Part 1: Understanding the Problem

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Table of Contents

System Overview

The Need

Recyclomania is a new system by Team Fantasia intended to encourage late elementary school children to **R**educe, **R**euse and **R**ecycle a wider range of items with greater frequency (also known as the *triple R process*). We plan to accomplish this goal by emphasizing the active roles a child can play in all three steps of the program.

The gap between current recycling programs that teach children the triple R process and the adoption of these behaviors is one we hope to fill with *Recyclomania*. Current programs provide ideas for potential recycling projects and current information on recycling, but the intended children for such programs appear to be either those who already know to recycle or those who know nothing about recycling. Currently, there is a scarcity in programs for the type of child who knows what recycling is, but wants to learn more about the basics.

What will it do?

Recyclomania is designed to allow children to actively participate in the three R's process. To accomplish this goal we hope to "gamify" the recycling process in an educational but unobtrusive manner. Through a multi-step process, *Recyclomania* will slowly introduce the process of recycling, materials that are recyclable, and the impacts it can have on the environment. Furthermore, we hope to design the system in a way that children are not confined to one particular device or environment to develop their understanding of the triple R process.

We also encourage adults to become involved in *Recyclomania* alongside their children, although they will not be our primary focus for this project. That being said, their involvement in educational process for children can have an effect on the way they view eco-friendliness. Through *Recyclomania*, we hope to directly educate and motivate kids while indirectly inspiring adults.

The Users

The first category of primary users are elementary school boys and girls between the ages of eight and ten years old. We consider the parents and teachers of the school children to be our secondary users. During preliminary research, we identified several important characteristics about each user category that will influence the design of *Recyclomania*. We grouped the discovered characteristics and limitations into three categories: physical abilities, mental abilities, and motives for recycling.

Primary Users: Children

Since *Recyclomania* is intended for use by elementary school children, it will need to be both durable accepting of interchange parts. We will design our system under the assumption that children will drop the device during regular use. In accordance with this assumption, we are designing our system so that broken physical features can be replaced with minimal effort.

Physical Abilities

Designing a product for children has presented a series of limitations. Physically, children have smaller hands than adults. Our design is going to be constrained by how much a child can comfortably carry in one hand and how large we can make the object before a child's grip fails.

Mental Abilities

Though our system's physical design is designed for the average 8-10 year old child, it is still limited by a child's mental capabilities. Based on the age range of the group, we estimate the median reading comprehension level is a fifth grade level. The language presented onscreen between the child and the system will be drawn from a standard fifth grade vocabulary. We cannot make a verifiable assumption about the duration of the child's attention span. To counter this limitation, the child will be instructed to recycle specific objects that will be printed on screen. This removes the pressure of remembering details of the task for the

child so they can focus on the purpose of the system. When the child is asked to remember instructions, we will limit the number of items the child needs to remember.

Motives for Recycling

As designers, we need to characterize a child's motivation for recycling. Asking children to describe their abstract motivation for an action is not a simple task. Based on Kohlberg's research on moral development, we conclude that recycling based on moral principle is not a motivating factor. We have identified three other motivations around which the *Recyclomania* design is based. One possible motivation is concern about the environment. A child may not want to understand the abstract reasoning behind why recycling is important, but may be motivated by a desire to keep a wild animal alive. The child is not motivated to recycle because it helps the planet, but because it helps animals. Another possible motivation is a pre-existing recycling project. The child may be participating in a recycling drive *prior* to using our system, but could use the system to reinforce their knowledge about recycling. Finally, the child may recycle out of habit. They may not know why they are recycling, but they recycle because the behavior has been modeled to them.

The three motivations inform the design characteristic of the interaction between the child and adult. We cannot assume that children have a single motivation for recycling. Therefore, our product has to balance multiple motivations to appeal to the greatest number of users. If we focus too much on one motive (i.e. engagement in a pre-existing recycling project), we may alienate users motivated by environmental concerns. On a fundamental level, we need to imply a direct consequence for not recycling.

Secondary Users: Adults

Our design is also influenced by the children's parents and teachers, our secondary users. The secondary may use a version of *Recyclomania* that would complement the

functionality of the child's model. The appearance of both devices would not be the same, but they would most likely be marketed as a set.

Physical Abilities

Physically, adults of both genders are (usually) larger than children. If a separate device were made for an adult, the product could be larger and heavier than the device meant for the child. This design choice is based on the knowledge that adults have a greater grip strength than children. We would design the adult version of *Recyclomania* to be physically larger than the child version, which would allow the adult version to accommodate a larger display area.

Mental Abilities

Since multiple adults in a child's life may use this version of *Recyclomania*, any design assumptions regarding an adult's mental abilities be flawed. When activity instructions are displayed onscreen or auditorily, we would present instructions in a step-by-step format. This gives the adult time to process and complete each step before advancing.

Motivations for Recycling

The secondary user's motivations for recycling are similar to the children's, but may be described in more abstract terms. An adult might be motivated to recycle based on the desire to preserve the planet's natural resources for future generations, a motivation comparable to a child's motive of not wanting to see a species go extinct. Adults may also recycle because they are incentivized to do so by a monetary reward. Finally, an adult educator may feel compelled to teach recycling, rendering their personal motives moot.

These motivations present characteristics we as designers must be mindful of. The motivations of adults and children to recycle may be correlated. A child's motivation of recycling to save a species may be correlated with the parent's desire to preserve natural resources. The child may not fully comprehend the abstract nature of the

parent's motive, but understands not wanting to lose an animal. If we design multiple systems, we much develop them to work in tandem so the adult's and child's motives are interacting towards the same goal.

Task Analysis

The main task our project is to *reduce, reuse,* and *recycle* products.

Task Characteristics

For our project to succeed, the task must be portrayed in a more interactive manner. A "gamification" approach appears to be the most logical choice, for children will have a much more hands-on experience in order to understanding the triple R process. The tasks themselves must be considered "fun" by kids. This is the most fundamental and significant characteristic of our task. Kids must enjoy our solution to the extent that the message will stick with them beyond the system we create for them. In a nutshell, our system must be fun, interactive, and educational. We hope that our system can be used in more than one scenario so that the task of reducing, reusing, and recycling can be reinforced through various environments.

Task Environment Characteristics

The environment itself must support the system that we create. Since we are encouraging children to develop a more eco-friendly mentality, the system must be usable in both outdoor and indoor environments.

Structured Task Analysis

A possible example of Recyclomania's general task analysis is mapped out below:

0. In order to begin reducing, reusing, and recycling materials
   1. Acquire Team Fantasia's system.
   2. Begin playing with the system
   3. Through the "gamification", learn more about the importance of the environment.
      3.1   Mission selection.
      3.2   Play through current mission
      3.3   Successful completion of current mission

3.4 Points assigned.
    3.5 Repeat 3.1 to 3.3 until all available missions have been completed.
4   Put device away
    4.1 Save current game status
    4.2 Power down device
    4.3 Store device
5   Consider ways to help the environment
    5.1 Talk to others (including parents) about recycling
    5.2 Begin recycling appropriate materials
    5.3 Spread the word about recycling
    5.4 Encourage peers to use Team Fantasia's system
If new user, do 1-2-3-4-5. If regular user, do 2-3-4-5

A more graphical representation is displayed below.
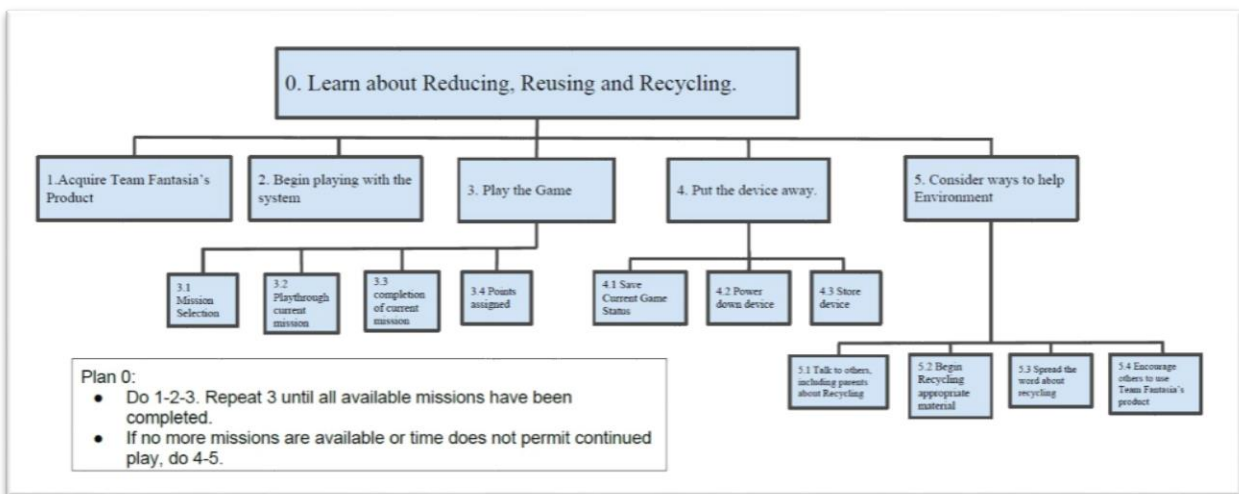

Existing Systems

The concept of recycling has been around for a long time. However, there is not a cohesive system that helps kids learn about recycling **and** encourages them to recycle more. We want our system to teach children the benefits of recycling, how recycling impacts the environment, and also inculcates the habit of recycling amongst them by making its practice more accessible.

As such, no system examined focused on children as the primary user. There are, however, various initiatives around the world which encourage people to recycle by

offering rewards for their efforts and by providing positive reinforcement when users actually recycle.

RecycleBank

RecycleBank was started in 2004 with the objective that people want to recycle but need a little push in the right direction. Once users are registered on RecycleBank, their families are given a special container with a chip that has to be filled with recyclable material or waste. Garbage trucks then weigh the container on their garbage route. The
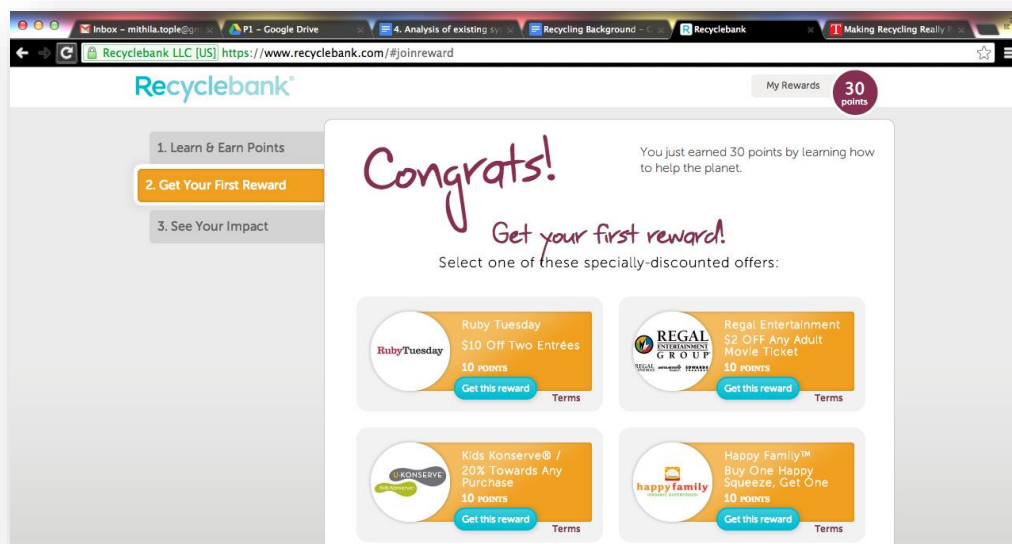
weight of material recycled by the family every week is then recorded, and the family earns a corresponding number of RecycleBank points. These points can be redeemed at various stores such as CVS Pharmacies and Regal Entertainment. points can also be redeemed at participating restaurants and clothing stores, including Burger King, GAP, Old Navy and Banana Republic.

RecycleBank also has an interactive website for registered members to check their current points, earn more points, and examine potential deals in exchange for their points. The website also acts as a social network where recycling progress and total points collected by uses can be tracked and monitored. Furthermore, the website aims to educate users about recycling and provides trivia questions. Users can pledge to follow certain instructions, and such pledges earn the user additional points.

RecycleBank is a great way to encourage individuals to recycle. However, it is aimed at adults and families rather than children. The website also offers deals at various locations, but does not contain a monetary reward option. Once a user pledges to perform a certain task and earns points for the pledge, there is no further tracking done by the system to check whether the user was adhering to their pledge.

Talking Bins

Talking bins have been installed in countries like Sweden and the United Kingdom. These bins sing songs and have polite conversations with the individuals who use them. They were designed to introduce a sense of whimsy and novelty to the mundane task of waste disposal with the intent of making the task interesting. It was observed in Sweden that the talking bins collected thrice the amount of garbage than other normal bins. Owing to the success of these bins in Sweden, 25 new talking bins have been installed in London as well.

Though these bins provide a fun way to perform a mundane task, they are not specifically aimed at children. Also, they do not provide a guideline as to what items can and cannot be recycled. The novelty of talking bins may also wear off, potentially causing users to return to their old habits before the bins were introduced. Lastly, this

system does not have any reward system which could encourage users to keep recycling.

Science kids: http://www.sciencekids.co.nz/recycling.html
Science Kids, a New Zealand website, aims to make science and technology exciting for children. The website has an entire page devoted to recycling, which is a fun and informative webpage encouraging them to recycle.

The interface is bright, colorful, and provides information about recycling. It also supplies links to various recycling projects which have been done around the world.

The website gives links to various videos related to recycling, contains interactive quizzes and facts about recycling, and has illustrations. It also contains games related to recycling and suggests projects to be executed which involve recycling and some technology. The website is a robust, interactive way for children to learn about recycling. However, it does not provide a means of tracking the progress made by the children in learning. Neither does it provide a tangible way of measuring how much recycling has actually been done by the children.

Floating Garbage Sea Creatures

Marine scientist and educator Masamichi Hayashi has found an innovative way of educating kids about recycling by recycling floating garbage such as plastic bottles, food containers, Styrofoam, raincoats and motors. He handcrafts this garbage into sea creature robots and conducts free shows to teach children about the movement and behavior of sea animals.

Though this system is aimed at kids and uses recycled material, it doesn't really encourage kids to recycle more. While it teaches kids about the movements of sea animals, the system does not reinforce the message of recycling.

Social & Technical System Description

Recycling has positive environmental, economic, and even social implications. The EPA listed several key benefits of recycling, including protecting and expanding U.S jobs,

reducing landfill and incineration, preventing pollution, reducing energy consumption, decreasing greenhouse gases emission, conserving resources, and sustaining the environment (United States Environmental Protection Agency, 1998).

The purpose of our system is not limited to teaching kids about recycling, but ultimately, is to protect the environment by effectively managing waste. Recycling is not the only way to achieve this goal, however. According to the EPA's website, the most environmentally sound method to manage municipal solid waste is "source reduction and reuse", followed by "recycling and composting", "energy recovery" and lastly, "treatment and disposal" (United States Environmental Protection Agency, 2012).

While many would generally agree to the benefits of recycling, their recycling behaviors are divided. There are the avid recyclers, who actively sort and recycles everything that can be recycled; There are those who never recycle or don't concern themselves with recycling; And there are individuals who fall somewhere in the middle of the spectrum. According to the focus group studies carried out in London in 2003, 11% of the population recycles everything that can be recycled, 30% recycles a lot but not everything, 29% do not recycle much while the other 29% admit they do not recycling anything. (Thomas, Slater, Yoxon, Leaman, & Downing, 2003) What has caused the gap between recycling awareness and recycling behavior? In the survey our group conducted, we attempted to understand the motivations behind individuals' decisions to recycle or not. Reasons not to recycle include: inconvenience (no recycle bins, no time to sort recyclables), lack of recycling knowledge (don't know if certain items are recyclable, where to recycle, don't think they will make a difference), and lack of appeal (no reward for recycling). Factors that will encourage people to recycle include: a deeper understanding of the environmental impact of recycling, whether or not peers and family are recycling, and knowledge of reusable recyclables. The research done by Thomas et al. (2003) demonstrated that sufficient information about recycling and its benefits is one of the key influences to increase recycling behavior, especially for young recyclers. Hard-hitting messages and personalized messages engaging directly with communities are effective in encouraging young individuals to recycle. The de-

motivators of recycling include: not feeling informed about what happened to the materials they recycled and a lack of awareness of recycling on a regular basis. They argue that because the significance of recycling is not a pressing issue in people's lives, recycling needs to become habitual or familiar behavior. The key message taken from the focus group studies is "get the service right, make it convenient and easy, get the facilities in place… then tell us about it and often" (Thomas, Slater, Yoxon, Leaman, & Downing, 2003).

We also hypothesized that a reward and refund system will motivate people to recycle, even though our survey results showed otherwise. Several states, including California, Connecticut, Delaware, Hawaii, Iowa, Maine, Massachusetts, Michigan, Minnesota, New York, Oregon and Vermont have introduced refund programs to promote environmental awareness and recycling, while other states don't. There are also organizations like RecycleBank that offer reward points to encourage recycling behavior. Even though these reward programs have gotten a lot of positive feedback, there are also people arguing that they are cost inefficient. Some RecycleBank programs have been discontinued due to various problems with the reward systems.

Usability Criteria

We will use both heuristic guidelines and user testing in the evaluation of our system. Below is a list of usability principles that we will refer to during our design as well as evaluation:

Neilsen (1995) has listed ten heuristics for user interface design
- "**Visibility of system status**": Users should always be able to tell the internal state of the system by looking at it. The system should provide excellent feedback on where the system is and where the user is in the interaction flow.
- "**Match between system and the real world**": The system should leverage familiar real-world metaphors. The language, concepts, and logic flow should

follow real-world conventions. In particular, we should use languages, concepts and metaphors that children are familiar with.

- "**User control and freedom**": Users should be able to explore the system freely in a controlled environment. The amount of freedom and control should be appropriate for the users and for the purpose of the system: teaching children about recycling. The system should keep them on track with the educational task while allowing some degree of freedom, rather than forcing them to take a fixed path. The system should also allow the users to undo and redo previous actions and recover from user mistakes.

- "**Consistency and standards**": The layout, fonts, color scheme, and terminology of the system should be consistent.

- "**Error prevention**": Especially when dealing with children, we want to prevent errors by providing simple and clear instructions in a bug-free system environment.

- "**Recognition rather than recall**": The system should make objects, actions, and options visible and easily retrievable, avoiding extra hurdles when performing a task such as attention span for children.

- "**Flexibility and efficiency of use**": The system should support the usage of novice and expert users, and different user groups (children and parents).

- "**Aesthetic and minimal design**": The system should make the relevant information clear to see for the users, avoiding using distracting colors and words. In addition, the system must be stimulating and appealing for kids.

- "**Help users recognize, diagnose and recover from error**": The system should provide informative error message in plain language to help user recover from the error state.

- "**Help and documentation**": The system should provide comprehensive help functions to guide the primary and secondary users when using the system, by possibly offering tutorials, examples, instructions, etc.

In addition, we think the below principles will also help us with evaluation

- **Learnability**: The system should be easy for both the kids and the parents to learn
- **Interactivity**: The system should be highly interactive and avoid intense reading for the user.
- **Design goal**: The system should engage children in learning about recycling and increase their awareness and behavior for recycling

For heuristic evaluation, we will invite 3-5 master students in Human Computer Interaction with different backgrounds in computer science, digital media, psychology, and industrial design. We will give them a list of tasks to perform on the system, after explaining the background and related information of our design. We will ask them to perform each task several times with the heuristics in mind. Then we will ask them to list problems with reference to usability principles with detailed explanations.

As for user testing, we will have several of our target users and their parents to try out our system while we observe their behavior. In addition, we will conduct interviews with children and their parents before and after they use the system, asking them specific, measurable questions that we can use as a metric to their user experience.
The feedback from the inspectors and users will serve as a measurement of the success of the program.

Information Gathering

After brainstorming, we decided that the project needed to be 'cool' in order to appeal to children, similar to the 'Magic School Bus' series. We thought of various ideas, possibly to teach them good behavior, take them away from computers, or teach them about nature. We then thought of the theme of 'recycling' which could be applicable for everyone since it is so important in today's times.

Once the problem space was defined, we discussed some ideas that ventured into possible solution, though not in great detail since we needed to conduct user research first. This was primarily done to investigate the problem space and define it further.

We also thought of where our interaction could be used. We spoke a little about the various possibilities of it being inside a house or maybe in a public domain. We approached the idea of an interactive bin in a public place which people could interact with. We also thought about the use of "gamification" to reinforce positive recycling habits/behavior amongst kids and adults.

Once we defined the scope of our project, the next step was towards 'knowing our user'. We decided that surveys and workshops should be used to compile information about our primary users (the children) and the secondary users (their parents). We decided to conduct separate surveys for the kids and parents which would address separate issues faced by both these demographics. We also considered consulting firms that are already working in this area of recycling to find out more regarding the specific problems they may have faced and why they chose any particular solution.

We compiled a list of questions for the survey and then separated them into 'Questions for Parents' and 'Questions for kids'. We went over each and every question, debating which questions to keep, rephrase, or add. We also decided the order in which the questions would appear and categorized them. We also decided on the type of answer for those questions (such as radio button, checkbox and text).

We then had casual discussions with a few kids and their parents where we asked them some questions from the surveys we had compiled. These discussions proved to be very fruitful since they gave us a better understanding of the awareness about recycling amongst kids and parents. We made observations about how the children had been instructed about recycling, the processes involved in recycling and its impact on the environment. These discussions helped us get feedback about our survey questions and eventually in refining our surveys to make them better-phrased and more suitable

for the involved age-group.

We also observed recycling areas around campus. We came to a realization that people want to recycle but sometimes lack the initiative or inclination. In addition, there is some confusion as to which waste can or cannot be recycled.

The surveys we have compiled are included below.

QUESTIONS FOR PARENTS:

1. Do you recycle? (radio)
   - Yes
   - No, please continue to question 3.

2. If yes on question 1, where do you recycle? (check)
   - At home
   - At work
   - Public space (street, mall, etc)
   - Private recycling center
   - Other:_____

3. If you answered no on question 1, or if you occasionally don't recycle, what are your primary reasons for not recycling? (check)
   - It's too much effort for one item.
   - I don't know if certain items are recyclable
   - No recycling bins are present where I would want to recycle.
   - I don't have time to sort recyclables.
   - I don't think I'm making a difference.
   - I don't know where to take my recycling.
   - My family recycles, but I don't.
   - Recycling does not appeal to me.
   - There is no penalty for not recycling.
   - Other: _____

4. Which of the following have you recycled? (check)
   - Electronics
   - Paper
   - Glass
   - Cans
   - Plastics
   - Cardboard
   - Styrofoam

- Paint
- Batteries
- other: please list

5. Do your kids recycle? (radio)
- Yes
- No
- I don't know

6. What do you think will be effective to motivate your kid(s) to recycle more? (check)
- If he or she can get rewards from recycling
- Teach him or her about the environmental impact of recycling
- If him or her family members are recycling
- If him or her friends are recycling
- If he or she can reuse recyclables in other things: composting, making arts and crafts, etc…
- Other:___

7. Have you visited a recycling center? (radio)
- Yes
- No, but I want to in the future.
- No, I have no intention of visiting one
- I don't remember

8. Do you use recycled material? (radio)
- Yes
- No
- I don't know

9. Do you reuse products instead of disposing of them ?
- Yes. I reuse product when possible.
- Yes. I reuse containers when if I feel they are safe for my family.
- No. I am not sure if the product can be used for another purpose.
- I don't know.

10. Are there any items that are made of recycled materials in your household?(text)
- Yes. Such items include:
- No.
- I don't know

11. Do you have a compost pile? (radio)
- Yes.
- No, but I am considering starting one.
- No, I can't start one where I live.
- I have no interest in composting.

- I don't know

12. When was the last time you recycled? (radio)
- This week
- This month
- This year
- I don't remember
- I don't recycle

13. What is your motivation for recycling? (checkbox)
- My friends and/or colleagues also recycle
- I am interested in protecting the environment
- I am trying to set an example for my children
- I receive rewards from companies/recycling centers

14. Can we contact you with more questions later about our recycling project. This will not take much of your time.
- Yes
- No

15. If yes, please leave your contact information below
- Name:
- Number:
- Email:

QUESTIONS FOR KIDS:
General
1. What grade are you in? (radio)
- 3rd grade
- 4th grade
- 5th grade
- 6th grade
- other:___ (text)

2. Do you know what recycling is? (radio)
- Yes
- No
- I'm not sure

3. What items do you think you can recycle? (checkbox) [reword: check the items you think you can recycle? It gives us an idea about what products children know can be recycled]
- cardboard
- plastic
- rubber

- metal
- batteries
- computer parts
- Glass
- Fabric
- Cooking oil
- Other

4. Have you recycled before? (radio)
- Yes
- No
- I'm not sure

5. Do you reuse recycled material? (radio)
- Yes
- No
- I'm not sure

6. If so, what do you use the material for? (checkbox)
- Toys
- Containers
- Class project
- Terrarium/fish tank decoration
- Artwork
- Clothing
- The object's original purpose.

At Home
7. Do your parents recycle? (radio)
- Yes
- No
- I'm not sure

8. Do you separate trash from recyclable material at home? (radio)
- Yes
- No
- I'm not sure

At School
9. Have your teachers taught you about recycling? (radio)
- Yes
- No
- I'm not sure

10. If yes, how have they taught you about recycling? (text)

11.   Have you done a recycling project in school? (radio)
- Yes
- No
- I'm not sure

For Future
12.   Would you like to recycle? (radio)
- Yes
- No

13.   If no, why not? (text)

14.   What items would you like to recycle in the future? (check)
- Glass
- Paper
- Plastic
- Rubber
- Other

Project Implications

After all is said and done, what does this research actually mean for our project? Below, we have separated the implications into physical, mental, motivational, and design-related.

Physical

- For children, the system must be smaller and lighter to be able to fit their hands.
- Though adults will not be the primary users, they would be able to use a larger device. That being said, they should not be required to have another device. Possibly an extension of a device they already own would resolve this issue.

Mental

- Children have short attention spans, therefore the instructions must be kept shot, explicit, and to the point.

- Although adults have longer attention spans, they also have live with more demands on a daily basis, so a similar approach must be taken with them.
- Adults should have a clear understanding about why their child is using the system and how they play a role in it.

Motivational

- There needs to be a correspondence between a child and adult.
- The system should avoid relying on abstract motivation for the child's system. Simply put, they just don't think in those terms. The system for kids should be direct. For adults, however, the motivation can be a little more abstract, relying more on the fact that that they're helping protect the environment.
- Motivations should be kept consistent across the system. For example, we can't talk about how penguins are dying off one-by-one and then immediately switch gears to discussing how reusing materials can be helpful for mother earth.
- The system should allow the users to be motivated by other users. Seeing that others are protecting the environment is good motivation to do the same.

Design-Related

- The system should be stimulating and interesting, yet simple and easy to use, utilizing animated characters and buttons that stand out.
- The system should be highly interactive and avoid intense reading.
- The child should be able to use the system in various environments.
- If "gamified", the system must be educational but fun.

With these implications, we hope to design a sophisticated system that will encourage children to reduce, reuse, and recycle. Although adults will not be the primary users of our system, they still play a big role in encouraging this eco-aware behavior. Now that there is a clearer understanding of our implications and limitations, we feel comfortable moving on the next big step: developing design alternatives.

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