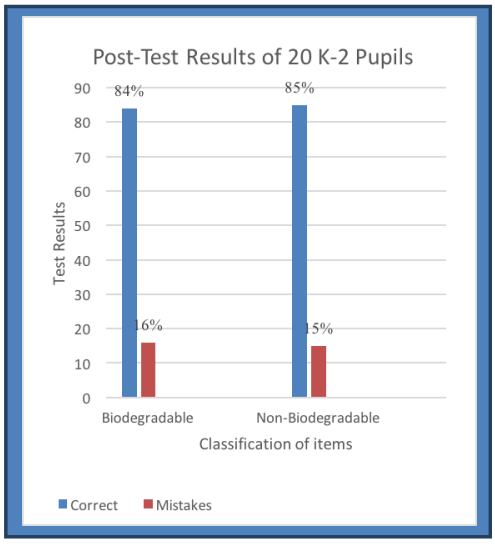


Figure 19. Post test results of 20 K-2 pupils 4 – 5 years of age from Macanhan Elementary School.

4. Conclusions and Recommendations

4.1 Conclusions

After conducting an actual testing of the application to different devices and functionality test by Thwack Application, the researchers conclude that the mobile application can be launched and installed on a device with a minimum API requirement of Gingerbread 2.3.1 and as high as the Lollipop 5.0.2 version. The application works well in tablet with a screen resolution of 1024 pixels by 600 pixels. Some of the images and buttons in the application are affected by screen resolutions. They may appear small and difficult to tap when the resolution is small.

After launching the mobile application to children 4 – 5 years of age, the researchers have noticed that children range within this age are active and motivated to learn the difference between biodegradable and non-biodegradable. Children needs assistance from the parents when they are home as well as the assistance from the teachers when they are in school.

After conducting a usability testing of the game application to the pre-school teacher of the K-2 pupils of Macanhan Elementary School, the proponents have concluded that the game application is easy to use and children will most likely use this application frequently. For better learning, children will need the assistance from their parents and teachers when playing the game. The children who will play this game may need to learn a lot of things before they can get going since this game requires knowledge in terms of classification of waste.

4.2 Recommendations

The application has limited and non-existing functions. For its further development, the researchers highly recommended the following;

- The researchers would like to recommend the game to children ages 3 years and above.
- Guidance from the teachers and parents are highly recommended when the child is playing the game.
- Additional language implementation for further understanding of the children.
- Additional places to practice and levels to make the application more interesting.

5. References

1. Gani G, Bogoro B. Knowledge, Attitude and Practice of Solid Waste Segregation in Bauchi Metropolis. Nigeria.2014; 2(3):1–10.
2. Licy CD, Raghan V, Saritha K, Anies TK, Josphina CT. Awareness, Attitude and Practice of School Students towards Household. Waste Management.2013; 2(6):147–50.
3. Goncharova G, Maria M. Planet play: designing a game for children to promote environmental awareness. Online Journal of Communication & Media Technologies;2012. p. 1–6.
4. Domka L. Environmental education at pre-school. International Research in Geographical and Environmental Education. 2004; 13(313):258–63.
5. Dorman SM. Video and computer games: Effect on children and implications for health education. Journal of School Health. 1997; 67(4):133–8.
6. Prensky M. Digital game-based learning. Computers in Entertainment.2003; 1(1):21–4.
7. Mi KY, Hye KJ, Hak LK, Kyeong BY. Development of virtual reality-based edutainment contents for children's English education.Indian Journal of Science and Technology. 2016 Jul; 9(26).
8. Hong SR, Shin IY. The application of multimedia and wireless technology in education. Indian Journal of Science and Technology. 2015 Aug; 8(20).
9. Park P, Hyungsung H. Relationship between motivation and student's activity on educational game. International Journal of Grid & Distributed Computing. 2012 Mar; 5(1);101.
10. Oblinger D. The next generation of educational engagement. Journal of Interactive Media in Education. 2004; 8:1–18.