

>> reCyCLOR

a game about recycling and waste disposal



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SUMMARY: VISION AND RATIONALE

Currently, world cities generate about 1.3 billion tons of solid waste per year. This volume is expected to increase to 2.2 billion tons by 2025.

- World Bank, A Global Review of Solid Waste Management, 2012

One of the ill-effects of urbanization as consumption and productivity increases, is the increased generation of solid waste. The demand to resolve the incessant issue of municipal waste disposal is twofold – individuals must a) recognize the three Rs, Reduce, Reuse and Recycle while segregating waste and b) be aware of the implications of their actions. Reflecting on the need and the urgency to engage individuals at an early age to inspire change in thought and action, led to the inception of *reCyCLOR*. *reCyCLOR* is a digital puzzle game, targeted at creating awareness among elementary aged children between 9 and 11, to help build an environmentally friendly society. Since appropriate disposal of trash and effective recycling may appear as an ambiguous goal to this demographic, *reCyCLOR* primarily encourages young children to take better care of their environment by performing simple tasks like putting trash in the bin, recognising and sorting recyclable and non-recyclable trash in their immediate environment, and learning the significance of keeping their communities clean and in time, our planet.

Conventional formal learning practices attempt to engage learners using facts and arguments which fail to entice younger players, more so if they already have little interest in the topic. However, games as systems (Salen, Zimmerman, 2004) complement real-world systems, promising an authentic experience making complex ambiguous challenges achievable, with a potential for greater comprehension. As stated by Ian Bogost (Plass et al., 2011), *reCyCLOR* deploys “procedural rhetoric”- a game’s ability to persuade players through rule-based interactions. Games on social change targeting this demographic has the potential to not just be informative, but persuasive and engaging.

Current educational games on recycling or disposal of trash are aesthetically dull, unstimulating and lack situated learning contexts; a high contrast to richer, livelier interactions in commercial games. With increased emphasis on the delivery, presentation and context of information, *reCyCLOR* promotes desired real-world behavior by providing compelling narratives, timely feedback, social network integration and self-representation. Digital games that highlight civic learning often distance feedback from behavior; truly effective user interface integrates information provided by waste management organisations into the game environment to influence player behavior, in-game player abilities and consequences of player choices. Since the current practice of waste disposal echoes ‘out of sight, out of mind’ syndrome, the game is designed to be highly fantastical in nature catering to a much younger demographic of players. *reCyCLOR* may be supplemented as a multimedia tool in elementary classroom grades 3 and higher to be integrated as formative assessments during a lesson or unit on “sharing the planet” or “waste management”. Thus, the potential for a game focused on the global problem of waste is enormous if approached with careful planning and foresight, with continuous evaluation to allow for modifications and further expansion.

BACKGROUND

Target Audience

It has been suggested that environmental awareness education is most effective on younger pre adolescent children who do not have well-established environmental habits - Asch & Shore, 1975.

reCyCLOR primarily targets:

- Elementary aged children, 9-11 years of age, male and female
- Children who are still impressionable on environmental issues and are more susceptible to behavioural change or influence
- Presumably in environments where recycling systems and infrastructure is already in place.

In subsequent prototypes, we expect to introduce different characters to broaden the appeal to both genders and a range of tastes (eg. female action figure, male warrior, non human characters, and so on).

Educational Objectives

In generating our game idea, we realised that while issues of the environment is very topical and has improved manifold over the past 10 years, there is still room for improvement. At ITP alone, the recycling bins contain a mix of both recyclable and non-recyclable waste. There is an assumption that someone else will do the sorting prior to trash collection, but it might also reflect a greater issue - one of complacency and poor habit.

The objectives of this game therefore seeks to influence awareness among the target audience, children between 9-11, and thus their behaviour:

- Increase the knowledge of different kinds of materials and what constitutes as recyclable and non-recyclable material
- Improve understanding of the various methods of disposing trash, and the impact of disposing correctly or incorrectly (medium - long term impacts)
- Grasp recycling terminology, as well as visual labels and icons
- Improve the ability of task switching in executive function.

reCyCLOR is a fast paced game that aims to improve players' processing and cognitive skills over time. The knowledge and skills acquired in the game will ideally form positive, actionable habits in the real world environment.

Description of Content

Each player begins by sorting the trash on his/her path into the corresponding trash receptacle. The first level includes a beast chasing the player and the player must keep ahead of the beast by sorting the trash items in his/her path into the appropriate bins at the top of the screen. The intro level introduces two acts of disposal - paper and organic waste. A series of items lay scattered on the player's path and is presented with images of magazines, corrugated boxes,

half eaten apples, banana peels, and so on. Proper disposal of organic waste helps slow the beast with the growth of bushes from the fertilizer derived from compost. The more organic waste is sorted, the higher the chances of survival in the introductory level of the game. Proper recycling of paper waste will build paper wings to fly the player off to the next level, providing a goal or incentive to aspire towards. If the waste is not recycled properly, or not enough waste is collected, the beast catches up with the player and the game is over.

While the prototype provides a basic visual reference for the first level of the game, the prospects for *reCyCLOR* are enormous. It is possible to add further layers beyond the first, which will not only increase difficulty over time but will reinforce the bond between the narrative and the player. Further complexity can be added to deepen the challenge and broaden the knowledge, while still tied to core learning goals:

- Increase the types of material to trash, with more obscure objects that increase difficulty standards but also provide more rewards
- Widen trash location points, which will test the player's processing skills
- Create player based responses that impact the environment, and thus linking action and response
- Introduce peripheral characters or objects that intervene and offer incentives, rewards, obstacles or collaborators
- Transform the original trash beast to something that can be nurtured or grow based on player decisions (the hunter becomes a comrade or pet)
- Encourage communal play, which can be either played together in a group or competitively.

The elements above can be added to a richer narrative experience overall, which might include:

- Change in environment: For example, the first level is a forest, the second level can be a town, the third level can be a city. The player's responsibilities and tasks become more complex as they move up levels
- Assigning roles: In level 2, the player might be promoted to looking after a local business and in level 3, they might oversee an entire town with various environmental issues
- Depending on what they recycle most, the player can enter a world related to that item. For example, if the compost heap receives the highest number of disposal, they enter a magical forest that they have to take care of
- The wings can instead be a spaceship, and the next level situated in another planet (which, for example, might be tasked with "saving" earth).

There are many methods for building the narrative, which can be explored with user testing and research with audiences and stakeholders (including environmental associations, psychologists and educators).

Core mechanic

The first level prototype introduces two levels of disposing - paper and compost.

- The player is running through the forest with a beast chasing him/her. The pace of the player is controlled by the computer. The pace of the beast is dependent on the player and how much he or she recycles

- The player has to dispose the items that come in its path in the relevant bins indicated. This is through a drag and drop method using a mouse or trackpad
- If paper items are placed in the correct bin, it adds to the player's indicator bar, which is located on the top left side of the screen. If it is wrong, the gap between the beast and player decreases
- If the compost items are placed in the correct bin, a shrub will grow, which will subsequently add an obstacle in the beast's path and slow it down
- The player must continue to dispose trash until their indicator bar maxes out, or the beast catches up to them and the game ends. Depending on how the player does, they can proceed to the next level or start again.

Market analysis

There are many online games which tackle the issue of recycling. Here is a review of some websites and the player experience they offer:

Name	Website	Limitations and benefits
Science Kids	http://www.sciencekids.co.nz/game_sactivities/recycling.html	Shows different types of materials for recycling. A little confusing to play because the recycle/polluted/compost bins constantly change. Otherwise the mechanic is reasonably good
Primary Games	http://www.primarygames.com/holidays/earth_day/games/recycle	Like Science Kids, it becomes limited in scope beyond sorting out the trash
Nickelodeon	http://www.nick.com/games/big-time-rush-recycle-rush.html	This game has great mechanics but limited learning aspects
NASA	http://climatekids.nasa.gov/recycle-this/	Interesting mechanic, but gets frustrating after a while because it is a little tricky to manoeuvre the trash into the right bin. The learning mechanics are good
A kid's heart	http://akidsheart.com/holidays/earth_day/trashdump.htm	No indication on how to even play this game
National Geographic	http://kids.nationalgeographic.com/kids/games/iggygames/kung-fu-trash-master/	Fun but the game mechanics are poor, as it's very hard to manoeuvre the trash in the designated time (slow movement using the spacebar and arrow

		keys)
Advanced Disposal	http://www.advanceddisposal.com/garbage-101/education-zone/kid's-corner/garbage-games	Recycle Rescue: Reasonably engaging but gets repetitive. Trashman: Very fast but game seems limited in its development

Nickelodeon and NASA boast strong game mechanics with reasonable learning mechanics, while National Geographic has poor game mechanics and fair learning tools. All games appear to provide ephemeral player engagement.

Inspired by non-learning games including “JetPack” and “Dumb Ways to Die”, we acknowledged a fundamental gap in recycling learning games:

- lack of a strong, overarching narrative
- awkward or undeveloped game mechanics
- inability to communicate short and long term effects of waste disposal recycling.

Some games contain one or two of these elements, but few contain all three. As such, *reCyCLOr* aims to build a strong narrative that is not only fun, but ties in with informative and actionable learning tools.

DESIGN

Overall game idea

reCyCLOR is a real-time puzzle game with 2D aesthetics. The game mechanic consists of correctly sorting incoming trash items in the appropriate bin. The pressure mounts as a beast is chasing the player through a forest. In level one, the player has to collect enough recycled materials to advance to the next level. The disposed paper trash will contribute to building paper wings, which offers an incentive to advance to the next level. Correctly disposing organic trash creates shrubbery in the path of the beast, which slows it down. If the beast catches up with the player before he/she has collected enough recycled material, the game ends. The recycled materials are collected by dragging each piece of trash in the corresponding bin (paper trash placed in the bin for recycling paper, edible items in the compost bin).

The first level aims to introduce players to simple concepts of recycling. The trash items used are common day objects (to connect the player with real life objects). However, some elements of the game are purely fantastical, to add whimsy and create a space for the player to enter the magic circle.

Game Rules

The objective of the first level game prototype is to stay ahead of the beast by:

- Collecting and assorting as much recycling goods as possible to build paper wings, which take the player to the next level
- Create obstacles in the beast's path by recycling appropriately (current example: compost nurtures plant life which will slow down the beast).

Rules include:

- If the player puts the wrong type of trash in the bin, the bin is disabled for a few seconds
- The player cannot control his or her own pace or direction
- The player can win by filling up the paper trash with paper goods, thus increasing their score bar. Or they can dispose more in the compost heap to place obstacles in the beast's path, which will buy them time to place more in the paper trash
- The player can either win or lose. If they win, they proceed to the next level. If they lose, the beast catches up to them and they have to restart the game
- The player can play as often as possible.

Walkthrough

The player starts the game by launching into an introductory page. This page contains an instruction button for how to play the game, or a start button to proceed with playing the game. The introductory page will contain visual references for the game elements so the player can easily identify what constitutes paper trash, compost trash, the beast, the indicator bar and the paper plane.

The game starts and the player is off! They feel a little pressure from the pace but there is sufficient distance between him/her and the beast. The amount of trash builds, but there is not enough time to collect them all. And sometimes, he/she gets it into the wrong bin, which displays

a symbol (and potentially callout box explaining why it is wrong). They see the gap closing in, which makes them nervous! Their heart begins to palpitate. They manage to get some compost in the bin and see the shrubs grow, which slows down the beast somewhat. A feeling of relief and excitement envelopes the player, and a sense of hope that they might outrun the beast and win the game. They really want to get the recycled paper wings to get to the next level.

Their strategy now is to quickly advance to the next level, so they begin placing more paper trash in the bin. Cardboard boxes, milk cartons and juice containers, items he/she see all the time at home and in the shops. They notice the indicator bar slowly creeping up, but it is not moving fast enough! There is some apprehension and concern. The beast is deadly close. Finally, the indicator bar reaches the end! The recycled paper wings appear, all built from the trash disposed. There is a feeling of satisfaction and pride as the player flies off to the next level. The wings are really cool looking!

Levels

The game will comprise of several levels. Each level will be increasingly difficult.

Level one is depicted in the prototype: only two types of trash to sort, paper and organic. No surprises that test task switching are present on the first level.

In subsequent levels, more complexity will be added:

- More types of trash to sort (glass, technoscrap, etc.)
- Unexpected occurrences that will require fast task switching and reflexes from players: on beginning to drag an item, it suddenly changes to something that can't be recycled (e.g., paper that happens to be oily); the trash bins are exchanged (an enemy purposely mislabeling them) for a short time; and more.
- Instead of the trash coming along the track, trash will start to be spread around the scene. This way it will try to trigger the a change in players to a more active role in looking for garbage around their surroundings.

Platform

The prototype was built as a browser page. This way, the game can be played on any device that runs a modern browser. Browser capability will allow greater access among users, and more importantly, it will enable access in the classroom since most kids do not have access to mobile or tablet devices at school but generally have access to computers. Given the nature of the project, teachers could even introduce the game within the classroom as a daily or weekly exercise, particularly if it evolves into a complex, situational game we envisage.

However, the full version would also be built as a tablet/smartphone native app, because the drag and drop mechanic would work very well with a touchscreen.

Aesthetic design

The look and feel of the game is aimed to appeal to the target audience. We therefore have chosen a fantasy style, which also reflects the narrative. The imagery is cartoonish which will allow for greater flexibility in creating dynamic sequences - such as a paper flight contraption or

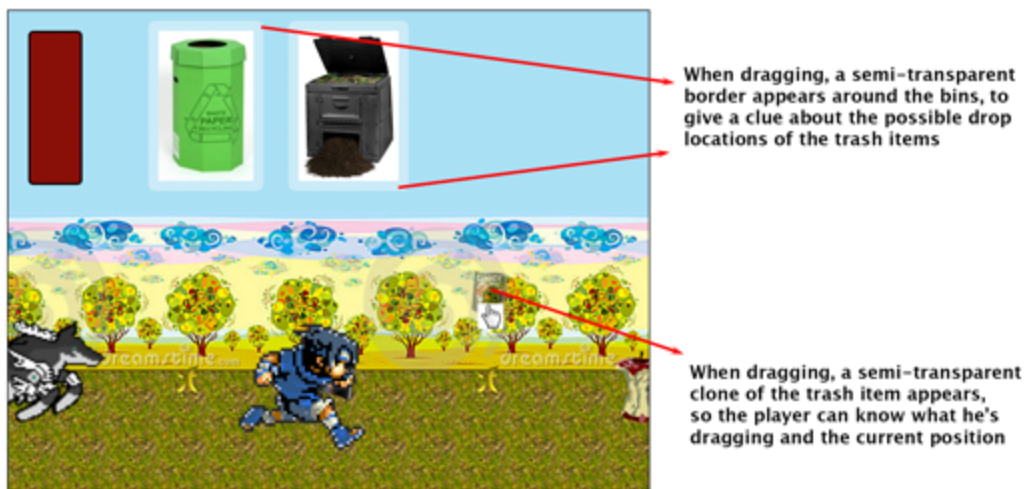
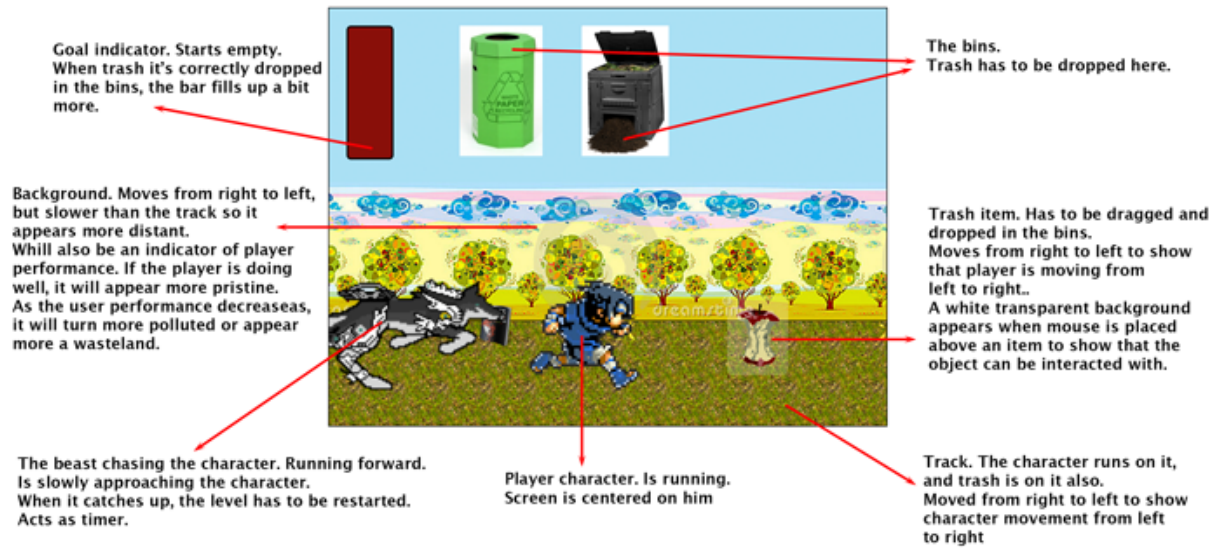
a city made out of recycled objects. Not only will this keep players engaged but it will not hamper with the learning objectives; we do not want kids to actually go out and attempt to with paper! That said, the learning objectives still need to be elucidated and that occurs through the actions of the player. The forest changes appearance based on the amount of compost they deposit. The more compost is deposited, the greener the forest but if there is not enough, the background will become more eery and dark. The mood and the appearance of the world is controlled by the player.



Example of first game prototype

Game Mechanics

- The core mechanic of the game is about dragging different types of trash that appears in the scene using the mouse or keypad, and then dropping it in the correct recycling bin, with a limited amount of time. Thus, it is about correct and fast categorization of items.
- The time is represented by the beast chasing the character. The less time the player has, the closer the beast is to the character. Once the beast catches up, the player has lost in the level and has to restart to try again.
- The required amount of recycled material is shown in the bar on the upper left. When the bar is completely green, the level has been beaten.
- If a trash bin receives an inadequate trash item, that trash bin will become unavailable for a few seconds.

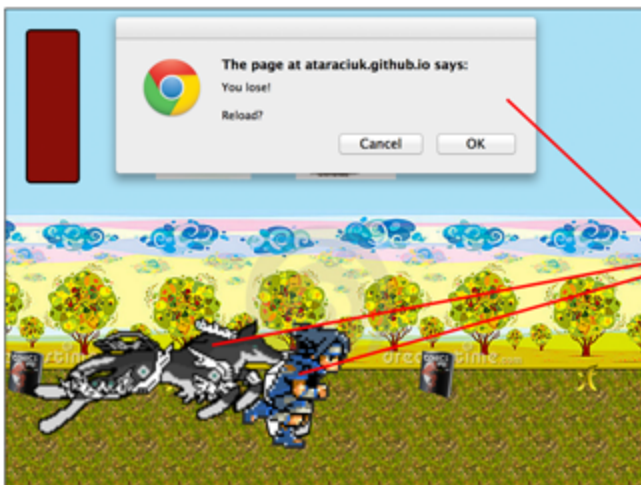




When the dragged trash item is over a trash bin, this trash bin has a yellow border to show that the item can be dropped, and that said trash bin will be the one where the item will be disposed



If a trash item is dropped in the wrong bin, that bin will be unavailable for a few seconds. A maintenance symbol is shown. The bin has a semi-transparent white overlay.



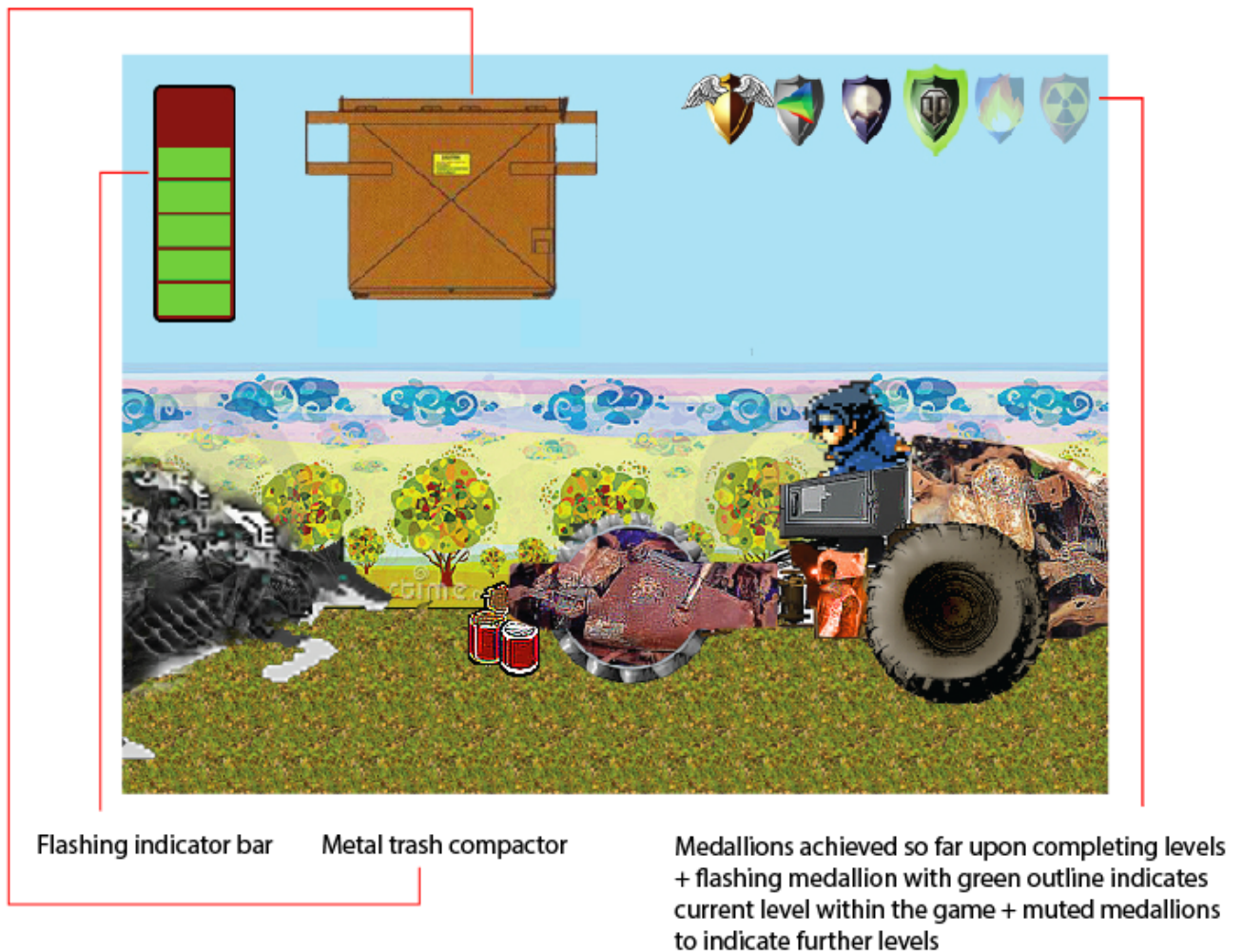
When the beast catches up with the character, the player lost. The level has to be started over

Incentive System

The game will span an overall narrative about fighting against trash. The students will feel incentivated to pursue the story, thus beating the levels to push it forward. Each level is a scene in this narrative. Every time a player completes a level, he is awarded a postcard with the background of the beaten level. The postcards can then be seen as a trophy collection. This way, on a per-level basis, the students will try to collect as many postcards as possible. Also, for each level, the background will slightly change based on the current user performance in that level: if the player is performing well (acting quickly and correctly disposing trash) the background will look happier or more pristine; alternatively, as the player makes mistakes (or time keeps running), the background starts degrading to a more polluted or sad one. When the level is complete, the image shown in the awarded postcard will match the state of the background at the moment of level completion. This will result in students trying to perform well to collect the best postcard possible, even replaying levels.

Also, the goal in many levels is to build something out of the recycled items. As an example, in the prototype, the player is building a pair of wings out of recycled paper. The final look of the item built will depend on the performance with that specific recycling bin. In the first level, if the user always put the right items in the recycled paper bins, the wings will look great; as the player puts compost (or any other item that is not recyclable paper), the final wings will look progressively tattered. The collected items will also be available for display later, as trophies. This will encourage students to replay levels to collect the items in the best possible condition.

Mid-level screenshot (under construction, not included in demo)



Here is a sneak peek of what the game could evolve into. Incorporating the feedback received from our demo, here is a sample of the next iteration of *reCyCLOR*, showing a role-reversal in the game when the character/ player gains the power to crush the trash monster. Since we are still in the preliminary stages of conceptualizing successive levels in *reCyCLOR*, we are yet to decide the specs of future iterations. Here are a few consistent ones—the flashing indicator bar above cues the player when he/she is close to achieving the winning state in each level. The ‘metal trash compactor’ bin is shown replacing the position of the ‘paper recycling’ and ‘compost’ bin from the prototype, and the shield-like icons indicate medallions that each player has achieved so far. The medallion corresponding to the current level begins flashing as the player comes close to completing the level. As for the narrative, to illustrate the game’s continuum, you are now seeing the character mounted on a tractor made entirely from recycled scraps of metal. As the player progresses through the game, he/she acquires enough medallions to build an inventory of combat tools to fight against the trash beast. Each of the medallions displayed on the top right corner of the screen, indicates the tactical advantage to be gained by completing the level. Each of the medallions on the far right, hint what the upcoming

levels represent; here's a plausible list— paper recycling, glass recycling, composting all organic waste, recycling scraps of metal, incineration, and radioactive waste management.

THEORY

Cognitive Design

Representation Type of Information: The rationale for using games for civic education on municipal waste management stems from information representation, which include– a) situated practices of reduction, recycling and reuse of trash, and b) archetypes with disposal. Seeking optimal civic learning, *reCyCLOR* integrates gameplay and content, helping players make connections between individual actions and environmental impact. The visual design of the game is primarily governed by Wolfgang Schnotz's theory; depictive information (icons, pictures, mental imagery) in contrast to descriptive information (symbols, metaphors, words) accommodates learners with low prior knowledge and reduces cognitive load. However some game states and events within the game are interpretational in nature occurring concurrently as the player is playing the game. Also *reCyCLOR* provides in-game graphical feedback (Plass et al, 2009; Rieber et al., 1996) encouraging favorable performance while the player is playing, to allow for the player to adapt to the feedback and alter their play strategy. Here's an example from *reCyCLOR* illustrating the same; appropriate sorting of organic waste into the compost bin, yields fertilizer for the growth of bushes in the path of the beast, slowing it down. Successive levels will also include cause-and-effect phenomenon, translating in-game states to real-world proceedings supplementing educational goals stated earlier.

An example of germane cognitive load using dynamic visualization, is an instance where instead of an analog or digital timer, the remaining time in the level is shown by the distance between the character and the beast. Potency of the player in each level is visually represented using a bar that fills up as the player comes close to achieving the goal in that level. Trash items are everyday objects that the learners will be familiar with; however at times with the introduction of a less discernable item like a greased corrugated box or foam the players' executive functions are put to test.

Keeping in mind, cognitive processes while playing a primarily visual game, we considered the following; a) surface level processing, b) semantic processing and c) pragmatic processing (Plass et al., 2009; Bertin 1983; also see Kosslyn 1989; Schnotz 2002; Shah and Hoeffner 2002).

Surface level processing

The runner/character, the chasing beast, trash bins, trash in the path of the runner, a plantation setting are the key visuals that the player sees as the gameplay screen opens.

Semantic processing

Perhaps with the introduction of a dashboard with the visual summary of in-game status, gamer profile icon, medallions achieved at the end of each level, and the player history made visible through a reputation system or leaderboard in comparison to previous play.

Pragmatic processing

The message scaffolded across the game and aggregated through mini-levels are recycle, reduce, reuse or consequentially experiencing the aftermath of responsible or irresponsible actions. The divergent paradigm of reusing materials is an example of pragmatics embedded in

each level for specific waste materials accumulated so far to construct say paper wings from the first level, before advancing to the next.

Task Appropriateness: The core mechanic of *reCyCLOR* is closely tied to the player's efficacy in achieving the core learning objectives, which include differentiating and disposing trash appropriately reducing impact on the environment, making the game educationally sound. Using spatial and temporal contiguity principle (Plass et al, 2009) for example, the temporal appearance of similar and dissimilar trash to be sorted or disposed allows the player to perform actions in a continuum thereby avoiding gaps in comprehension.

The current prototype is governed by a gesture based interface with click and drag stimulation of trash into appropriate trash receptacles in an interactive whimsical puzzle; this Seussian like environment is visibly altered with improper disposal of trash. The first few levels in *reCyCLOR* help prepare the players for upcoming tasks to be performed (Plass et al., 2009; Levin 1989; Schnotz and Bannert 2003) in the successive levels as the player progresses through the game.

Guided-discovery (Plass et al, 2009; de Jong and van Joolingen 1998; Kirschner et al. 2006; Mayer 2004): In multimedia contexts, since novice learners struggle with self exploration in the absence of guided support , discovery learning in *reCyCLOR* is aided with temporal introduction of guided instruction for the benefit of novice learners and also to reduce cognitive load to allow learners/players to process new information as the game progresses. In the event of incorrect sorting, the game freezes momentarily displaying deliberate cues in the form of pop-up references both primarily visual to indicate the type of material and the corresponding bin the selected item is to be disposed in. This helps reinforce expected action and shadows the learning mechanic in the game.

Cueing: Adequate cueing of design illustrated in the storyboards, directs the learner's attention to key learning concepts. Signaling as demonstrated in the successive screenshots enhances learning, reducing the need to process extraneous information during play. Helps minimize learners searching for key information in addition to helping players pace their play.

Also carefully integrated soundtrack would compliment imagery and gameplay enhancing the experience of the player. Soundtrack must be designed to emulate or augment the game's content, genre, and narrative. Deliberate sounds at key decision making junctures of the game, could serve as action cues for players; thereby integrating sound as one of the affordances in the game. Playback of key sounds adds to the established schema from previous play instigating familiar actions.

Constructivism: *reCyCLOR* is intended to build knowledge structures to recognize and act on familiar patterns of information facilitating recall, comprehension and knowledge transfer. While the game is based on replicating real world rules in the disposition of trash, the experience of the player is built as a continuous narrative with the player empathising with the character. Upon completing each level, the player constructs an inventory of combat tools to fight against the trash monster, experiencing a role-reversal from being hunted to becoming the hunter. The premise here is to encourage learners to tackle the source of the problem.

Narrative Design

The game as a whole will be organized as a succession of mini levels. There won't be much of an opening scene, so the students can get into action as soon as possible. Also, the idea is for the students to discover the overarching narrative as they complete the mini levels, thus having the narrative and the mystery as part of the incentive. The first few levels will share the same base mechanic, the classification of trash into the corresponding recycling bin, but the environment and background will change with each level. The mini-levels will be connected by an overarching narrative; It is the story of a character that fights against trash. In the first levels (the prototype is an example), the character is chased by trash monsters. As the player advances in the game, the character then progressively swaps from the 'hunted' to the 'hunter'.

Acknowledging systems thinking (Gee, 2007), the narrative guiding the mid-levels in the game, will be about researching clues about the origin of the trash monsters, what is their motivation, and how they can be stopped. In the later levels, the character will take the initiative in chasing the trash monster and fighting them. This serves as a metaphor for showing that, in the beginning the environment is in a dire situation, and as more levels are completed, i.e., more areas are being cleaned from trash and items are being recycled, the 'fight against trash' is turned over and the players are in the offensive.

Between each level, there will be a short cut scene to transition between the mini levels, to explain what happens, and to keep the narrative together. As an example, the first level (the prototype) is beaten when the character has recycled enough paper to build a set of paper wings. The cut scene to next level will then be the character taking off and flying to the next level or destination.

Sociocultural Theory and Design

The character sprinting across the screen, sets the stage for the player to inhabit the role of the character. Thus placing the problem solving and game play in service of the embodied role. By instigating the player on practices central to the act of recycling waste materials, players are invited to explore the affordances of the gaming device, mechanics, interactivity and situated learning. Looking beyond the whimsical nature of the game, interacting within the game environment, players are immersed in a microworld, drawing a metaphorical reference to systems in the real world. As the artificial intelligence within the game, begins to manipulate the found trash items (like switching a corrugated box to greased pizza box) or alter other parameters within the game, the game provides opportunities for active learning.

Since waste management is a communal problem that affects everyone, we think that the social factor is an important one in the game. In future iterations of the product, a shared online world will be present for each participating class in school. Each class will have its own online world to better monitor student's activity. In this scenario, the game will still be played in single player mode. The difference will be that, once a level is completed, this will be reflected in the general state of the virtual world. The performance of all the students in the class will be taken into account to compute how the world is doing. This way, we expect students to develop the the following understanding:

- How they treat trash has an impact in their world and on other peoples'.

- Alternatively, how other people deal with trash has an impact in their world.
- If only one person is taking care of waste disposition, the effect is much smaller than if more people are playing an active part in it.

The interaction between students will be small then. Each will play by their own and then results are added together. This reflects how daily trash disposition works (on a simplified level of course): each is responsible for their own waste, but that has an impact on everyone. Drawing from Anderson and Krathwohl's revision of Bloom's taxonomy, learners are engaged in remembering, understanding, applying, analysing, evaluating and creating. The game also teaches 21st century skills such as critical thinking and collaboration.

Having a ranking of student participation and rigor, at first, can be seen as a motivation for the students, but it's not something we would encourage. This can prove intimidating to students and can turn away players that don't excel at it. Also, collectively dealing with trash waste should not be a competitive experience. Each time a student completes a level, a congratulatory message may appear also made viewable to all students. Additionally, the player (and only this player) could receive achievement medallions like 'trash hero', so students may compete for a honorary title. The affective desires of players are echoed in player achievements and from the implications of online gamer personas imitating social realism.

EVALUATION

The current prototype was developed to serve as a tool to test assumptions and conclusions derived from preliminary research on the topic and the feasibility of inducing learning mechanics in a game imparting civic knowledge to children as young as nine years old. Commencing with a player study better supported our prototype development to begin playtesting. We conducted research taking into account multiple variables: research on players, existing games, interactions, animations and simulations on recycling and concepts closest to the topic, and current literature to evaluate dimensions of playability.

Following are some evaluation methods to study and improve successive iterations of the game for optimum engagement to advance the quality and effectiveness of *reCyCLOR*.

Evaluation to track learning mechanisms:

- Stealth assessment, embedded as data within the system to observe player habits, actions and contexts of play among the target group:
 - Pace of the player moving through the levels tests reaction time
 - Percentage and amount of trash correctly disposed. This will measure student's ability to correctly identify types of trash.
 - Performance when trash bins are switched or when a trash item changes its composition when the drag start (e.g. paper that at first glance looks recyclable turns out to be oily). This measures improvement on task switching executive function.
 - On advanced levels, when trash is more spread and even hidden, the amount of hidden trash collected. This will measure student curiosity and proactivity when looking out for trash.
 - Programmer log files will capture all of this information and help debug data.
- Playtesting and usability testing:
 - End of the game- testing reactions/opinions , learning (acquired knowledge, skills etc), behaviour / performance (actual performance changes), impact (increased efficiency, productivity, quality, reduced cost etc) = > Kirkpatrick model
 - Think aloud protocols as players experience the game and importantly, identify emotions.
- Surveys:
 - Using pre and post game surveys to measure changes in knowledge and behaviour, and using the pre-test as a benchmark for any change (alternatively, a control group can be used). The surveys can be conducted over a period of time to detect longer term changes.

In addition to the above, the following methods can be used to explore more complex levels, including player emotions, knowledge and response:

- Biometric data using TRUE (Tracking Real Time User Experience) to observe how quickly each player moves to the next level, which trash they get in which bag correct and incorrect. This can be applied in more complex game levels as it is time consuming and costly to implement.

- EMG (Electromyography) - Emotion and arousal measurement arising from facial actions.
- Video observations to understand and evaluate gamer's preferences and also their interaction with other players. This complements think aloud data sets.
- Player dossiers contextualize game rewards and players learning from previous behavior: player ID, game state, game events, player interactions, game time/ timestamp.

The evaluation must be continuous, from when the game is conceptualised to design and its first beta release, and on a semi-regular basis as the game evolves to account for any changing forces such as player demographics and the environment (politics, social, economy). The concept of scaffolding will help build skills over time and increase player knowledge and behaviour in a structured and meaningful manner. Ultimately, the player's behaviour and interaction will speak volumes in terms of attraction and engagement with the game. This, combined with proper user testing and monitoring market conditions, will increase *reCyCLOR*'s chance for success and the potential to reach the next level, perhaps incorporating other environmental themes and ideally, impacting long term habits and knowledge on the core issues regarding recycling.

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