Emergent Dialogue: Eliciting Values during Children's Collaboration with a Tabletop *Game for Change*

Alissa N. Antle, Jillian L. Warren, Aaron May, Min Fan, Alyssa F. Wise*
School of Interactive Arts & Technology
Simon Fraser University
250 -13450 102 Avenue
Surrey, B.C. Canada V3T 0A3
*Department of Education
Simon Fraser University
2400 Central City
Surrey, B.C., Canada V3T 2W1
[aantle, jlw29, amay, minf, afw3]@sfu.ca

ABSTRACT
Games for Change (G4C) is a movement and community of practice dedicated to using digital games for social change[1]. However, a common model of persuasion built into most G4C, called Information Deficit, assumes that supporting children to learn facts will result in behavior change around social issues. There is little evidence that this approach works. We propose a model of game play, called *Emergent Dialogue*, which encourages children to discuss their values during interaction with factual information in a G4C. We summarize a set of guidelines based on our Emergent Dialogue model and apply them to the design of Youtopia, a tangible, tabletop learning game about sustainability. Our goal was to create a game that provided opportunities for children to express and discuss their values around sustainable development trade-offs during game play. We evaluate our design using video, survey and questionnaire data. Our results provide evidence that our model and design guidelines are effective for supporting value-based dialogue during collaborative game play.

Categories and Subject Descriptors
H.5.m. Information interfaces & presentation (e.g., HCI): Misc.

Keywords
Tangible computing; multi-touch interaction; digital tabletop; sustainability; games for change; collaboration; children.

1. INTRODUCTION
Children's educational games are designed to support children to meet specific learning outcomes. When the topics of these games involve social issues (e.g. antibiotic overuse, bullying, sustainability, social justice) then the goal is for children to learn not just facts but to eventually behave in line with social values. Games for Change (G4C) are digital games that purport to change or influence people's attitudes or behaviors around specific issues. Many G4C are developed based on implicit knowledge or assumptions about how external persuasion can influence attitudes and/or behaviours. This set of assumptions is called a model of persuasion. Hundreds of games have been created but there is little evidence that many of them contribute to either learning facts, or influencing attitudes and/or behaviors [21]. One of the contributions of this paper is to make these models of persuasion explicit and to present a new model, called *Emergent Dialogue*, which is grounded in empirical work and translated into design strategies for digital games for learning around social issues in which we hope to influence children's attitudes and behaviors.

Elementary school curricula around sustainability often focus on key concepts such as balancing conservation and consumption. However, most learning activities do not explicitly expose the role that children's values have in learning or on their longer term behavior. For example, most children know that recycling is "good" and that they "ought" to do it. However, many children and adults do not consistently recycle. Thirty years of research in sustainability education has shown that telling people the "right thing to do" rarely results in the longer-term behavior changes we hope to encourage [21]. In particular, when values and attitudes contradict what we "should do", people often align their attitudes with their behaviors to justify the behavior [17].

We see these issues as an opportunity to contribute to both G4C and educational game design research. Our research question is then, *How can we design a children's educational G4C around sustainability that explicitly supports children to think about and discuss their values and attitudes about sustainable living*? For example, most children would say that they support preservation of forests but if this requires them to live in denser housing units, what then? Where do their values lie?

To address these challenges we first introduce different models of persuasion that have been used for G4C design. We point out the deficits of these models and briefly outline a new model, called *Emergent Dialogue,* put forward in [21]. This model originated in public workshops associated with environmental education and policy making [17]. Based on our work in [2], we summarize how the Emergent Dialogue model was translated into actionable design guidelines for digital games. We next describe *Youtopia*, a tangible, multi-touch tabletop sustainability game for elementary school-aged children, which we developed using these guidelines. The goal of playing Youtopia is to experience the challenges of balancing environmental and human needs in terms of food, shelter, energy and pollution while creating a world you would like to live in. A user study of Youtopia was designed to evaluate if children discussed their values during collaborative activity using Youtopia. We collected and analyzed video data from twenty sessions with forty children in order to identify sequences of value-rich dialogue and conflict between children during play sessions. We also analyzed interview and survey data to investigate if children were aware that they were discussing their values during interaction. We conclude with actionable recommendations for designing to support value-laden dialogue

[1] www.gamesforchange.org

IDC'14, June 17–20, 2014, Aarhus, Denmark.

http://dx.doi.org/10.1145/2593968.2593971

around social issues in G4C and games for learning for children. The main contribution of this paper is our evaluation of Youtopia and the subsequent revision of our design guidelines for Emergent Dialogue based on designing a system and our study results.

2. BACKGROUND

There are many models of persuasion – more than we can discuss in one paper. We delimit our work by focusing on two common models and a new model, called Emergent Dialogue, which we derived from environmental education and policy workshops [2]. The most common model for attitude and behavior change seen in G4C is the Information Deficit model, summarized in [10]. The Information Deficit model persuades through "correct information". Our review of over thirty G4C found evidence of this model in most G4C. This model likely originated as "best practices" were mapped uncritically from educational games focused on teaching facts to G4C. We are now suggesting we should revisit the design of educational games with a more informed understanding of how learning facts, changing attitudes and influencing behaviors are all required in social issues education. The second model of persuasion, called Procedural Rhetoric, recently emerged from the games studies community as an alternative to the Information Deficit model, and possibly a more effective approach to serious game design [6]. The Procedural Rhetoric model focuses on persuasion through interaction or experiencing the consequences of one's actions. The third model, Emergent Dialogue, focuses on the role of dialogue around personal values in social issues education [21].

There is no empirical evidence that any one model is more effective than any other [21]. Each may have a role to play in both education and persuasion depending on the specifics of the social issue at stake. However, we think the practice of developing G4C can be made more effective if designers are explicitly aware of the persuasion model they are using. We propose that the Emergent Dialogue model may be effective at facilitating dialogue around personal values. When it is "designed into" an educational game for children, it may facilitate children to discuss their values in conjunction with learning facts about social issues and, in the long term, lead to better social outcomes. Before we can evaluate long term effects we must discover how to design G4C that support children to participate actively in discussion about their values during game play. This is the focus of our paper.

2.1 The Information Deficit Model

The *Information Deficit* model assumes that providing correct knowledge or facts about social issues will lead to desirable behaviors. Many approaches to sustainability education are based on this model. The Information Deficit model suggests that providing information will influence or change people's *values*, and that value change drives changes in their *attitudes*; which in turn drives changes in their *behaviors* [10]. For example, it is common for local governments and organizations to run community workshops and lectures intended to educate participants in the benefits of recycling, conservation, reuse and other environmentally friendly practices. These types of events are mirrored in most elementary school curricula. This approach is based on the assumption that unsustainable behaviors arise from a lack of knowledge.

The Information Deficit model assumes a top-down model of sustainable behavior change where some authoritative entity or organization (such as a curriculum, government, or NGO) already has determined the *core message*. This information-centric model assumes that by using best new media practices to communicate the right information, behavior change will follow. Quiz games are the quintessential form of Information Deficit oriented G4C. For example, NASA's Recycle This![2] and Global Climate Change quizzes[3] are based on the Information Deficit model.

2.2 The Procedural Rhetoric Model

The *Procedural Rhetoric* model of behavior change emerged from game studies as a response to the criticism that many G4C, most based on the Information Deficit model, were either ineffective, unappealing or both [21]. Bogost coined the term Procedural Rhetoric to describe the practice of authoring arguments (i.e. rhetoric) through game mechanics (i.e. procedures) that result in pre-defined kinds of interactions [6]. In this model the argument of persuasion (i.e. the core message of the game) is not represented through information but through interactive processes. The rules of interaction in the game mechanics are in line with an argument for influencing attitudes or behaviors. Instead of simply providing players with facts or rewarding players for knowing facts, players are given an opportunity to interact with the core messages of the game through experiencing the consequences of their choices and actions during game play.

For example, in a simulation style environmental G4C, using a lot of energy usually results in high energy prices, environmental degradation or energy shortages. The implicit message is often that these effects are "bad" or negative. Cultural values around sustainability and responsible energy use are communicated to the player through the game rules, triggered by their choices through interaction. Rhetoric refers to the value-laden and culturally specific argument that behaviors which reduce energy use are good or right. Procedural refers to the rules programmed into a game through mechanics, algorithms and other forms of code. *Futura: The Sustainable Futures Game*[4] is an example of a simulation in which players experience the consequences of their actions through value-laden content. For example, if players create many energy plants, the colour palette of the world map changes to brown-grey and the ambient sound turns ominous. Users experience the core game message – that energy consumption and pollution are wrong – through interaction.

An underlying assumption of the Procedural Rhetoric model used in G4C is that by creating a set of game rules (procedures) that enable children to experience – through their interactional choices – particular events, they will modify their (future) behavior in line with the claims of the argument being made. In the case of both the Information Deficit and Procedural Rhetoric models, a top-down approach to content and information design is taken. Both models are based on the assumption that the desired outcome is a known quantity that must be advanced through the core message of the game, delivered through either facts or interactions.

2.3 The Emergent Dialogue Model

In [21] we introduced a model of persuasion for G4C called *Emergent Dialogue*. We suggested that this model could be applied in the design of digital media games. The model was taken from environmental education research about creating and running policy workshops with the general public. We worked to

[2] http://climatekids.nasa.gov/recycle-this

[3] http://climate.nasa.gov/interactives/quizzes

[4] http://www.antle.iat.sfu.ca/Futura

develop our model with sustainability social scientist John Robinson, who developed the core concepts of Emergent Dialogue in response to extensive critiques of the Information Deficit model. In [2] we presented the Emergent Dialogue model as an alternative approach to designing digital games for change and learning about social issues that may address the failure of existing models to elicit or influence future behaviors through learning facts or through interaction.

Robinson suggests that the previous conception of a unidirectional flow from information to behaviors is incorrect. Instead, he has found that people often bring their attitudes in line with their behaviors, rather than the other way around [17]. Because social issues are value laden, multiple conflicting views of sustainability exist and these cannot be easily reconciled. There is no one answer or set of facts or behaviors that is "correct". He suggests sustainability education should reveal that multiple conflicting values, moral positions and belief systems are involved in all issues of sustainability [17].

In this light, we suggest that when learning through game play is about influencing behavior around social issues, then success requires not only information and interaction but also and most importantly personally meaningful *participation* in dialogue. This is the fundamental premise of our work. In this paper, we apply and evaluate the Emergent Dialogue model in an educational G4C for children about sustainable living called Youtopia.

3. DESIGN METHODOLOGY

To date the Emergent Dialogue model has only appeared in public policy workshops and facilitated sessions with adults [21]. The challenge of the Emergent Dialogue approach is to find ways to support it through design decisions about content, procedures, rules and rewards in children's digital games. The elementary years International Baccalaureate curriculum[5] is pedagogically committed to participation, dialogue, and understanding the differences between facts, values and opinions. We use this as evidence to suggest that the Emergent Dialogue approach may be age-appropriate for elementary school-aged children.

3.1 From Model to Design

In order to design a game based on a model of persuasion we need ways to translate the model to actionable design decisions. In particular we needed a way to translate Emergent Dialogue into guidelines for a G4C for children. To understand how to apply the Emergent Dialogue model in G4C, we adapted a humanities research methodology called *Close Reading,* which has been used to understand important factors in video games [5]. Analysis of existing G4C was used to reveal some of the ways that persuasion models were implemented in games. We chose ten web and DVD G4C suitable for children on the topic of sustainability. Our close reading analysis identified six ways that persuasion models showed up in G4C. We call these *design markers* because they mark or provide evidence that a particular persuasion model has been instantiated into a game through the design process [2]. Design markers related to specific decisions made about content, how the player will interpret that content, how that content is communicated to the player, the goal of the game, what is rewarded in the game, and how the player can progress through the game to the final outcome. For each model: Information Deficit, Procedural Rhetoric and Emergent Dialogue we described markers that can be used to identify a model of persuasion at work. We delimited our study by focusing on G4C related to issues of sustainability and the environment, but we suggest that the results are applicable to other educational G4C around social issues where the core objective is learning that influences current or future attitudes and behaviors. A full description of our design marker derivation is available in [2].

We propose that design markers can be used as *design guidelines* for G4C based on each model of persuasion. This is possible since we explicitly identified relationships between each model of persuasion and designable game elements. In the next section, we define six design markers for the Emergent Dialogue model and describe how they can be used as guidelines to design a G4C.

3.2 Design Markers for Emergent Dialogue

For each marker we provide a definition and describe how it can be instantiated in game design decisions. The six markers are described individually, but we found that they are inter-related.

3.2.1 Content

The Content marker is about the information, meaning or "text" of the game or the message the game is trying to communicate. It is one of the most important markers because it deals with the *What?* of the game. What is the *core message* of the game?

The Emergent Dialogue model deals with the player's personal narratives about the content domain, rather than an authored or encoded message or judgment. This content is not present in the game; rather, the game provides opportunities to reflect and discuss personal meanings and values outside the mechanics of the game. For Emergent Dialogue to occur, the game artifact serves as a means of *eliciting* a player's perspective on the content domain using content, game mechanics or other forms of motivation. In contrast to the Information Deficit and Procedural Rhetoric models, in which the core message is directly encoded into the game, the player is invited to participate in discussion about their values about the content.

3.2.2 Interpretation

The Interpretation marker is about how the designers of the game intend the core message (content) to be interpreted by children. Do children reach their own interpretation of the core message as they experience the results of their actions in the game play? Or are they left to form their own interpretation of what the core message of the game was? Interpretation can fall anywhere on a continuum between "closed" or forced to "open" or unenforced.

In the Emergent Dialogue model, content and mechanics are used to create opportunities for children to create their own interpretations and perspectives about what content and experiences mean, based on their personal meaning-making process. This is in contrast to the Information Deficit model, in which content interpretation is fixed or closed since the content reflects what is "right" or "correct" in terms of sustainable behaviors. It contrasts with the Procedural Rhetoric model, in which players interpret the core message through their interactions and experiences in the game, leaving interpretation of the core message somewhat but not completely open.

3.2.3 Mode of Communication

This marker deals with *how* content is communicated through the game to the player. Are children told or shown the core message through text, graphics or sound? The mode of communication is a comparatively simple marker and is largely a function of the interaction of the previous two markers.

[5]http://www.ibo.org/diploma/curriculum
https://www.bced.gov.bc.ca/irp/plo.php

Figure 1 (a) Stamping trees into lumber (b) Groups of related tree & wrench stamps (c) Placing stamp into Info "ring" displays Info card that describes land use type, what it needs, what it produces and how it contributes to the world.

In Emergent Dialogue the system does not communicate the core message directly. Children should experience the core message through their dialogue in the context of game play. The system should give opportunities to participate in this process. This can be through the game interface or mechanics indirectly or through content directly (e.g. through a question: What do you think about ...?). This contrasts with the Information Deficit model, where the core message is directly communicated through content and feedback, and Procedural Rhetoric, where the message is communicated through specific system responses to player choices and actions.

3.2.4 Game Goals

Most contemporary definitions of games include some notion of winning and losing and both Information Deficit and Procedural Rhetoric adhere to this. By definition, a game is a system in which players engage in artificial conflict, defined by rules, which results in a quantifiable outcome [19]. In the Emergent Dialogue model, the goal is to arrive at some shared narrative around the social issue. In design this calls for open-ended tools or opportunities throughout the game to encourage players to discuss and share ideas and values, and most importantly through supporting players to determine their own game goals.

3.2.5 Motivation and Rewards

This marker is closely related to game goals. How does the game motivate the player to take specific action? What types of rewards are provided to encourage the player? In Emergent Dialogue oriented design there are no pre-defined objectives that the system can easily measure quantitatively. Therefore feedback should focus on the *process*, providing incentives and reward for authentic participation and honest engagement in the experience. For most social issues, children may bring their own sense of right and wrong and find the desire to "do good" provides internal motivation and reward independent of the game. This is in contrast to the other models in which what is right or good is encouraged by game mechanics and the game reward system.

3.2.6 Game Path and Outcomes

Our final marker is concerned with the path children take through the game, and the nature of the game's outcome. In the Emergent Dialogue model, the path to be navigated is less clear and there are no predetermined outcomes for the player to encounter. Players should be able to move in different directions and take different pathways through the game space, and it is up to the player to determine his or her own stopping point(s). In the other two models, there may be several paths but often these are uni-directional and converge on a preset outcome, such as finishing a level or winning the game.

4. SYSTEM DESCRIPTION

Youtopia is a hybrid tangible and multi-touch land use planning game for elementary school aged children [4]. It was implemented on a Microsoft PixelSense digital tabletop. A short video of functionality is available at (www.antle.iat.sfu.ca/Youtopia). The main method of interaction is through physical stamp objects that children use to "stamp" different land use types onto an interactive map (Figure 1a). Youtopia was developed to investigate issues around tangibility, collaborative learning and G4C based on Emergent Dialogue. In this paper, we focus on exploring design to support Emergent Dialogue.

4.1 Learning Goals

Our system was designed to meet learning outcomes for the B.C. (Canada) Prescribed Learning Outcomes and the International Baccalaureate (IB) grade 5 unit on the environment and sustainability (ages 10-11)[5]. Sample learning outcomes include:

- Analyze the relationship between the economic development of communities and their available resources;
- Analyze data to determine if a resource is renewable or non-renewable;
- Understand that some resources are constantly available and are considered to be renewable resources (e.g. hydropower);
- Describe potential environmental impacts of using living and non-living resources.

Our preliminary results (below) indicated that all children successfully met the learning outcomes.

4.2 System Functionality

With Youtopia children work together to explore how their land use decisions either support or do not support a small or large population with shelter, food and energy. There are different types of shelter, food and energy sources as well as nature reserves, each with different benefits and limitations. Pollution results from human developments. The map is of a small area of land including mountains, forests, grasslands and a river. There are four maps, each with equivalent resources. Only the terrain elements are arranged differently. Together, the different populations and maps add sufficient complexity to the application so that children can play for long sessions. The underlying system model was designed to reflect real world relations between resources and developments. It was then calibrated to make it difficult to satisfy human needs without some pollution in the small population model, and impossible to do so with a larger population.

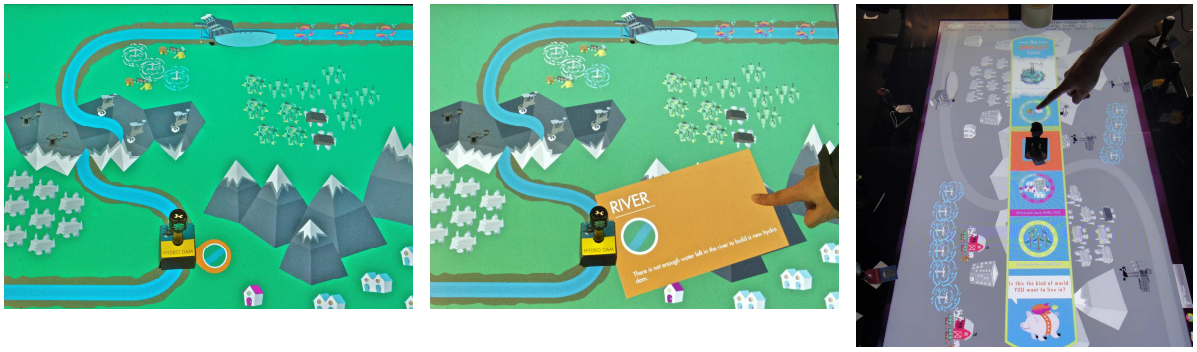

Figure 2 (a) Learning tab appears (b) Pulling tab reveals message (c) Impact tool & touch display world state information.

Natural resource and human developments are two main kinds of stamps, designated with a tree or a wrench on the top of the stamp handle. Each is also labeled with a picture and text to designate the land use type. To help children understand the relationships between lands uses related stamps are labeled with like colours. For example, irrigation, farms and garden stamps, which are all related to food production, are all colour-coded green (Figure 1b).

Another set of tools includes: erase, Info (information) ring (Figure 1c), impact (Figure 2c) and a 3D pig. The erase stamp enables "undo" without consequences. When a land use stamp is placed in the circular Info ring the system displays an information card about what the land use requires, produces and contributes to the world and constraints on usage, such as legal locations. For example, placing the apartment stamp in the ring displays how much lumber is needed to produce an apartment complex, how many people the structure can shelter and that it can be built in grasslands (Figure1c). Information is provided both textually and pictorially. When the Info tool is in use, the map is frozen and greyed out, so that no other children can interact at that time. The impact stamp also freezes interaction (Figure 2c). It displays an overlay showing the current state of the world in terms of what proportion of the population has its need met for shelter, food and energy, and how polluted the world is (expressed as partially filled-in rings, see Figure 4 below). The pig (Figure 1c, bottom of image) asks "Is this the world you want to live in?" Touching any circle highlights all the resources and developments contributing to that state on the map. For example, touching the food ring causes the system to highlight irrigation, farms and gardens (Figure 1c). A 3D pig object is used to create printable images of the current state of the world map, and the impact display.

4.3 Learning Feedback

If a child places a stamp in an illegal location then one of five types of learning tabs will appear (Figure 2a). For example, if the hydroelectric dam is placed on the river but there isn't enough water left (because it has been used up with other developments or reserves), then the "resource used up" orange tab appears (Figure 2a). A child can use their finger to drag the tab away from the stamp to display a message (Figure 2b). Messages are focused on explaining land use relationships and providing information that enables legal placement of a land use type. A child can resize or rotate the message so other children can see it.

4.4 Support for Collaboration

Researchers studying interaction with multi-user tabletops have suggested that even coherent groups of users may not immediately work together on collaborative applications [15]. To support collaboration we designed inputs that are co-dependent [3]. While each stamp is sensed individually, to successfully build anything requires two or more stamps placed in sequence. Typically, this is one or more natural resource stamps followed by a human development stamp. For example, since developments like the farm or garden require water, irrigation must first be placed on the map adjacent to the river. However, the river's water levels can be depleted so developments that depend on its usage may be limited due to this constraint. In this case, a development that uses water has to be removed, then irrigation placed, and then a farm or garden placed. We expected this strategy would require children to coordinate stamps and actions, and in doing so, negotiate what they want to achieve. Our preliminary results (below) indicated that children largely collaborated. More detailed analysis of collaboration is beyond the scope of this paper, outside of how it relates to Emergent Dialogue.

4.5 Applying Design Markers for Emergent Dialogue

In this section we describe the ways we incorporated the Emergent Dialogue model into the design of Youtopia for each type of design marker. Our goal was to use the six markers as guidelines to create a system that encouraged value-rich dialogue about sustainable land use planning.

4.5.1 Content

Content in the Emergent Dialogue model focuses on eliciting a dialogue that contains personal values about the content domain (sustainability) between the system and children, and ideally beyond the game into the classroom. The core message of Youtopia is that the children are responsible for making choices to develop and preserve the land to reflect the kind of world they want to live in. Because our system is a simulation style game, children can iteratively experiment with the consequences of their decisions, providing an opportunity to reflect on the effects of different choices. We also expected that requiring co-dependence of stamp inputs would encourage discussion about coordinating resources and developments. When children place the impact stamp tool anywhere on the map, they find out how much of their population's needs are met. The tool freezes the interface, displays a graphical overlay with images and text. This overlay is touch-sensitive and provides an opportunity to further explore the current world state by touching the food, shelter, energy and pollution rings to see all the land uses associated with that state. This provides another opportunity for children to discuss how

their decisions are impacting the world that they are creating. After they have completed the game, children can use the 3D pig to create printable images of their final world map and impact display. The 3D Pig feature provides images that provide opportunities for children to continue to discuss their choices and values within the community of their classroom.

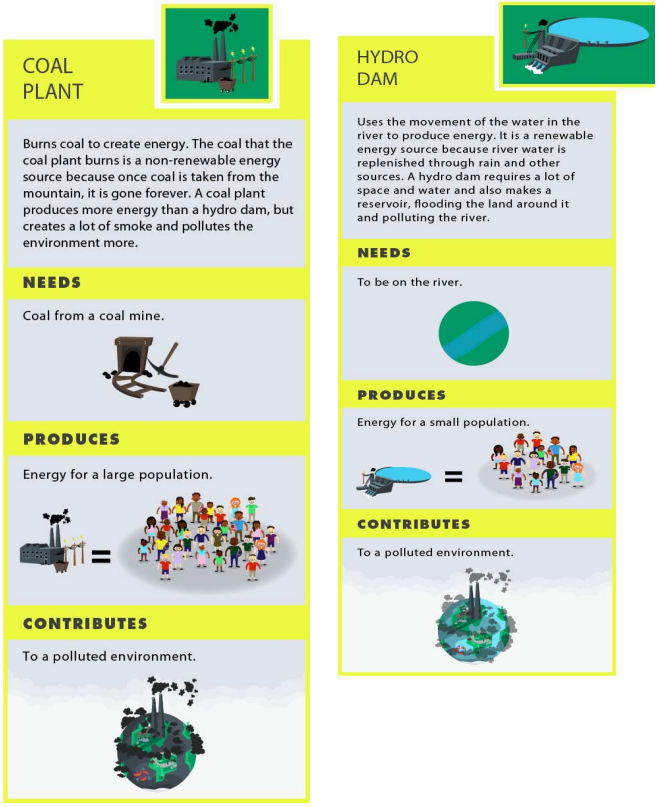

Figure (3a) Info card for coal plant (3b) and hydro dam.

4.5.2 Interpretation

We encourage open interpretation throughout our game. First, content (e.g. Info cards, learning tab cards) was all written without reference to any value judgments. For example, the Info card that explains how much energy and pollution a coal plant produces does not suggest that the pollution created by burning coal is "bad" or "wrong" or that cleaner solutions should be sought (see Figure 3a). We found this task harder than one might imagine, largely because values are routinely embedded into such content in source materials.

The interpretation of consequences of children's actions is also open since there is no winning or losing (see game Goals below). Children use the impact tool (Figure 2c) to display the state of the world. The system provides graphical information about food, shelter, energy and pollution levels using value-free means such as the proportion of rings filled, as shown in Figure 4. We used words that communicated general quantity but not quality or value judgment, such as "Most of the population has shelter." and "There is some pollution in the world."

4.5.3 Communication Mode

This marker deals with how content is communicated through the game. In our system children are not told the core message. Much of the content is accessed when they want it using the learning tabs or Info ring. They can choose to access Info cards on any land use stamp by placing that stamp in the Info ring. This freezes the game and graphically displays images and text that are descriptive and value-free (Figure 3). Based on the children's values about balancing human and natural needs, they can decide how to proceed. The game does not tell them what or how to play correctly; they must discuss this and in doing so experience the core message of the game.

Figure 4. Using graphical means to show proportion of population sheltered (left) and pollution levels (right).

4.5.4 Game Goals

There is no explicit goal or "winning state" in our game, challenging the definition of it as a game. Children are invited to create a world they want to live in. It is open to the children to choose a map, decide the size of the population, how much of the population's needs they will or will not support, and how much pollution they can tolerate. They can use different types of shelter, food and energy as well as nature reserves, each with different benefits and limitations. The goal is for children to explore, through game play, how to create a world they would like to live in, which reflects their personal preferences, opinions and values. The impact stamp gives children information they can compare to their own personal goals for the game, rather than an absolute end state (since filling all the rings is very difficult).

4.5.5 Motivation and Rewards

Without a winning state it is difficult to know how to motivate children. We thought children might be motivated by the challenge of the task (intrinsic motivation), or by being able work together (external motivation). We also hoped the reward would come, in part, from being able to work through how to create a world that reflected their personal values. In the game there was no reward for meeting the population's needs without over-polluting the world. And conversely, not meeting the population's needs or creating pollution was not associated with right or wrong judgments or values. The activity ended when the children decided they were satisfied with their world. However, children knew they would have to print out their final map and impact display to later present it to their classmates. We thought this would provide external motivation to participate authentically.

4.5.6 Game Path and Outcomes

Using our system, children can play forward and backward through hundreds of game paths, each resulting in a slightly different outcome. At any time, they can start over, change the map, change the population, erase land uses and continue playing. We expect that providing multi-directional pathways and an underdetermined end outcome may encourage children to engage in dialogue. For example, they need to decide which natural resources to use at any point, which to preserve, which and where

to put development and when they are satisfied with the game outcome (current state of their world).

5. USER STUDY METHODOLOGY

We evaluated Youtopia using a mixed methods user study at a local school with forty children, aged 10 and 11. We set up two identical systems on tabletops in pull-out rooms to ensure sound isolation and reduce distractions created by the novelty of the systems. Each room had two HD video cameras: one hung from the ceiling, the other on a tripod with a viewing angle that captured two children, the facilitator and the tabletop. In each room, we captured video and log data, and two additional researchers took still photographs and observational notes using structured observation sheets. We followed each session with a short survey and interviews which we recorded and transcribed. Two weeks later students presented their map and final world in a class presentation that was also recorded with video and assessed against learning outcomes by teachers using a standardized rubric.

In this paper we focus on using data to explore if Emergent Dialogue occurred and how specific design decisions for each design marker type may have encouraged it. We used coded video data to identify segments of Emergent Dialogue, which we summarize both quantitatively and with quotes. We augment this data with quantitative results from survey data related to Emergent Dialogue, and qualitative data from interviews in which children reflect on how their values played out in the sessions. Sample survey and interview questions appear in the results section. We did not notice observer effects, possibly because the research team interacted with the children informally outside of sessions to reduce such tension, and the main researcher was known to the children through other events. Although there may have been novelty effects in terms of enthusiasm for game play, we do not think that enthusiasm led to more or less discussion about values.

Children were grouped by their teachers into pairs with similar abilities and who worked well together. This pairing strategy was chosen to optimize chances of successful interaction and collaboration. The facilitator began each session with a preamble and tutorial about basic system functionality including how to use stamps, touch menus and tools. Children were instructed to "Create a world you would like to live in." Twenty minutes into the session they were told they had about seven minutes left.

5.1 Data Analysis

To verify that children successfully met learning outcomes we analyzed scores from a rubric developed by the teachers based on IB[5] learning outcomes. The average score for combined "content" and "reflection" categories was 4.8 out of 5 (SD =0.4). To date, most video coding of collaboration within the HCI literature involves looking at equality of participation – both verbal and physical (e.g. [9, 18]). Recent work has focused on mechanisms of negotiation and coordination (e.g. [1, 8]) and the interplay of physicality, space and conflict (e.g. [16]). Within the Learning Sciences literature the focus is more on the cognitive and socio-cultural processes supporting learning, resulting in fairly complex coding schemata. For example, Higgins et al. [11] developed a schema based on hierarchical categorisation that identifies increasing complexity in reasoning. Koschmann et al. [12] focus on microanalysis of small group meaning-making in the learning process. Dillenbourg and Evans [7] present an excellent summary of work in this area. However, none of the schemata presented are suitable to identify instances of dialogue about personal values in their reasoning. As such we developed our own schema.

To verify that children collaborated (including verbal and physical participation) our coding began with a category called *working together* that involved both children working on a shared element of the task. This initial coding revealed that children almost exclusively collaborated throughout the sessions. We then created two non-mutually exclusive categories related to Emergent Dialogue: *in-depth* and *conflict*, both of which are subsets of *working together*. Refinement of these two categories and training of coders followed a standard process, which was repeated once for *in-depth* and later for *conflict*. The group included three coders as well as the principal researchers who did not code but oversaw the process and helped the coders refine categories. First the entire group met to define and agree on prototypical examples taken from observational notes. The three coders then worked together to code short segments of a training video. This led to refinement and further examples for both categories. This process continued until coders reached a Cohen's kappa value, K > .75 on the training video. *Cohen's kappa* is an estimation of the degree of consensus between raters.

In-depth includes events in which one or both children talk about decisions about what resources and developments to use. An *in-depth* event involves a sense of the world or individual values, which differs from simple preference. It must also involve reasoning using those values, typically around tradeoffs between human and natural needs. So the statement, "I think we should have houses not trees" is preference and would not be coded. However, the statement, "No, let's build houses instead of apartments because they use less lumber, and we can make more trees into nature reserves." would be coded *in-depth* because it involves values in the context of reasoning about tradeoffs.

Conflict includes verbal and/or physical disagreement with another person's action or utterance related to sustainability domain. *Conflict* requires an objection or stance on an issue. Presenting available options or suggestions is not *conflict*. *Conflict* may result in resolution, abandonment (unresolved) or uni-lateral decision-making.

After we developed our schema on the training video, we coded the 20 session videos in three rounds. First, three videos were coded by one person and cross-checked by another person (K >.75). Next, five videos were coded by one person and two of these were cross-checked by another person (K >.75). Finally, the remaining 12 videos were coded by one person and four were cross-checked (K >.75). After we coded *in-depth* and *conflict*, we ran descriptive statistics. Rather than looking exclusively for quantitative evidence at this early stage, we used video coding to identify segments in which children participated in Emergent Dialogue. We analyzed these segments in detail and triangulated with other data sources so that we could develop rich examples (following best practices in [11]) rather than only counting types of events within or across sessions.

6. RESULTS

Our results show clear evidence that children met learning outcomes and also engaged in discussion, negotiation and conflict about tradeoffs between human and environmental concerns that reflect their individual values. Sessions lasted on average 23 minutes (SD=4:23 minutes). On average there were about 10 *in-depth* (Emergent Dialogue) events per session. These tended to be short (10 seconds or less) although the longest lasted a full minute. These kinds of discussions comprised about 5% of the

total collaboration time. Our video analysis revealed that children had significant *conflict* about 2.5 times per session, lasting on average 17 seconds. Of these we identified cases where children had conflict because of their different values. Sometimes they resolved differences, other times not. Overall the proportion of session time spent in these in-depth value-laden discussions and conflicts was small. However, we suggest that these segments of interaction were rich and that these kinds of interactions have the potential to transform children's understandings of the interplay of facts, values, and attitudes in social issues.

6.1 The Core Message

In the interviews all of the children reflected on the issues and tradeoffs they faced balancing human and natural needs, which is part of the core message of our game. They rated this issue as important, with an average score of 4.4 out of 5 (SD=0.6). In the interviews, one child said, "How I would think about it is .... I kind of anticipate what would happen before I put the stamp down … like I think about if I put the human down it would help them or I can put the nature reserves down will it help humans and nature." And their partner said, "Yes, like I would think like what would it do for us that would be what we really need, like if you don't do it, it won't be the end of the world." Another child said, "Probably we want to kind of even it out because humans are no better than any other animal and they can take the world for granted just because they are kind of bigger and we can do that; if we can do it then we have ..... to space it out with animals because the animals have as much right as we do."

All the children grappled with the core message despite never being told what it was, or being rewarded for enacting it. They experienced it, prompted by opportunities within the game mechanics to reflect and discuss their values and choices to develop and preserve the land area in order to reflect the kind of world they wanted to live in.

6.2 Emergent Interpretation

Children used the erase, Info ring and impact tools repeatedly in sessions to understand the effects of different choices. These tools and their effects on the game provided opportunities for children to discuss their values in the context of reasoning about their actions. For example, after P1 placed the impact tool, the pair looked at the food, energy, shelter and pollution rings, and discussed the trade-off between pollution and housing levels, comparing to their own values for what was "good."

P1: There is no pollution, all people have food, most people have shelter, all people have energy.
P2: This is a good world.
P1: You know what ... it says most people .. I think if we add one more house. (*Uses eraser tool to erase a forest reserve to free up lumber*).
P2: What! Why are you erasing it? (*Continues to protest*)
P1. There's little pollution – it's OK.
P2: No ... wait.

P1 thinks that a little pollution is OK if all the population can have shelter. P2 disagrees and thinks a good world should have no pollution even if some people have no housing. With value-free content, their interpretation of what is good or enough emerges in the context of interaction; it is up to the children, and their differences prompt discussion (and compromise) about the kind of world they want to live in.

We often saw *in-depth* events when there were enough developments to support "most" but not "all" of the population. Often, one child felt that this was fine but the other had a personal game goal to support all of the population. For example, P1 and P2 were working on shelter and placed the impact tool.

P1: Let's see if all people have shelter.
P2: Most people have shelter. That's good.
P1: Let's think about it more … wait."
P2: It's good enough. *Starts to do something else*

Our language choice of "some" and "all" was made to avoid value-laden words. However, because these words are subjective and there was no objective winning state, different interpretations emerged about what was "enough", which in turn prompted discussion and compromise. This idea of compromise inherent in this sequence is promising since compromise is at the heart of environmental planning.

One concern with using open interpretation in a learning game is that children may make false connections between their actions, system responses and the reasons for such responses. For example, they might think they have enough housing but too much pollution and so delete housing to impact pollution. However, in our case the impact tool provided evidence that pollution had not changed since deleting housing may free up trees but does not noticeably impact pollution.

6.3 Conflict as Motivation

Some pairs had little conflict, others had more. We observed that pairs that had conflict discussed their reasons for their choices, which sometimes involved using the Info ring or impact tool to present their case with facts and sometimes involved values. The impact stamp that triggered the world state overlay often resulted in reflection and discussions involving conflict about what to do next. Thus, conflict was beneficial in motivating discussion that involved values and further game play to try out alternatives. This finding is consistent with seminal work by Malone [13], who suggests that conceptual conflict is intrinsically motivating. Unlike a competitive game where conflict drives competition between two players, in our game conflict motivated negotiation and compromise during collaboration.

In the interviews when asked *If you had to do this activity on your own would your world have been different?* one child said, "She's leaning slightly towards natural resources and I'm leaning towards human side; like I said before I wanted to change some of it to apartments and she said no we should keep some more ..... but I eventually managed to get her to where she could change it all to apartments. Should I let her do that right away?" The facilitator then asked, *Would you have cut more trees down? Or did you have a debate about that as well?* The child said, "Yes, we had a little debate but I know that the trees are very, very, very important …" The children's conflict over the value of trees versus shelter motivated discussion, furthered game play and enabled them to make progress towards self-determined goals.

6.4 When do values emerge?

In many of the sessions we identified *in-depth* discussions about values in the latter half of the session when resources were running low and children were told they had seven minutes left. At the beginning of most sessions, resources were still in abundance so compromise was not yet needed. However, later the task became harder. For example, this late-game segment shows both *in-depth* dialogue and *conflict* about trying to create adequate shelter while conserving trees.

P1: Most people have shelter. Are you kidding me?
P2: What? No, no – most people can have shelter.

P1: No we have to try and do what we did before.
P2: There's only like only … four more trees!!
P1: It's ok, it's ok.
P2: Four more trees …

To address P2's concerns, P1 says, "Kill some of the houses" and erases most of the houses, to get trees back and builds higher capacity apartments, which still does not satisfy P2, who says, "What? People can't just live in apartments all their lives!"

We noticed that this type of value-laden conflict typically increased with time pressure when the pair had not yet created a world they were both satisfied with. This ties in to the issue of game challenge level.

6.5 Challenge as Motivation

We designed our system so that it was impossible meet all of a population's needs and have no pollution. However, it was possible to come very close to this state. Our *in-depth* analysis revealed that when children had difficulty, they were motivated to work together to find solutions, which in turn often resulted in *in-depth* discussions. For example, after P1 placed the impact tool,

P1: The world has to have some pollution if we're going to have all of those (*Points to all the developments*).
P2: No, No. I don't take that.
P1: What?
P2: Keep trying. (*Uses erase to try different approaches*)
P1: (*Eventually joins in*)

Challenge motivated Emergent Dialogue. This finding is also consistent with Malone [13], who suggests that appropriate challenge level is intrinsically motivating.

6.6 Emergent Dialogue is fun!

While conflict might be construed as negative, all children said they enjoyed working together. They also said working together helped them learn about balancing human and natural needs, rating this statement 3.7 of out 5 (SD=0.9). Children also said working together helped them understand their partner's values, rating this statement 4.0 out of 5 (SD=1.0). In response to the interview question, *How did having to work together affect the kind of world you created?* One child said. "Well we both had different ideas so we kind of liked different ideas .... we'd like something better so that's how it worked together." And the other child added, "I think that we both had different input and different views on this so if we both worked together two heads are better than one."

7. DISCUSSION

Overall we suggest that the design of our system was effective at eliciting collaboration and participation around deciding what kind of world the children wanted to live in, learning about the tradeoffs required, and encouraging some value-laden dialogue. In particular we think the ways we created opportunities for children to experience and discuss issues related to the core message worked well. Using value-free content combined with no right or wrong feedback or game goal meant children had to discuss their pathways through the game, use information and impact tools to discuss tradeoffs, and decide when to end the game. We suggest that it is largely the interplay of Emergent Dialogue design markers – rather than any one particular marker – that worked well to support the kinds of rich dialogue and productive conflict we saw. Compared to earlier work [1], we saw more heads-up inter-personal interaction.

Our initial assumptions were that children would only collaboratively work together some of the time. However, our first pass at coding showed they almost exclusively worked together. While we did not focus on the tangibility of the stamps in our design rationale, we suggest that having a set of sixteen physical objects, which were used for input and control, created situations where children were prompted to share the stamps and, in doing so, often discussed their reasons for wanting one stamp or another, or they discussed their plans based on the stamps they were looking or asking for, or about to use. Sometimes one child would reach to take a stamp before it was used by the other child, which also prompted conflict and subsequent discussion. Our video coding results showed this kind of overlap between *conflict* and *in-depth* discussion. This mirrors findings reported in [8] around productive conflict in tabletop learning. However, it is unclear if this pattern would have emerged if we had used only multi-touch buttons rather than physical "stamps". Speelpenning et al. found more evidence of dialogue around sharing tangible tools than equivalent touch tools in a sustainability game [20]. Olsen et al. found similar results when comparing tangible and touch toolbars [16]. Another factor that may have supported productive conflict is that there was only one of each stamp type. This may be similar to findings reported in [9] that suggest a single-touch interface requires more negotiation than multi-touch. We suggest that the combination of multiple unique input objects with the Emergent Dialogue design markers supported collaboration and productive conflict rather than non-productive conflict such as that reported in [14] in which children develop strategies to "own" input buttons and fight to gain control.

Children set their own winning state during game play. All children tried to meet the population's needs with as little pollution as possible and repeatedly checked to see if they had achieved this difficult task. Since it was not possible, *In-depth* dialogue and productive *conflict* often arose as they iteratively negotiated trade-offs and goals based on their own values throughout the game. We see this as similar to the way children iteratively discuss and modify game goals and rules in playground games such as tag, or hide and seek. No two games are alike. We suggest the openness of our system design in terms of content, game paths and lack of explicit goals enables this kind of organic determination of play. More work is needed to determine if more rigorous game rules and goals would eliminate this openness to interpretation.

We revised our markers based on our results and for clarity. We added two new markers (challenge level, tangibility), and separated marker six into two markers (multiple pathways and outcomes). In summary we present our revised guidelines:

1. **Content**: Enable children to experience the core message through system-generated opportunities that require discussion related to that message (e.g. overlays provide information about game world and current game state to encourage discussion but do not tell children what is "right" or what to do or how to win);

2. **Interpretation**: Use value-free information and consequences that are open to interpretation; but also provide a way for children to check their assumptions about causes and effects to avoid reinforcing misconceptions (e.g. impact tool enables them to see if changing developments impact pollution);

3. **Mode of Communication**: Provide on-demand content to support learning rather than forcing children through content (e.g. Info Ring, learning tabs, impact tool);

4. Goals: Enable children to determine their own game goals in line with their personal values;

5. Challenge: Calibrate challenge level difficulty so that it motivates discussion around how to achieve goals;

6. Tangibility: Use multiple unique physical inputs that require coordination (e.g. through co-dependent input design);

7. Reward: Rely on intrinsic motivation and provide mechanism to reward authentic participation (e.g. printout to share game outcomes with peers);

8. Multiple Pathways: Provide "no cost" opportunities to explore the consequences of a range of choices;

9. Outcomes: Enable game to finish when outcomes are in line with personal values and game goals.

8. CONCLUSION

We see this work as a first step at incorporating the Emergent Dialogue model into the design of children's G4C for social issues education. Our contributions include: encouraging designers to explicitly use one or another model of persuasion; providing an illustrated case of how to design using Emergent Dialogue guidelines in a G4C about sustainability; validating our design rationale with a robust mixed-methods user study; and providing a refined list of design guidelines to support Emergent Dialogue. We see this as a starting point for this work, and encourage other educational game designers to apply, validate and refine design markers for other styles of games, and social issue topics.

9. ACKNOWLEDGMENTS

Funded by NSERC, SSHRC, PICS and GRAND. We gratefully acknowledge the contributions of John Robinson, Allen Bevans, Anna Macaranas, Rachael Eckersley, Saba Nowroozi, Perry Tan, Amanda Willis and the fantastic school we worked with.

10. REFERENCES

[1] Antle, A.N., Bevans, A., Tanenbaum, J., Seaborn, K. and Wang, S. Futura: Design for collaborative learning and game play on a multi-touch digital tabletop. In *Proc. Conference on Tangibles, Embodied and Embedded Interaction*, ACM Press, (2011) 93-100.

[2] Antle, A.N., Tanenbaum, J., Macaranas, A. and Robinson, J. Games for Change: Looking at Models of Persuasion Through the Lens of Design. In Nijholt, A.(ed.) *Playful User Interfaces: Interfaces that Invite Social and Physical Interaction*, Springer, 2014, 163-184.

[3] Antle, A.N. and Wise, A.F. Getting down to details: Using learning theory to inform tangibles research and design for children. *Interacting with Computers 25*, 1, (2013) 1-20.

[4] Antle, A.N., Wise, A.F., Hall, A., Nowroozi, S., Tan, P., Warren, J., Eckersley, R. and Fan, M. Youtopia: A collaborative, tangible, multi-touch, sustainability learning activity In *Proc. Conference on Interaction Design for Children Conference*, ACM Press, (2013) 565-568.

[5] Bizzocchi, J. and Tanenbaum, J. Well Read: Applying Close Reading Techniques to Gameplay Experiences. In Davidson, D.(ed.) *Well Played 3.0: Video Games, Value, and Meaning*, ETC-Press, Pittsburgh, USA, 2011, 262 - 290.

[6] Bogost, I. *Persuasive Games: The Expressive Power of Video Games*. The MIT Press, Cambridge, 2007.

[7] Dillenbourg, P. and Evans, M. Interactive tabletops in education. *Int. Journal of Computer-Supported Collaborative Learning 6*, 4, (2011) 491–514.

[8] Fleck, R., Rogers, Y., Yuill, N., Marshall, P., Carr, A., Rick, J. and Bonnett, V. Actions speak loudly with words: unpacking collaboration around the table. In *Proc. Conference on Interactive Tabletops and Surfaces*, ACM Press, (2009) 189-196.

[9] Harris, A., Rick, J., Bonnett, V.J., Yuill, N., Fleck, R., Marshall, P. and Rogers, Y. Around the table: Are multiple-touch surfaces better than single-touch for children's collaborative interactions. In *Proc. of Computer Supported Collaborative Learning*, (2009) 335-344.

[10] He, H.A., Greenberg, S. and Huang, E.M. One size does *not* fit all: Applying the Transtheoretical Model to energy feedback technology design. In *Proc. Conference on Human Factors in Computing Systems*, ACM Press, (2010) 927-936.

[11] Higgins, S., Mercier, E., Burd, E. and Joyce-Gibbons, A. Multi-touch tables and collaborative learning. *British Journal of Educational Technology 43*, 6, (2012) 1041–1054.

[12] Koschmann, T., Stahl, G. and Zemel, A. The video analyst's manifesto. In Goldman, R., Pea, R., Barron, B. and Derry, S. (eds.) *Video Research in the Learning Sciences*, Lawrence Erlbaum, 2007, 133-143.

[13] Malone, T.W. Toward a theory of intrinsically motivating instruction. *Cognitive Science 5*, 4, (1981) 333-369.

[14] Marshall, P., Fleck, R., Harris, A., Rick, J., Hornecker, E., Rogers, Y., Yuill, N. and Dalton, N.S. Fighting for control: Children's embodied interactions when using physical and digital representations. In *Proc. Conference on Human Factors in Computing Systems*, ACM Press, (2009) 2149-2152.

[15] Marshall, P., Morris, R., Rogers, Y., Kreitmayer, S. and Davies, M. Rethinking 'multi-user': An in-the-wild study of how groups approach a walk-up-and-use tabletop interface. In *Proc. Conference on Human Factors in Computing Systems*, ACM Press, (2011) 3033-3042.

[16] Olson, I.C., Leong, Z.A., Wilensky, U. and Horn, M.S. It's just a toolbar!: Using tangibles to help children manage conflict around a multi-touch tabletop. In *Proc. Conference on Tangible, Embedded, and Embodied Interaction*, ACM Press, (2010) 29-36.

[17] Robinson, J. Squaring the Circle? Some thoughts on the idea of sustainable development. *Ecological Economics 48*, (2004) 369-384.

[18] Rogers, Y., Lim, Y., Hazelwood, W. and Marshall, P. Equal Opportunities: Do shareable interfaces promote more group participation than single user displays? *Human-Computer Interaction 24*, 2, (2009) 79-116.

[19] Salen, K. and Zimmerman, E. *Rules of Play: Game Design Fundamentals*. MIT Press, Cambridge, MA, USA, 2004.

[20] Speelpenning, T., Antle, A.N., Doring, T. and van den Hoven, E. Exploring how a tangible tool enables collaboration in a multi-touch tabletop game. In *Proc. INTERACT*, ACM Press, (2011) 605-621.

[21] Tanenbaum, J., Antle, A.N. and Robinson, J. Three perspectives on behavior change for serious games In Proc. of *Conference on Human Factors in Computing Systems*, ACM Press, (2013) 3389-3392.