Designing a Persuasive Game to Raise Environmental Awareness Among Children: A Design Science Research

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Abstract

Considering the environmental problems that happen globally, environmental education was perceived in this study as an important key to deal with the problems. This study was carried out to support environmental education by exploring persuasive games to raise environmental awareness. Through a design science research (DSR) approach, EcoScout Game was designed as a mobile persuasive game for conveying some existing environmental issues to children. During the DSR, a playtest phase was conducted to evaluate the first level of EcoScout Game that contains persuasion goals to keep the environment clean and to dispose waste correctly. The playtest involved 10 participants age 4 to 6 years that provided various responses. Majority of the participants showed their interests to play the game. When the participants were playing the game, all of them understood that they must keep the environment clean. More than a half of the participants (60%) understood and motivated to follow the waste disposal rules. Several improvements for the game are proposed, especially to help children who are still not able to read textual labels and descriptions in the game. Further development and research are required to advance the game and to confirm its effectiveness in persuading children. However, this study showed a possibility to use persuasive games for raising environmental awareness among children in the context of environmental education. Finally, this study demonstrated a potential to apply DSR in persuasive game design.

Keywords
Design cycle, design science research, environmental awareness, environmental education, game design, persuasive game, persuasive technology

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Foreword

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1. Introduction

In the last decades, many governments and organizations, who concern about sustainable development, have prioritized environmental issues in their agendas and policies. Some environmental issues, such as pollution, deforestation, and global warming, have brought effects in some parts of the Earth. Those environmental issues become global problems, which require global actions and solutions too. Consequently, individuals, private sectors, and all stakeholders are encouraged to concern on environmental issues and to care about the environment.

One of important solution for the environmental issues and problems is to educate children about environmental awareness. This research came from an idea to handle daily environmental issues and problems by raising environmental awareness. For instance, the author used to see littering habits which make environment polluted and unclean in Indonesia. Many people in Indonesia do littering in beaches, streets, and public places. The author even saw multiple times when Indonesian parents directly taught children to litter their plastic waste in public transportations. Littering habits also happen in Finland, where environmental awareness index (EAI) is higher than Indonesia (Kokkinen, 2013). In spite of the high EAI, sometimes people in Finland litter the public places with their trash (Fig. 1) and do not separate their domestic waste regardless of waste disposal regulation in Finland. Those habits of handling waste are real environmental problems that need to stop by educating children.

Figure 1. An example of littering problem in Oulu, Finland

Wijsen and Wijsen (2015) emphasized the children’s roles in handling environmental issues and problems, such as plastic pollutions. In TedGlobal London, they said that “Us, kids may be only 25% of the World’s population, but we are 100% of the future”
Therefore, environmental education (EE) should be provided for children in order that they will develop their awareness to care about the environment. Nunes et al. (2016) also highlight that providing EE for children is the key to raise environmental awareness because children will be the representation of the society in the future. This solution is in line with Kokkinen’s study (2013) that the way people care about environment depends on their environmental awareness level. Environmental awareness level represents the knowledge, motivation, and skill of someone in concerning about the environment (Kokkinen, 2013). The high level of environmental awareness of someone motivates her/him to act responsibly and friendly toward environment (Harju-Autti, 2013).

In this research, several environmental problems were taken and adopted into a mobile game, which was designed to raise environmental awareness among children. The game is a typical persuasive game that developed through a design science research (DSR) and named EcoScout Game. The design of the game consists of three levels in which has specific persuasion goals. The first level of the game contains persuasion goals, which are related to littering habits and waste disposal. The second level has a persuasion goal to motivate children in energy conservation. Lastly, the third level has a persuasion goal to make children care about animal welfare. By conveying those persuasion goals, the game is intended to raise environmental awareness among children and generally to support environmental education (EE). At the end of game development, the game became the DSR artifact and evaluated through a playtest phase that involved children as game testers. The whole processes of the DSR are reported in this thesis and expected to give useful insights and contributions for research of persuasive technology.

This thesis introduction is followed by the explanation of theoretical background in Chapter 2 and then research methodology in Chapter 3. The discussion of research methodology covers the research objective, the research method, and particularly the implementation plan of DSR method to construct EcoScout Game. Chapter 4 explains how the DSR method implemented in two iterations of the design cycle. Chapter 5 reports the game evaluation of the last iteration (the 2nd iteration) in detail. The implications, conclusion, and impact of research are discussed in the last two chapters.
2. Background

This chapter explains the theoretical background of the research that divided into three sections. The first section gives an overview of persuasive games. Afterward, the second chapter presents the concept of environmental awareness and environmental education (EE). The third section discusses the development and the use of persuasive games to raise environmental awareness. The third section also gives some examples of the existing persuasive games.

2.1 Persuasive Games

In this research, a game persuasive game is designed and proposed as a tool to raise environmental awareness among children. Persuasive games are a genre of game, which is developed to persuade or to influence players’ opinions and behaviors that can be educational, political, or advertising games (Khaled et al., 2007; Lavender, 2007). When the primary purpose of a game is to persuade players about a specific set of values or messages, it can be classified as a persuasive game (Løvlie, 2007). Bogost (2007) provides some detail characteristics that persuasive games are intended for bringing messages, presenting arguments, convincing a viewpoint, affecting people’s beliefs, or influencing behaviors in real life (as cited in Trépanier-Jobin, 2016). From this review literature, it could be concluded that persuasive games aim to persuade people who play the games.

Persuasive games have been used for conveying various persuasion messages and purposes since long time (Ferrara, 2013). Ferrara gives the Checkered Game of Life and the Landlord’s Game as some old examples of persuasive games (Ferrara, 2013). The Checkered Game of Life was used in 1866 to convey religious content and moral values (Ferrara, 2013). Meanwhile, The Landlord’s Game was patented in 1904 by Elizabeth Maggie to teach Henry George’s Single Tax theory (Moncada & Moncada, 2014). One century later, computer-based persuasive games have significant increase to support many domains, along with the progress of digital age.

Referring Bogost (2007), persuasive games are a sub-category of serious games (as cited in Busch, 2015). Trépanier-Jobin (2016) mentions that many of serious games are persuasive games too. Michael and Chen (2005) emphasize that a serious game has a main purpose, which is not for amusement (as cited in Wouters, Van der Spek, & Oostendorp, 2009). Serious games are created for non-amusement purposes in general, meanwhile, persuasive games more specifically concern on persuasions purposes to change knowledge, beliefs, or attitude. Since the proposed game in this research particularly conveys persuasion goals to promote environmental awareness, the terminology of persuasive game is used, instead of serious game.

2.2 Environmental Awareness and Environmental Education

Developing environmental awareness has been included in education system of many countries as a part of environmental education (EE). In 1972 the Scottish Education
Department published a report of EE that EE should be provided from primary school and applied by every school (Palmer, 2012). The report also emphasizes that young people should be educated to recognize and to analyze critically the recent environmental problems (Palmer, 2012). The Malaysian government in 1993 included the contents of environmental awareness into the Malaysian curriculum (Noordin & Sulaiman, 2010). Meanwhile, Finland established a strategy for EE in 1994, then it was followed by the establishment strategy of sustainable development education in 2006 (Jeronen, Jeronen, & Raustia, 2009). The Finnish National Core Curriculum for Basic Education (2004) states that “the schools must teach future-oriented thinking and building the future on ecologically, economically, socially, and culturally sustainable premises” (as cited in Jeronen et al., 2009, p.3). One of the curriculum objectives is to educate citizens in order that they are environmentally responsible and support a sustainable lifestyle (Jeronen et al., 2009). Those all examples indicate that education systems have recognized the importance of EE, which promotes environmental awareness.

Environmental education (EE) is “an interdisciplinary effort aimed at helping learners gain the knowledge and skills that would allow them to understand the complex environmental issues facing society as well as the ability to deal effectively and responsibly with them” (Hungerford, 2009, p.2). One important milestone on EE is the Tbilisi Declaration, which is held in 1977 by UNESCO cooperated with UNEP (Gillett, 1977; Newman, 2011). Notably, the declaration resulted in the goals, objectives, and guiding principles for providing EE at local, national, regional, and international levels (The Global Development Research Center, 2018). The declaration also pointed the five objective categories of environmental education which are awareness, knowledge, attitudes, skills, and participation (The Global Development Research Center, 2018). This research focuses on the awareness as objective, which environmental education has "to help individuals and social groups acquire an awareness and sensitivity to the total environment and its allied problem" (The Global Development Research Center, 2018).

The terminology of environmental awareness is highlighted and used for the persuasive content of the game designed in this research. Harju-Autti (2013) explains that someone with high environmental awareness has a certain motivation, knowledge, and skills toward the environment. The motivation leads him/her personal values and attitudes in order to be aware of environmental issues and be environmentally responsible (Harju-Autti, 2013). The knowledge of environmental awareness enriches him/her with information regarding recent environmental problems and the related causality (Harju-Autti, 2013). The skills enable him/her to solve environmental problems or to take the required actions (Harju-Autti, 2013). The Pachamama Alliance offers a definition that environmental awareness is “an understanding the fragility of the environment and the importance of its protection” (Pachamama Alliance, 2017; Ali, Toriman, Gasim, & Juahir, 2015). Referring to the Pachamama Alliance’s definition, EcoScout Game is designed to convey an understanding to children regarding the environment’s fragility and the need to care about the environment. That understanding is expected to lead and motivate children in caring and protecting nature in their daily activities. Overall, this research and EcoScout Game have a primary objective to support environmental education (EE) for children.

2.3 Persuasive Games and Environmental Awareness

Several digital distribution platforms, such as Google Play and App Store, provide many games with environment-related themes. Some examples are TirNua, BBC
Climate Change, Kids for Saving Earth (KSE), and Green Living Game by KIZI. Generally, those games are developed to promote environmental awareness and to support environmental education (EE). Nevertheless, most of those games are lack of evaluation and research. Regardless the increased number of the persuasive games and technology, there are still only a few academic studies that particularly focused on the use of persuasive games to raise environmental awareness in the context of EE.

A research was carried out in Northern Cyprus to observe the use of mobile learning for developing environmental awareness among undergraduate students (Uzunboylu, Cavus, & Ercag, 2009). The research reported significant increase of students’ environmental awareness after they have learned some ways to keep environments clean and to prevent pollution through integrated mobile technologies for six weeks (Uzunboylu et al., 2009). The research did not mention specifically that the mobile learning is a typical persuasive technology. However, it enhances the possibility and the success story of using technology for introducing specific contents that related to environmental awareness.

Rua and Prada (2013) reported a study of Ecofarm as a persuasive game which was developed to raise awareness of agriculture conciliation with local biodiversity in the region of Castro Verde, Portugal. Ecofarm also aimed to encourage users in gaining more knowledge of local business and economics (Rua & Prada, 2013). The development of Ecofarm was motivated by the failures of two previous persuasive video games (Ecofarmer and Rural Value) in persuading users about the sustainability of agricultural systems in Castro Verde (Rua & Prada, 2013). Several techniques and strategies were implemented for the Ecofarm’s development. As the result, Ecofarm was considered more effective than two previous games in increasing users’ awareness of agricultural conciliation with biodiversity in Castro Verde (Rua et al., 2013).

A study published the evaluation of EnergyLife that designed to increase awareness of household energy conservation (Gamberini et al., 2011). EnergyLife was a typical mobile persuasive game which targeted adult people as the end users. The evaluation was conducted through two test fields (Gamberini et al., 2011). The first field focused on user acceptance and usability. The second field measured the effectiveness of the persuasive game to increase energy conservation. The research resulted that EnergyLife was well-accepted and helpful for users to manage electricity consumption (Gamberini et al., 2011). The game also encouraged users to practice efficient habits in energy usage (Gamberini et al., 2011).

Another game was named Protecting the Earth and proposed to raise children’s environmental awareness (Nunes et al., 2016). The game had 3D interfaces and three levels. For the usability test, ten children (between 7 to 10 years-old) played and evaluated the first level of the game in experiments (Nunes et al., 2016). At the first level, the game showed a square full of garbage. Children were expected to make it clean by collecting garbage into the appropriate garbage bin. Mathematics and Science contents were also added to the game by giving the rules of dangerous waste and the maximum capacity of each garbage bin. An adult character, which was called Lady Rose, was provided in the game to help children in handling dangerous waste. The experiments showed that children found difficulties to define the categories of garbage (Nunes et al., 2016). Some of the children did not notice that Lady Rose could assist them (Nunes et al., 2016). At the end of the experiments, enhancements on the game’s interfaces were suggested to improve the user satisfaction (Nunes et al., 2016).
This research of EcoScout Game has similarities with the previous studies and related works that explore the use of technology to raise environmental awareness. Nevertheless, this research focuses on the design process to create a persuasive game that could be played by children between 4 and 6 of age. This age range is chosen because environmental awareness could be introduced during the early childhood years (Wilson, 1996). The research also takes account of the interface drawback of the previous persuasive game, Protecting the Earth. For that reason, attention is given to the game interfaces to avoid playability problems for children. Furthermore, the research is a design research that concerns a game evaluation to assess the game quality. Finally, EcoScout Game is expected to be a mobile persuasive game, which is useful to educate young children about environmental awareness.
3. Research Methodology

This chapter has two sections to describe the methodology used in this research. In the first section, the research objective is defined and then formulated into the research questions. The second section of this chapter presents an overview of design science research (DSR) and the reason to use it as the research method. The second section includes how a DSR framework is adopted to reach the research objective.

3.1 Research Objective

The objective of this research is to construct EcoScout Game as a persuasive game to raise environmental awareness among children. That objective is formulated into these following research questions that are intended to be answered from the whole research.

- **RQ1**: How can a persuasive game be designed to raise environmental awareness among children?
- **RQ2**: What are the benefits and challenges of designing a persuasive game with the used method?
- **RQ3**: What are the required improvements for the further game development?

RQ1 is the main research question that used to find a way to design a persuasive game. The game is expected to be a tool to raise children’s environmental awareness and to support environmental education (EE). The concept of environmental awareness must be determined explicitly in persuasion goals in order that the concept can be transformed into a game design. RQ2 is a sub-question of RQ1. Particularly, RQ2 is designed to identify the pros and cons of the method chosen. Answering RQ1 and RQ2 could be useful to gain insights that related to persuasive games and research design. The last research question (RQ3) is also a sub-question of RQ1. RQ3 is used to identify the improvements, which are required for the further development to reach a better quality of EcoScout Game. In the end, the game becomes a research artifact, including the documentation of game design, development, and evaluation.

3.2 Research Method

Compared to quantitative or qualitative research, DSR is selected and considered appropriate for this research. The main reason is that this research aims to construct a persuasive game. According to Markkula (2016), DSR is appropriate to apply when researchers aim to design or build new/improved products, or artifacts, or innovation. The primary approach of this research is DSR, despite the addition of an interview session to collect feedback from children’s perspective during the artifact evaluation.

DSR is “a research activity that invents or builds new, innovative artifacts for solving problems or achieving improvements” (Iivari & Venable, 2009, p.4). Hevner and Chaterjee (2010) give a similar definition that DSR is “a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to body of scientific evidence”. In the
field of information and communication technology (ICT), many researchers and
engineers apply this research paradigm to produce innovation and generate knowledge
by doing, designing, implementing, and evaluating ICT artifacts. The main principle of
DSR is to obtain knowledge of a problem and its solution during artifact development
(Hevner & Chaterjee, 2010). A model, a method, an instantiation, or a prototype, which
is constructed to address certain problems, becomes the artifact of DSR (Ronkainen,
2016).

Although DSR is relatively a young approach in scientific research, there are already
some existing frameworks and guidelines to conduct a DSR (Markkula, 2016;
Ronkainen, 2016). The research follows DSR cycles that explained by Hevner (2007)
as the research framework. The DSR cycles are inherited from IS research framework
(Hevner, March, Park, & Ram, 2004), which positions DSR between a conceptual
environment and a knowledge base. Simon (1996) defines the conceptual environment
as a problem space where the researchers have a concern about an issue or a
phenomenon (as cited in Hevner et al., 2004). From the conceptual environment,
problems and opportunities are identified for research. Later, the outcomes of DSR are
applied into the environment to answer problems and opportunities. On the other hand,
the knowledge base consists of foundations, theories, methods, expertise, or experience
that supply applicable knowledge for DSR. The knowledge base is enriched or updated
with the outcomes of research.

![Figure 2. Design Science Research Cycles (Hevner, 2007)](image)

As shown in Figure 2, the IS research framework is enhanced into the DSR cycles by
recognizing the design cycle, relevance cycle, and rigor cycle. The design cycle
contains main activities of DSR which focus on the construction and the evaluation of
design artifacts. During the design cycle, researchers evolve the design artifact
iteratively until they achieve a satisfying design (Simon, 1996, as cited in Hevner,
2007). The relevance cycle connects the conceptual environment and the activities of
DSR, while the rigor cycle connects the activities of DSR and knowledge base. The
relevance cycle focuses on requirements and field testing, whereas the rigor cycle
focuses on grounding and additions to the knowledge base. Hevner emphasizes that in a
DSR, researchers must obviously determine these three cycles (Hevner, 2007).

Following Hevner’s emphasis, the elements of DSR cycles are determined clearly in
this research. This research takes EE for children and persuasive games as the
conceptual environment or the problem space. In the relevance cycle, the requirements,
problems, and opportunities from the domain of EE and persuasive games are analyzed.
Furthermore, the field testing is going to be by evaluating the game artifact for supporting EE. On the other hand, the knowledge base of this research is DSR methods and the theoretical background that related to the usage of persuasive games for EE. In the rigor cycle, some existing game artifacts are also observed and used as a benchmark, especially the persuasive games which are mentioned in Section 2.3. The design cycle is the core cycle of this research that focuses on the construction and the evaluation of EcoScout Game. The design cycle of EcoScout Game consists of five phases which are planned and illustrated in Figure 3.

**Figure 3.** The Design Cycle of EcoScout Game

The design cycle of EcoScout Game can be carried out in several iterations. Each iteration at least has these five phases.

**Phase 1: Determination of persuasion goals**

The research of Ecofarm game shows that the persuasion goals of the game are explained at the beginning of development (Rua & Prada, 2013). Following the Ecofarm development, the persuasion goals of EcoScout Game are determined in the first phase of the design cycle. In this phase, the concept of environmental awareness is transformed and determined more specifically into some persuasion goals, because environmental awareness is a big topic. The detail implementation of this phase is explained in Chapter 4.

**Phase 2: Requirements Analysis**

The requirement analysis phase aims to collect requirements for the persuasive game, either functional or non-functional requirements. The requirements can be taken from various related sources, ideas, and practices. If there are too many requirements, the most important requirements should be prioritized. The requirements are used to create the gameplay and the game design.

**Phase 3: Design**
Based on the collected requirements, the gameplay of EcoScout Game is created in the design phase. The gameplay contains the concept of the game, including the structure, rules, players, and features of the game. Gameplay represents the user experience (UX) of a game that becomes the key feature of the game design (Duarte & Battaiola, 2017). In this phase, the requirements and the gameplay are translated into mobile application wireframe by using prototyping tools. This design phase aims to provide a user interface (UI) design. The layouts, pictures, music background, and resources required for the game are prepared during this phase.

**Cycle 4: Game Development**

This development phase aims to execute the game design resulted from the third phase. It is the main technical part of the design cycle. Some programming language and development toolkits are used and chosen. In this phase, some parts of the gameplay or interface design can be adjusted or improved to achieve better design quality of EcoScout Game.

**Cycle 5: Playtest**

Robertson and Howells (2008) suggest that a game testing is a best practice after design and development phases. This design cycle follows that practice by performing a playtest phase after the development phase. Playtest means asking people to play a game in order that their experience of playing the game can be known (Schell, 2014). Playtest is one of the most popular methods to evaluate game design (Korhonen, 2010). Through a playtest method, a game designer or developer can obtain the feedback from other perspectives. Playtest is considered as the best technique to evaluate or test a game (Fullerton, Swain, & Hoffman, 2004). Hence, playtest is used in this design cycle by asking people to play EcoScout Game. In particular, the third research question (RQ3) is going to be answered based on the playtest results.
4. Research Implementation

This chapter explains how the design cycle of EcoScout Game has been implemented from September 2017 until April 2018. The design cycle implementation has been done in two iterations. Therefore, this chapter has two sections that represent both iterations of the design cycle. Each iteration consists of five phases of the design cycle of EcoScout Game. The design resulted from each iteration are also shown in here.

4.1 Iteration 1

The iteration 1 of the design cycle was carried out from early September 2017 to February 2018. It started with determining the intended persuasion goals and then followed by requirements analysis, game design, and development. From the development phase, the initial artifact of EcoScout Game was produced. At the end of the iteration 1, three teachers were asked to evaluate the artifact through a playtest phase.

4.1.1 Determination of the Persuasion Goals in Iteration 1

This phase aimed to set the intended persuasion goals which were taken from some existing environmental problems. Many daily environmental issues and problems could be addressed in a persuasive game. Nevertheless, only four environmental issues were taken and determined as the persuasion goals of EcoScout Game. The main consideration was that the four issues are relevant to children’s daily lives and considered simple to adopt into a gameplay. Table 1 describes how the environmental issues were determined as the persuasion goals in the first iteration.

Table 1. The Persuasion Goals of EcoScout Game

<table>
<thead>
<tr>
<th>No.</th>
<th>Environmental Issues/Problems</th>
<th>Persuasion Goals</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Littering habits</td>
<td>To persuade children to keep the environment clean by conveying an understanding that littering is not a good habit and pollutes the environment.</td>
<td>This goal was motivated by the existing littering problems. The author used to see the problems of littering habits in Indonesia, especially in public places. More surprisingly, the author used to see parents teaching their children to do littering in Indonesian public places, such as throwing their trash out of a car window. Unfortunately, littering also happens in Finland, where environmental awareness index (EAI) is relatively high (Kokkinen, 2013). This littering problem is adopted into Eco-Scout Game design to show children that littering makes our environment unclean and polluted.</td>
</tr>
<tr>
<td></td>
<td><strong>Waste Disposal</strong></td>
<td>To convey an understanding to children regarding the importance and the rules of waste disposal.</td>
<td>There are many educational programs and games which are intended to teach children about waste disposal. One of them is the ABC of Sorting program from the Environmental School of the Helsinki Metropolitan Area Reuse Centre (Kierratyskeskus, 2018). The ABC of Sorting program is adopted into Eco-Scout Game to help children recognize types of waste and dispose waste correctly.</td>
</tr>
<tr>
<td>---</td>
<td>------------------</td>
<td>-------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td><strong>Energy Conservation</strong></td>
<td>To persuade children to save energy at home by promoting good habits of energy conservation.</td>
<td>This goal has the same idea with Green Living Game, the EnergyLife game, and the PowerHouse game (KIZI, 2018; Gamberini et al., 2011; Bang, Torstensson &amp; Katzef, 2006). The three games promote awareness to save energy in the home. Unlike Green Living Game which is a desktop-based game, Eco-Scout Game uses Android mobile platform. Compared to the EnergyLife game, the design of EcoScout Game is also simplified and adjusted for children. Also, EcoScout Game targets smaller children than the PowerHouse game that targets teenagers between 13 and 18 of age (Bang et al., 2006).</td>
</tr>
<tr>
<td>4</td>
<td><strong>Animal Welfare</strong></td>
<td>To persuade children to care about animal welfare by promoting proper treatments of animals.</td>
<td>This goal came from the author’s personal experience. The author used to see people hunt and treat birds, monkey, and many rare animals badly in her Indonesia. Unfortunately, children follow the bad treatment. People compete to get rare animals and smuggle the animal for commercials and entertainment. For that reason, animal welfare issue was included in EcoScout Game to raise children’s awareness in caring and loving animals. This goal adopts the idea of the Animal Puppet Show game which effectively helps children in Indonesia to understand and to care about living things (Pramuditya, 2016).</td>
</tr>
</tbody>
</table>

### 4.1.2 Requirements Analysis in Iteration 1

After having the persuasion goals, the iteration 1 went to the requirements analysis phase in the middle of September 2017. This requirement analysis phase was the bridge between the persuasion goals and the game design. In this phase, the functional and non-functional requirements of EcoScout Game were collected and analyzed. The requirements came from some practices and related works, including the benchmark of the previous games.
The most important requirement was that the design of EcoScout Game should convey the four persuasion goals to children. The game design was expected to be easy to use and a simple structure. The other requirements were related to instructional supports communication style, and platform. In general, the game should be relevant to children’s understanding because the targeted users of the game are children.

In game design, there is always a challenge to make users interested in the game and to create user engagement. Rue and Prada (2013) highlight that entertainment factors must be maintained in a persuasive game to reach user engagement. There must be something fun and interesting in persuasive games. To address this challenge, EcoScout Game should have a reward mechanism to appreciate and motivate users' achievements. Without a reward mechanism, users could be less interest to play the game.

Table 2. The requirements of EcoScout Game in the iteration 1.

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>The game design should convey the persuasion goals.</td>
<td>This is the main requirement of EcoScout Game, which refers to the development of EcoFarm (Rua &amp; Prada, 2013).</td>
</tr>
<tr>
<td>02</td>
<td>The game should have a simple structure in which all parts of the structure are easy to access by users.</td>
<td>Considering that the targeted users of EcoScout Game are children, the game should be maintained in a simple structure. Some intuitive button navigations that connect all parts of the game structure should be given.</td>
</tr>
<tr>
<td>03</td>
<td>The game should use a concise language to communicate with users.</td>
<td>The communication used in the game should be relevant to children’s understanding. Therefore, complicated words should be avoided.</td>
</tr>
<tr>
<td>04</td>
<td>The game should provide instructional supports for helping users to understand the way to play the game.</td>
<td>Robertson and Howells (2008) emphasize the importance of providing instructional supports to make a game successful.</td>
</tr>
<tr>
<td>05</td>
<td>The content of the game should represent the situation of children’s daily lives.</td>
<td>Creating game contents and rules for children is often resembled to the social situation in their everyday lives (Winther-Lindqvist, 2009).</td>
</tr>
<tr>
<td>06</td>
<td>The game should have at least one reward mechanism.</td>
<td>This requirement refers to the three core game concepts identified by Glover (2013).</td>
</tr>
<tr>
<td>07</td>
<td>The game should be developed for Android smartphones and tablets.</td>
<td>EcoScout is designed for smartphones and tablets in order that children feel convenience when they play it. Also, Android is chosen as the platform of the game because Android is the most popular operating system for smartphones by dominating the 85,9% of the global market share in 2017 (Statista, 2017). Meanwhile, the other platforms will be considered for the next development.</td>
</tr>
<tr>
<td>08</td>
<td>The game should be developed in Indonesian language.</td>
<td>The game evaluation is planned to be conducted in Indonesia, where the environmental awareness index (EAI) is below average (Kokkinen, 2013). The English version</td>
</tr>
</tbody>
</table>

The requirements were related to instructional supports communication style, and platform. In general, the game should be relevant to children’s understanding because the targeted users of the game are children.
The last requirement was about the language used in EcoScout Game. The first iteration prioritized that the game should be developed in the Indonesian language because the game evaluation was planned to be held in Indonesia. The English language or other versions could be added in the further development. Finally, the requirements analysis of the first iteration resulted 8 requirements. Table 2 provides the detail requirements of EcoScout Game, including the description and the justification of each requirement.

4.1.3 Design in Iteration 1

The requirements analysis was followed by the design phase in which the requirements were used to create the gameplay. The gameplay covered the structure, the rules, and the features of EcoScout Game. Based on the second requirement (R02), the structure of Eco-Scout Game was designed simply and only consisted of a main page, a level selection page, some instruction pages, and three game levels. On each page, simple navigation buttons were provided for users to access the other pages. Each level has a theme, a certain reward, and at least one persuasion goal. All the persuasion goals were included in the three levels of EcoScout Game to accommodate the first requirements (R01), as shown in Table 3.

Table 3. The themes, goals, and rewards of EcoScout Game in the iteration 1.

<table>
<thead>
<tr>
<th>Level</th>
<th>Theme</th>
<th>Persuasion Goals</th>
<th>Reward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>A picnic on the beach</td>
<td>Goal 1 (Littering habits) &amp; 2 (Waste disposal)</td>
<td>a hat</td>
</tr>
<tr>
<td>Level 2</td>
<td>In your EcoHome</td>
<td>Goal 3 (Energy saving)</td>
<td>a neckerchief</td>
</tr>
<tr>
<td>Level 3</td>
<td>Love Animals!</td>
<td>Goal 4 (Animal welfare)</td>
<td>a uniform</td>
</tr>
</tbody>
</table>

The gameplay of EcoScout Game has a simple rule that users are asked to collect points on each level by choosing or performing eco-friendly tasks. The users can collect points as much as possible, but the maximum points of each level are 100 points. The collected points are shown in a score counter of the game. When users collect 50 points or more in each level, they will receive a special reward. These reward mechanisms were designed to meet the requirement R06.

This design phase applied three core game concepts, which were goal-focussed activities, reward mechanisms, and progress tracking of a game (Glover, 2013). Each level of EcoScout Game was designed to have goal-focussed activities, that must be performed by users to earn points. A time limitation and a time counter were added to give the players an obstacle in achieving goals. Performing the goal-focussed activities and overcoming obstacles at the same time could be interesting challenges for users. The reward mechanisms were implemented by giving points and a specific reward at the end of a level. Giving rewards in a system could be a way to result the expected behavior change (Robson, Plangger, Kietzmann, McCarthy & Pitt, 2015). Furthermore, the progress tracking was provided in the game by showing the score counter and the time counter in the top corners of the game interface. The score counter indicated the current collected points. Meanwhile, the time counter indicated the remaining time for users to be able to collect points.
On November 2017, the gameplay of EcoScout Game was illustrated into mock-ups with a prototyping tool. The required resources for the game interfaces were also provided, such as layouts, buttons, and a kid character. Some music files were also prepared for the music background of the game. Most of the resources and game elements were created by the author during this phase, but some of the pictures, 3D models, music files were also taken from online websites with respect to the intellectual property rights (See Appendix A). Nevertheless, only the first level (level 1) was executed in this phase and next phases due to time limitation. Finally, this design phase resulted the visual prototypes of EcoScout Game.

![EcoScout Game](image)

**Figure 4.** The iteration 1 of EcoScout Game: The design for the main page.

The resulted prototypes of EcoScout Game are shown in Figure 4 until Figure 9. Figure 4 shows the main page of the game that has a background of a tropical island. Figure 5 presents the level selection page that allows users to choose and play a level of the game. An opening screen was added to connect the level selection page with the Level 1 (Fig. 6). The opening screen was expected to introduce users with the theme of the Level 1, which was about having a picnic on a beach. Figure 7 is the design of the Level 1 which shows a view of a beach full of trash and a dustbin. Showing the view of a polluted beach was related to the first persuasion goal and expected to make users notice about the littering habits. Moreover, the instruction pages with the textual instructions were provided to fulfil requirement R04. In the instruction pages, the way to play a game was presented in detail, including the explanation of the waste disposal rules. Figure 8 shows the design of one instruction page.
Figure 5. The iteration 1 of EcoScout Game: The design for the level selection page.

Figure 6. The iteration 1 of EcoScout Game: The design for the opening screen of level 1

Figure 7. The iteration 1 of EcoScout Game: The design for the level 1
4.1.4 Game Development in Iteration 1

On December 2017, the game development phase was started to execute the game design into Android development. Java was used for the main programming language. Android Studio was used for the development toolkit. In this phase, some layouts and images were redesigned to be brighter. The gameplay of Level 1 was also enhanced in a scenario of a kid character who visited a tropical island. A beach scenery was shown on the screen, but there was 10 waste that made the beach looks dirty. On the beach, there were also three different type of dustbin that represent respectively for organic waste, non-organic waste, and hazardous waste. The types of dustbin were adjusted to the most common waste disposal in Indonesia.

In the game scenario, a user or player was given 50 seconds to dispose each waste into the correct dustbin by dragging and dropping the image of the waste. There was no other task. Two kinds of audio notification were added to make the users know whether they drop the waste correctly or not. If users drop waste to the correct dustbin, they get an audio notification, “A right place! You got 10!” and they earn 10 points. If users drop a waste to the wrong dustbin, they get an audio notification, “Oh, a wrong trash bin!” and are appreciated with only 1 point.

After two months of the development phase, EcoScout Game was successfully constructed as the result of Iteration 1. Figure 9 shows the constructed main page in the iteration 1 that has brighter colors than the previous prototype (Compare with Fig. 4). Figure 10 presents the level selection page, which also has bright colors. Figure 11 is the opening screen that connects the level selection page with the Level 1.
Figure 9. The iteration 1 of EcoScout Game: The main page.

Figure 10. The iteration 1 of EcoScout Game: The level selection page.

Figure 11. The iteration 1 of EcoScout Game: The opening screen of level 1.
Figure 12 is the executed interface of the Level 1 where users are asked to clean up the beach by dragging and dropping waste into the dustbins. In this way, the Level 1 accommodated the first persuasion goal with its interface that showed a polluted beach. There were banana peels, plastic bottle, paper waste, and other waste on the beach. The interface also showed three types of dustbins to promote the waste disposal rules, which became the second persuasion goal. Practically, the users were expected to match each waste to one correct dustbin. Lastly, the design of the instruction page was changed to bright colors that synchronized with other pages (Fig. 13).
4.1.5 Playtest of Iteration 1

On February 2018, the iteration 1 moved to the playtest phase in which three Indonesian teachers were asked to play EcoScout Game. Afterward, they suggested these following improvements for the next iteration.

1. The game should be translated into the English language. This suggestion could enable more children to play the game, not only Indonesian children. The teachers mentioned that many Indonesian children are familiar with English words in digital games. Hence, they recommended using English for EcoScout Game.
2. In the instruction page, descriptive images should be used, instead of textual descriptions.
3. The images of waste and dustbins should be big enough to be touched by children.

4.2 Iteration 2

After conducting playtest in the iteration 1, several considerations were taken to improve the artifact of EcoScout Game. The iteration 2 began in the middle of February 2018 to achieve a better quality of EcoScout Game. It was also performed in 5 phases of the design cycle. The difference of the iteration 2 was that the playtest phase involved children, instead of teachers or educators.

4.2.1 Determination of Persuasion Goals in Iteration 2

The iteration 2 started by reviewing of the persuasion goals of EcoScout Game. The four persuasion goals from the iteration 1 were still relevant for the iteration 2. The issues of littering problems and waste disposal were still prioritized in iteration 2, as well as the animals welfare and energy conservation. Therefore, the four persuasion goals were not changed in this phase.

4.2.2 Requirements Analysis in Iteration 2

In this phase, the requirements were analyzed again according to the playtest results of the iteration 1. Most of the requirements stayed the same, but there were only a few adjustments to the requirements R04, R05, and R08. Table 4 explains the adjusted requirements for the iteration 2.

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>The game design should convey the persuasion goals.</td>
<td>This requirement remained the same in the iteration 2.</td>
</tr>
<tr>
<td>02</td>
<td>The game should have a simple structure in which all parts of the structure are easy to access by users.</td>
<td>This requirement remained the same in the iteration 2.</td>
</tr>
<tr>
<td>03</td>
<td>The game should use a concise language to communicate with</td>
<td>This requirement remained the</td>
</tr>
<tr>
<td></td>
<td>users.</td>
<td>same in the iteration 2.</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>04</td>
<td>The game should provide instructional supports for helping users to understand the way to play the game.</td>
<td>Following the second suggestion from the playtest result, some images should be added to enhance the instructions of the game.</td>
</tr>
<tr>
<td>05</td>
<td>The content of the game should represent the situation of children’s daily lives.</td>
<td>As the consequence of the change of R08, the content of the game was adjusted. For instance, the categories of dustbins could be more than three.</td>
</tr>
<tr>
<td>06</td>
<td>The game should have at least one reward mechanism.</td>
<td>This requirement remained the same in the iteration 2.</td>
</tr>
<tr>
<td>07</td>
<td>The game should be developed for Android smartphones and tablets.</td>
<td>This requirement remained the same in the iteration 2.</td>
</tr>
<tr>
<td>08</td>
<td>The game should be translated into the English language.</td>
<td>This change refers to the first suggestion of the playtest in the iteration 1. This change emphasizes that the targeted users of the iteration 2 are not only children in Indonesia but children in any country. In fact, the playtest could not be carried out in Indonesia. The playtest was finally conducted in Finland by involving children from multinational background and nationalities.</td>
</tr>
</tbody>
</table>

### 4.2.3 Design in Iteration 2

The iteration 2 moved into the design phase in the middle of February 2018. The design phase aimed to change and improve the game design of EcoScout Game based on the adjusted requirements. First, the Indonesian language used in the game was replaced with the English language to accommodate the requirement R08. Second, the game content was adjusted to fulfill the requirement R05. Last, some samples of waste and dustbins were added to enhance the instructional supports, as expected the requirement R04.

Regarding the fifth requirement (R05), the content of the game was adjusted to Finnish environment. Thus, the layout background was changed from a beach scenery to a city park scenery in the level 1 (Fig.14). The four persuasion goals were still accommodated in the three levels of EcoScout Game, but with a little adjustment on the theme of the level 1 (Table 5). The theme change had no significant impact on EcoScout Game, however, using the words “Littering is not cool” is considered more clear and persuasive than “A picnic on the beach”. Moreover, the types of dustbin were changed into four categories, which were biowaste, paper waste, plastic waste, and metal waste (Fig.15). The categories of biowaste and paper referred to the documentation of the Finnish Municipal Solid Waste Management in 2010 (Piippo, 2013). According to the documentation, the biowaste and paper waste were the most numerous waste in Finland.
The categories of plastic waste and metal waste were added because the author used to see these types of waste in public places (Fig.1).

Figure 14. The layout background of the level 1 was changed to a city park scenery.

Table 5. The themes, goals, and rewards of the second iteration.

<table>
<thead>
<tr>
<th>Level</th>
<th>Theme</th>
<th>Persuasion Goals</th>
<th>Reward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Littering is not cool</td>
<td>Goal 1 (Littering) &amp; 2 (Waste Disposal)</td>
<td>a hat</td>
</tr>
<tr>
<td>Level 2</td>
<td>Save energy!</td>
<td>Goal 3 (Energy Saving)</td>
<td>a neckerchief</td>
</tr>
<tr>
<td>Level 3</td>
<td>Love animals!</td>
<td>Goal 4 (Animal Welfare)</td>
<td>a uniform</td>
</tr>
</tbody>
</table>
Figure 15. The design of dustbins was changed in iteration 2.

For the requirement R04, the instructional supports of the game were improved and enhanced in this design phase. First, examples of the waste disposal rules were represented with some waste images and provided on the opening screen. The images show users that they need to drag and drop every waste into a dustbin according to the waste category (Fig. 16). Second, pictures of waste replaced the textual description in the instruction page (Fig. 17). One more instruction page was also added and inspired by the design of a local dustbin in Finland, as shown in Figure 18 and 19.

Figure 16. The examples of waste disposal rules were given in the opening screen.
Figure 17.  The instruction page describes the waste disposal rules with pictures.

Figure 18.  A local dustbin in Finland.

Figure 19.  An additional instruction page inspired by a local dustbin was added.
4.2.4 Game Development in Iteration 2

After fixing the design of EcoScout Game, the iteration 2 went into the development phase in early March 2018. This development phase took account of the adjusted requirements and the fixed design. The development finally was completed in the middle of March 2018. The new EcoScout Game was successfully produced. Figure 20 shows the main page of EcoScout Game in the English version and Figure 21 shows the main part of the level 1. The other pictures of the new EcoScout Game are presented in Appendix B.

Figure 20. The iteration 2 of EcoScout Game: The main page.

Figure 21. The iteration 2 of EcoScout Game: The level 1

The EcoScout Game of the iteration 2 became the current artifact of this design science research (DSR) that needed to be evaluated in the playtest phase. Before the playtest, the current artifact was matched with the requirements to ensure that all requirements were fulfilled or completed (Table 6).
Table 6. The game artifact was matched with the requirements

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirements</th>
<th>Is it completed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>The game design should convey the persuasion goals.</td>
<td>Yes.</td>
</tr>
<tr>
<td>02</td>
<td>The game should have a simple structure in which all parts of the structure are easy to access by users.</td>
<td>Yes.</td>
</tr>
<tr>
<td>03</td>
<td>The game should use a concise language to communicate with users.</td>
<td>Yes.</td>
</tr>
<tr>
<td>04</td>
<td>The game should provide instructional supports for helping users to understand the way to play the game.</td>
<td>Yes, the instructional supports were enhanced, as shown in Figure 16, 17, and 19.</td>
</tr>
<tr>
<td>05</td>
<td>The content of the game should represent the situation of children’s daily lives.</td>
<td>Yes, the layout background was adjusted to the Finnish environment (Fig. 14).</td>
</tr>
<tr>
<td>06</td>
<td>The game should have at least one reward mechanism.</td>
<td>Yes (Appendix B).</td>
</tr>
<tr>
<td>07</td>
<td>The game should be developed for Android smartphones and tablets.</td>
<td>Yes.</td>
</tr>
<tr>
<td>08</td>
<td>The game should be translated into the English language.</td>
<td>Yes (Appendix B).</td>
</tr>
</tbody>
</table>

4.2.5 Playtest in Iteration 2

The playtest phase, which was held in Finland from 30th March 2018 to 15th April 2018, completed the iteration 2. The playtest participants were 10 children from 4 until 6 of age. The age range was chosen with a consideration that environmental education should begin in early childhood or before school age (Davis, 1998; Wilson, 1996). In the playtest, the children were asked to play EcoScout Game that installed in an Android tablet. While they were playing the game, their behaviors were observed. From the playtest, some important findings and feedback were obtained. More specifically, the playtest procedures and the results are reported in Chapter 5.
5. Evaluation

Evaluation is an important part of Design Science Research (DSR) to assess the quality of design artifacts and to identify the required improvements. As mentioned in the previous chapters, this DSR included a playtest phase to evaluate EcoScout Game. The first section of this chapter explains the procedures of the playtest that performed with children in Oulu, Finland. The second section presents the general information of the children who participated in the playtest. The third section reports the playtest findings. Last, the fourth section provides additional findings from the parents, who accompanied their children during the playtest and gave their opinions regarding the design of EcoScout Game.

5.1 Playtest Procedures

Several procedures were prepared before conducting the playtest phase. The first procedure was to install EcoScout Game resulted in iteration 2. The installation was done on an Android tablet. The second procedure was to prepare a parental consent form, as shown in Appendix C. The parental consent form was prepared and adopted from a sample consent form by Rochester Institute of Technology (2018). The parental consent form was used as the agreement between the author and the parents that they allowed their children to join the playtest. Meanwhile, the question list was prepared to interview the participants after playing EcoScout Game. The third procedure was to find the playtest participant by contacting some parents in Oulu, who had children from 4 to 6 years-old. The parents were known and contacted from a foreigner community in Oulu with a purposive sampling technique. At the end of March 2018, six parents agreed to let their children join the playtest. The parents received and signed the parental consent forms. Afterward, the playtest was scheduled for each child. Last, the playtest phase was done based on the schedules.

The playtest was finally performed in Oulu from 30th March 2018 to 15th April 2018 and involved 10 the participants. Each participant was asked to play the game and accompanied by the parent. The author was observing the gestures, reactions, or behaviors of the participants during the playtest. After playing EcoScout Game, the participants were given the following questions regarding their experience of playing the game.

1. Do you like this game? Do you want to play it more?
2. Is the game easy/difficult for you?
3. Do you know how to get a high score in this game?
4. What do you see on the game?
5. Have you ever seen a place with much trash/waste?
6. Where should we put trash/waste?
7. Do you sort trash/waste in the home?

The first question was given to know whether the participants were interested in the game or not. The second and the third question were asked to measure the difficulties and the playability of the game. The fourth question was related to the first persuasion goal and used to check whether the participants noticed about the littering problem in the game. The fifth and the sixth questions were also related to the first persuasion goal and used to assess the participants’ understanding to keep the environment clean. The
seventh question was related to the second persuasion goal and to know whether the participants’ understanding of the waste disposal.

Unfortunately, most of them were too quiet or just responded to the questions with their gestures. Sometimes there were language barriers because some participants answered the questions in other languages than English. In some cases, the parents helped the author by translating the participants’ answers. Figure 22 and Figure 23 show two documentations of the playtest phase.

Figure 22. A participant was playing EcoScout Game.

Figure 23. Another participant was playing EcoScout independently and rejecting any help.
5.2 Playtest Participants

From the signed parental consent forms, the participants’ age and gender were known. Meanwhile, the participants’ ability to read and ability in languages were known by asking their parents. Table 7 shows the participants’ information background that covers age, gender, ability to read, and ability in languages.

Table 7. The participants’ background information

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Date of the Playtest</th>
<th>Age</th>
<th>Gender</th>
<th>Is he/she able to read?</th>
<th>Languages</th>
<th>Does he/she understand English?</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>30.03.2018</td>
<td>4</td>
<td>male</td>
<td>Not yet</td>
<td>Indonesian, Finnish</td>
<td>No</td>
</tr>
<tr>
<td>02</td>
<td>31.03.2018</td>
<td>5</td>
<td>male</td>
<td>Not yet</td>
<td>Indonesian, English, Finnish</td>
<td>Yes</td>
</tr>
<tr>
<td>03</td>
<td>03.04.2018</td>
<td>4</td>
<td>male</td>
<td>Not yet</td>
<td>Finnish, Indonesian</td>
<td>No</td>
</tr>
<tr>
<td>04</td>
<td>03.04.2018</td>
<td>6</td>
<td>female</td>
<td>Yes</td>
<td>Finnish, Indonesian</td>
<td>No</td>
</tr>
<tr>
<td>05</td>
<td>05.04.2018</td>
<td>5</td>
<td>male</td>
<td>Not yet</td>
<td>English, Korea</td>
<td>Yes</td>
</tr>
<tr>
<td>06</td>
<td>08.04.2018</td>
<td>5</td>
<td>male</td>
<td>Not yet</td>
<td>Finnish, English</td>
<td>Yes</td>
</tr>
<tr>
<td>07</td>
<td>10.04.2018</td>
<td>4</td>
<td>female</td>
<td>Not yet</td>
<td>Finnish, Indonesia</td>
<td>No</td>
</tr>
<tr>
<td>08</td>
<td>12.04.2018</td>
<td>6</td>
<td>male</td>
<td>Yes</td>
<td>Finnish, Indonesian, English</td>
<td>Yes</td>
</tr>
<tr>
<td>09</td>
<td>12.04.2018</td>
<td>4</td>
<td>male</td>
<td>Not yet</td>
<td>Finnish, Indonesian</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>15.04.2018</td>
<td>4</td>
<td>male</td>
<td>Not yet</td>
<td>Chinese, Finnish, English</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 24, Figure 25, Figure 26, and Figure 27 respectively present the percentage of the participants’ age, gender, ability to read, and ability to understand English. From Figure 24, it can be concluded that 50% of the participants were 4-year-old. The rest of the participants were 5-year-old (30%) and 6-year-old (20%). The majority participants (80%) were male children, and only the 20% of them were female (Fig.25). Figure 26 shows that only the 20% of the participants were able to read. Most of the participants (80%) were still not able to read a text description. Meanwhile, Figure 27 shows that only a half of the participants (50%) who understood the English language. This information of participants is matched with the playtest findings in Section 5.2 and used to identify factors that may affect children in playing EcoScout Game.
Figure 24. The age range of the participants.

Figure 25. The gender of the participants.

Figure 26. The participants’ ability to read.
5.3 Playtest Findings

The playtest phase resulted in various responses from the participants. The detail responses from each participant were observed and reported in Appendix D, including her/his gestures, reactions, statements, and behaviors during the playtest. Table 8 summarizes the playtest results.

Table 8. The summary of the playtest results.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Gender</th>
<th>Ability to read</th>
<th>Ability to Understand English</th>
<th>Does he/she have an interest in playing EcoScout Game?</th>
<th>Does he/she understand to keep the park clean in EcoScout Game?</th>
<th>Does he/she understand about the waste disposal in EcoScout Game?</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>4</td>
<td>Male</td>
<td>Not yet</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>02</td>
<td>5</td>
<td>Male</td>
<td>Not yet</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>03</td>
<td>4</td>
<td>Male</td>
<td>Not yet</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>04</td>
<td>6</td>
<td>Female</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>05</td>
<td>5</td>
<td>Male</td>
<td>Not yet</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>06</td>
<td>5</td>
<td>Male</td>
<td>Not yet</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>07</td>
<td>4</td>
<td>Female</td>
<td>Not yet</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>08</td>
<td>6</td>
<td>Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>09</td>
<td>4</td>
<td>Male</td>
<td>Not yet</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>10</td>
<td>4</td>
<td>Male</td>
<td>Not yet</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
From the playtest results, the following findings are highlighted.

1. Majority of the participants (80%) had interests to play EcoScout. Most of them showed their interest to go to the other levels or voluntary repeated the first level of EcoScout Game. Two participants (02 and 05) tried the game twice, but they did not want to play it anymore. The participant 02 was bored easily and explicitly asked for racing games. For the participant 05, the game was too difficult since he was not familiar with a touchscreen. He was not able to drag and drop the images of waste smoothly.

2. All participants understood that they needed to clean up the city park by moving (dragging and dropping) the images of the waste into the dustbins. Nonetheless, two participants (05 and 10) were not familiar to touch the tablet screen. Consequently, moving the images with their fingers was hard for both participants.

3. More than a half of the participants (60%) understood the waste disposal rules that they needed to drop each waste into the appropriate dustbin. Four participants (40%) did not realize the rules at the first attempts, but then they showed their willingness about the waste disposal rules.

4. All the female participants (04 and 07) understood the waste disposal rules. However, the data is not enough to conclude the correlation between gender and the ability to follow the waste disposal rules. There were only two female participants (20%) out of total participants.

5. There were four participants (40%) who did not understand the waste disposal rules. Two of them (09 and 10) were still not able to read textual descriptions. Both participants moved each waste to a dustbin with the similar color to the waste. The other participants (02 and 05) had no interest to play the game or to learn about the waste disposal rules.

6. Most of the participants were not aware of the sound notification when they dropped the waste. Two participants (06 and 07) were even disturbed with the music background and preferred playing the game in silence.

7. There was no correlation between the participants’ ability to play EcoScout Game and the participants’ ability to understand English.

8. All participants (04 and 08), who were already able to read a text, understood the rules and reached high scores (more than 50 points) in all attempts.

9. None of the participants noticed the existence of the instruction pages unless the pages were told to them.

5.4 Suggestions from Parents

Although the playtest phase was intended to gain the feedback from children’s perspectives as the end users of EcoScout Game, some opinions were also obtained from the parents. They accompanied their children during the playtest and voluntarily suggested several improvements for the game. Their suggestions are explained below.

1. Some example of the waste should put in the dustbins and be visible. By providing examples inside the dustbins, users will notice where they should drop the waste (Fig. 28).

2. When users touch or drag a waste, a little sign or animation should appear on the appropriate dustbin. The sign or the animation can help them to identify the right dustbin for the waste. For instance, the biowaste dustbin is shaking, when a player touches the image of a banana.
3. The game can be improved by enriching the interfaces with emotional expressions. For instance, a dustbin should show a smiling animation or emoticon after users drop an appropriate waste. After a dustbin receives a wrong waste, the bin should show a sad emoticon or an angry animation.

The suggestions become the additional findings from the playtest which can be used and considered for the next iteration or game development. In fact, all the suggestions have a similar objective, which aims to help users understand about the waste disposal rules.

![Figure 28](image.png)

**Figure 28.** Parents suggested putting some visible examples of the waste inside the dustbins.
6. Discussion

This chapter covers the discussion of the research results and the implications. The first section discusses EcoScout Game as the constructed artifact of this design science research (DSR). The second section presents the evaluation of the used DSR cycles as the research framework. The last section explains some feedback for the next game development. The answers to the research questions are also given in each section of this chapter.

6.1 EcoScout Game as a DSR Artifact

The main research question in the present study is: How a persuasive game can be designed to raise environmental awareness among children? This section presents an answer from a DSR approach. A persuasive game can be designed to raise children’s environmental awareness by following the design cycle planned in this research. The design cycle for designing a persuasive game is taken from the DSR cycles by Hevner (2007). The design cycle can be started by setting the persuasion goals and analyzing requirements for the persuasive game. Based on the persuasion goals and requirements, the design cycle goes to design and development phases. The game or artifact that developed in the design cycle can be evaluated by conducting playtest to obtain feedback from user perspectives. Furthermore, the design cycle can be done in several iterations to improve the quality of the artifact design.

Particularly, the design cycle in this DSR was done in two iterations to design EcoScout Game as a persuasive game that conveys persuasion goals of environmental awareness to children. At the beginning of the first iteration, EcoScout Game was planned to have three game levels, which contains four persuasion goals and specific themes. The design applied some game mechanisms, such as reward mechanisms and progress tracking. The first iteration resulted in the first level of the game in the Indonesian language which conveys the first persuasion goal (to keep the environment clean) and the second persuasion goal (to dispose of waste based on the waste categories). Afterward, the second iteration was conducted to change the game into English version and to improve the quality design. At the end of the second iteration, the game evaluation was conducted through the playtest that involved children as the targeted users of the game.

The playtest in the iteration 2 successfully brought some insightful feedback from children’s perspective and even some suggestions from parents who accompanied their children during the playtest. The playtest was held in Oulu by asking 10 children to play the game and observing their gestures, reactions, or behaviors. Several questions were also given to interview children after they played EcoScout Game. In fact, interviewing children to answer the questions was challenging because most of the children were shy or quiet. Sometimes there were language barriers between the author and the children. Nevertheless, most of the children (80%) showed interest to play the game. Despite their interest, all participants tried the game at least twice. All of them understood the task to clean the city park that represented the first persuasion goal. Only 60% of them understood or showed their willingness to learn about the rules of waste disposal that represented the second persuasion goal. In addition, most of the participants (80%) were still not able to read text labels in the game that affected them in understanding the waste disposal rules.
EcoScout Game has some significant differences with the previous persuasive games. It is different with EnergyLife by Gamberini et al., 2011 and Ecofarm by Rue and Prada (2013). Both previous games persuade adults to adopt specific awareness toward the environmental issues, meanwhile, the game of this research is more specifically designed for children as the end users. Compared to the Protecting the Earth game by Nunes et al., 2016, EcoScout Game has similar end users and gameplay that asks users to collect and separate waste. But, EcoScout is simplified with easy 2D interfaces. The gameplay of EcoScout Game is also less complicated because it does not contain rules which are related to Mathematics and Science contents.

The constructed game becomes the DSR artifact, although the design cycle still concerned to execute the first level of the game, instead of the whole design. As a DSR artifact, EcoScout Game can be applied to the conceptual environment through the relevance cycle. The conceptual environment of this research is the context of environmental education (EE) and persuasive games, as explained in Chapter 3. It implies that EcoScout Game can be applied as a persuasive game to raise environmental awareness among children and to support EE. Also, the game can be added to the knowledge base through the rigor cycle. In the rigor cycle of this research, EcoScout Game enriches the existing knowledge base of the DSR and the use of persuasive games for supporting EE.

6.2 Evaluation of DSR

This section covers the reflection of the research method to answer the second research question, which is: What are the benefits and challenges of designing a persuasive game with the used method? Regardless of many DSR frameworks and guidelines, this research applies the DSR cycles by Hevner (2007) to design a persuasive game. The benefits of designing a persuasive game with DSR cycles are explained in the following statements.

1. DSR cycles are a framework to design any system with DSR and consist of a relevance cycle, a design cycle, and a rigor cycle (Hevner, 2007). The DSR cycles can be adopted or implemented flexibly by tailoring the steps or activities of the design cycle. Moreover, the DSR cycles can be combined with other development concepts. For instance, the DSR cycles in this research were combined with the three core game concepts by Glover (2013) and playtest concept.
2. The constructed artifact in a DSR does not have to reach a high quality at the beginning of the design cycle. An imperfect artifact can be improved and evaluated continuously during the cycles. The artifact can be evaluated in the relevance cycle by conducting field testing in the environment/application domain. Based on the results of the field testing, the quality of the artifacts can be analyzed. Some additional iterations can be decided later. Particularly in this research, the DSR cycles of EcoScout Game were conducted in two iterations to reach better quality design.
3. Referring to the study of Ecofarm by Rue and Prada (2013), four persuasion goals were determined at the beginning of the design cycle. Apparently, the persuasion goals were helpful to give a direction in the gameplay design.
4. The playtest of EcoScout Game was an effective way to gain perspectives from children and even parents. Some playability problems were also identified from the playtest results. The practice of the playtest phase in this research confirmed
that playtest is one of the best technique to evaluate a game and effective to find the playability problems of a game (Fullerton et al., 2004; Korhonen, 2010).

There were also the following challenges in designing a persuasive game with DSR cycles, especially in the design cycle of EcoScout Game.

1. Building an artifact of the persuasive game requires certain technical skills and knowledge, including skills in game design and design graphic.
2. A playtest requires sufficient participants who want voluntary to play the game. Interviewing children requires good communication skills and approach.
3. The playtest of this research was challenging enough because several children did not answer the given questions or just showed their responses by gestures. In some cases, there were also language barriers between the author and the children.

6.3 Feedback for Further Development

This section is provided to answer the third research question, that is: What are the required improvements for the further game development? The answers are given in the following descriptions based on the entire DSR cycles, especially the playtest results.

1. The two other levels of EcoScout Game should be developed because most of the participants showed their interest to go to the level 2 and 3.
2. As none of the participants were aware of the instruction pages, the level 1 should be linked to the instruction pages by providing a help button clearly. A help button can be useful for players who do not remember the waste disposal rules.
3. Referring to the third suggestion in Section 5.3, the suggestion can be implemented to improve game interfaces by putting emoticons in the dustbins. Figure 29 shows two examples of emoticons, which can be added to the dustbins. This suggestion is in line with a study by Huang, Yen, & Zhang (2008), which concluded that the use of emoticons was enjoyable for users and potential to give an additional value to communication methods. The addition of emoticons to the dustbins is expected to increase user enjoyment in the game. Also, the emoticons may be helpful for the users to understand whether they dispose the waste correctly or not, especially for the users, who are still not able to read or get disturbed with the sound notification.
4. The options can be given in the game to choose the difficulty levels because the game was too easy for all participants who were able to read. The difficulty levels can be categorized into two options which are easy and difficult. In the difficult option, more challenges should be given. For example, the time counter should affect the points. When they dispose a waste faster, more points will be obtained. Another challenge can be added by showing more than 10 wastes.
5. The implementation of game concepts and mechanism is still limited to simple concepts of reward mechanism and progress tracking. More advanced concepts of game mechanism, such as badges, progress bar, and leaderboards, should be explored and implemented in the next development.
6. Although the playtest method was effective enough to find the playability problems of EcoScout Game, the game evaluation can be enriched with the expert review method. According to Korhonen (2010), the expert review can be
used in game evaluation to reveal the fundamental problems for the game playability.

**Figure 29.** The dustbin design in the further development should show emotion after a waste is disposed.
7. Conclusions

This study is a design science research (DSR) that aims to develop a mobile persuasive game for children in order that children will have an understanding of environmental awareness by playing the game. The DSR adopted the three DSR cycles that consisted of relevancy cycle, design cycle, and rigor cycle. The relevancy cycle became the bridge between the DSR and the context of environmental education as the application domain. The rigor cycle became the bridge that connected the DSR and the knowledge base of persuasive games. The design cycle, the core cycle of DSR, was carried out in the five phases, which were the determination of persuasion goals, the requirement analysis, the design, the game development, and the playtest. Practically, the DSR cycles were combined with the concepts of game design.

Following the planned DSR cycles, this study successfully resulted in a mobile persuasive game called EcoScout Game as the artifact of DSR. Although not all parts of the game design were executed, the first level EcoScout Game was successfully constructed. The first level of the game conveyed two persuasion goals that persuaded children to keep the environment clean and understand the waste disposal rules. Later, the game was evaluated through a playtest phase with the participation of 10 children from 4 to 6 years old. Based on the playtest, most of the participants (80%) showed their interest to play the game. All participants understood the rules of the game that they must keep the environment clean. More than a half of them (60%) understood that they need to dispose the waste correctly in the game and showed their willingness to learn about the waste disposal rules. In addition, three suggestions were also obtained from the parents who accompanied their children during the playtest. The suggestions were related to the improvements for the game interfaces, especially to help children who were still not able to read textual labels and descriptions in the game.

This study of EcoScout Game enriches the success stories of the previous studies and works, which also brought positive results in game exploration to raise environmental awareness and to support environmental education. This study confirms the possibility to involve children as the co-designers or partners in technology development (Mellonio & Gennari, 2012; Fails, Guha, Druin, 2013). Particularly, the design cycle of EcoScout Game can be an example of children participating in persuasive game design. Overall, this design research brings insights and directions for future research in the context of persuasive games, game design, design science research (DSR), or even environmental education (EE).

7.1 Limitations

Regardless of its positive results, this study has several limitations that could be improved in future research and development.

1. This research was the first experience of the author to conduct a DSR and to develop a game on the Android platform. Therefore, this DSR lacked high game development skills and resources.
2. Due to time limitation, the research was only focused to design the first level of EcoScout Game on the Android platform.
3. The playtest phase did not involve an evaluation from experts in the field of education and technology.
4. The playtest phase focused on the evaluation of EcoScout Game for the next iterations or development. However, it is not enough to justify the effectiveness of EcoScout Game in raising environmental awareness among children. Further research is required to assess the effectiveness of the game.

5. Many concepts of game mechanisms were still not explored or implemented in EcoScout Game, such as leaderboard, badges, and progress bar.

6. The playtest was carried out only in Finland, where the environmental awareness index (EAI) was considered high (Kokkinen, 2013). The playtest results might differ if conducted elsewhere.

7.2 Future Research

EcoScout Game obviously needs more development to improve its quality and to implement other parts of the game because of the research limitations. Nevertheless, the game is a useful artifact of this research that could be applied in the domain of environmental education and enrich the knowledge base of persuasive games and DSR. Further research is required to measure specifically the game effectiveness in persuading children regarding environmental awareness. Also, this research gives a direction for future research to explore the adoption of DSR cycles for designing persuasive technology or game design. In the context of education and technology, this research could encourage more research to explore the use of persuasive technology for supporting environmental education (EE).
References


Iivari, J., & Venable, J. (2009, June). Action research and design science research: Seemingly similar but decisively dissimilar. In ECIS (pp. 1642-1653).


PIIPPO, S. (2013). Municipal Solid Waste Management in Finland. Greensettle project, University of Oulu, Finland.


Ronkainen, M. (2016). Designing a drone based measurement system for outdoor material fields in industrial environment.


## Appendix A. License List of Game Elements

Some elements of EcoScout Game were adopted and developed from these following sources:

1. Freepik.com
2. CGTrader.com
3. Soundcloud.com
4. Zapsplat.com

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Appendix B. Game Artifact in Iteration 2

The following figures show the artifact of EcoScout Game resulted in iteration 2.

![Figure 30](image1.png)

**Figure 30.** The iteration 2 of EcoScout Game: The level selection page

![Figure 31](image2.png)

**Figure 31.** The iteration 2 of EcoScout Game: The opening screen of level 1 shows some examples of the disposal rules.
**Figure 32.** The iteration 2 of EcoScout Game: The points collected by a player is shown at the end of level 1.

**Figure 33.** The iteration 2 of EcoScout Game: A player got a hat when he/she achieve more than 50 points.
Appendix C. Parental Consent Form for Playtesting

This form is adopted from the parental consent sample that is provided by Rochester Institute of Technology (2018).

PARENTAL CONSENT FORM

Research Title: “Designing a Persuasive Game to Raise Environmental Awareness Among Children: A Design Science Research”

Introduction

Your child has been invited to join a research study to look at his/her experience on playing EcoScout Game. Please take whatever time you need to discuss the study with your family and friends, or anyone else you wish to. The decision to let you child join, or not to join, is up to you. In this research study, we are evaluating EcoScout Game. Your child will be asked to play EcoScout Game and will be given a short interview. The interview is a semi-structured interview that focuses on some questions related to his/her experience of playing EcoScout Game. We think this will take him/her 30 minutes. The researchers may stop the study or take your child out of the study at any time they judge it is in your child’s best interest. Participation in this study is voluntary. Your child has the right not to participate at all or to leave the study at any time. Deciding not to participate or choosing to leave the study will not result in any penalty or loss of benefits to which your child is entitled, and it will not harm his/her relationship with anyone.

Risks and Benefits

This study involves this risk: getting confused, bored, or tired with the game (less likely, but not serious). There may also be other risks that we cannot predict. Meanwhile, the benefit of taking part in this study is gaining experience of playing EcoScout Game. Others may benefit in the future from the information we find in this study.

Confidentiality

When your child plays EcoScout Game and participates in a short interview of this research, his/her voice will be recorded. We will not use your child’s name when data from this study are published. This step is taken to keep information confidential and to protect it from unauthorized disclosure, tampering, or damage. Every effort will be made to keep research records and other personal information confidential.

PERMISSION FOR A CHILD TO PARTICIPATE IN THIS STUDY

As parent or legal guardian, I authorize ___________________________ to become a participant in the research study described in this form.

Child’s age:

Child’s gender:

Parent or Legal Guardian’s Signature       Date
Appendix D. Detail of Playtest Results

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<th>Participant ID</th>
<th>The Detail Playtest Results</th>
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<td>01</td>
<td>He knew how to start EcoScout Game. He knew that he must drag and drop the images of the waste into dustbins. At the first attempt, he scored only 27 points because he dropped the waste based on the colors of the waste. He dropped the red apple into the metal dustbin that also has red color. He was still not able to read the text labels of the dustbins. He did not notice the existence of the instruction pages. His mother told him about the waste disposal rules from the instruction pages. He tried to memorize the examples of the waste disposal rules at the opening screen and the instruction pages. At the second attempt, he got 60 and a hat. Later, he was aware to move the waste faster. He scored 82 points at the third attempt. He voluntary repeated the game several times and his gesture asked for the next level. When he was given some questions regarding his experience, he said that he enjoyed the game and knew how to play it. He showed a willingness to learn the waste disposal rules.</td>
</tr>
<tr>
<td>02</td>
<td>He knew how to start EcoScout Game. He touched the opening screen several times because he was not patient enough to play the game. At the first attempt, he dragged and dropped the images of the waste fast into the dustbins. However, he scored only 37 points because he did not know the waste disposal rules. He was still not able to read the text labels of the dustbins. He did not notice the existence of the instruction pages. He was told that he must drop the waste correctly into the dustbins, but he didn’t care about the rules. At the second attempt, he only got 26 points. He showed that he was less interested in the game, therefore, he did not want to play again. He got bored easily with the game and asked for some racing games.</td>
</tr>
<tr>
<td>03</td>
<td>He knew how to start EcoScout Game. He knew that he must drag the images of the waste and drop the images into the dustbins. He could drag the images well, but he had no idea to identify the correct dustbins. He scored less than 40 points in the first trial and second trial. He was still not able to read the text labels, but he was trying to memorize the examples of the waste disposal. He did not notice the existence of the instruction pages. After seeing his sister (participant 04) scored high points several times, he was motivated to repeat the game for the third attempt. He scored 45 points with the help of his sister.</td>
</tr>
<tr>
<td>04</td>
<td>She knew how to play EcoScout Game and how to get high points. Respectively, she got 60, 91, and 100 points. She showed a willingness to reach a high score. She voluntary repeated and showed the game when her older sister was coming home. She always received a hat. She was able to read text labels and description. The game seemed easy for her, although she did not check the instruction pages. In the end, she helped her little brother (03) to play EcoScout Game one more time. She said she liked the game and wanted to play the next level. Her parents also said that at their home, she separates the waste into paper, glass, mixed-waste and bio-waste categories.</td>
</tr>
<tr>
<td>05</td>
<td>He knew how to start EcoScout Game and knew that he needed to move the images of the waste into the dustbins. However, touching a tablet screen with his fingers seemed so difficult for him. He was not familiar to touch a tablet’s screen. He only played the game twice and scored 21 and 30 points respectively. He said he did not like the game and did not want to play it more. He also did not notice the existence of the instruction pages. His mother said that he prefers watching videos to playing digital games. When he was asked about some polluted environments around him, he answered that he rarely sees a place with</td>
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much trash. However, he heard that people litter in the ocean. He said that he prefers clean environments.

<table>
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<tbody>
<tr>
<td>06</td>
<td>He knew how to start EcoScout Game and knew that he needed to move the images of the waste into the dustbins. At the first attempt, he reached 27 points and tried to go to the next level. He did not notice the existence of the instruction pages. His father said that the next level was still not available and then explained the waste disposal rules from the instruction pages. He tried to understand the rules and repeated the game. At the second attempt, he scored 62 points and got a hat. He had a motivation to reach better points. He repeated the game again and respectively scored 81 and 100 points. Although he scored high points and was rewarded with the hat three times, he said that the game is quite difficult for him. He was not able to read the text labels and description. In addition, he was disturbed when the background music of the game was loud. Therefore, the sound of the device was turned off when he played the game.</td>
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<tr>
<td>07</td>
<td>She was quite shy to start EcoScout Game. Her mother encouraged her to play it. Later, she knew how to play the game quickly. At the first attempt, she only scored 37. She was motivated to reach a higher score. With the help of her mother, she got 91 points and a hat at the second attempt. Afterwards, she voluntarily repeated the game without any help and scored 64 points. She did not notice the existence of the instruction pages. She was disturbed when the background music of the game was loud, therefore, the sound of the device was turned off. When she was given questions regarding her experience of playing EcoScout Game, she was shy and kept silent. Her mother said that she likes this type of games that required her to think.</td>
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<tr>
<td>08</td>
<td>He was excited to play EcoScout Game. He knew how to start and play the game. He got 64 points and a hat. He voluntarily repeated the game and scored 73 points. He showed a willingness to play the next level. Although, he did not check the instruction pages, he used to reach more than 50 points and get the hat. He was already able to read text labels in the game. However, he only played three times because there was an interruption from his friend.</td>
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<tr>
<td>09</td>
<td>At the first, he was not interested to play EcoScout Game. He asked for a racing game. When he was playing the racing game, he got frustrated and then cried several minutes. He kept trying the racing game and crying again. After waiting for more than 30 minutes, he was getting better. He was asked to play EcoScout Game. He understood how to start and play EcoScout Game. At the first attempt, he only scored 17 points. Surprisingly, he repeated the game five times. Respectively, he scored 21, 27, 37, 37, and 45. However, he did not know about the waste disposal rules. He was still not able to read the text labels and description. He was sure to drop the waste according to the colors, although he was reminded to drop the waste correctly based on the dustbin categories. Most of the time he wanted to play the game independently and refused any help from others during the playtest. He did not notice the existence of the instruction pages.</td>
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<tr>
<td>10</td>
<td>He was shy to start EcoScout Game. His father encouraged him to play the game. He knew how to start it. Respectively, he scored 20, 30, and 12 points. He understood that he needed to drag and to drop the images of the waste, but mostly he dropped them based on the colors. He did not notice the existence of the instruction pages. After his father explained the rules of the waste disposal from the instruction pages, he repeated the game again and scored 60 points. He said that he likes the others game, but he asked for another level.</td>
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