EXPLORING HUMAN BEHAVIOUR IN DESIGN EDUCATION: SUPPORTING SUSTAINABLE DECISION-MAKING WITH A TABLETOP ACTIVITY

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Abstract

This paper explores the behaviour of learners engaging with a sustainable tabletop activity. Fitting with the theme of Resource-Sensitive Design, this paper takes the viewpoint that the early educational experiences of future designers can shape how they conceive the complex issues of resource scarcity, and therefore design education using technology can support learning and behaviours for sustainable decisions. Videos of twenty pairs of students playing the land planning game "[Blinded]" were qualitatively analyzed using a speech-act theory framework to identify emergent themes on collaboration and decision-making. The findings showed that learners used tools with speech acts in many ways that enhanced collaborative behaviours: 1. advocating for issues using evidence, and 2. sharing values to convince a partner and 3. engaging a non-attentive partner. The implications for design include supporting: informed decision-making, highly visible information, buy-in processes, and encouraging learners to express their values. These findings provide new avenues for exploring spaces for negotiation about the environment and decision-making about difficult trade-offs.

Keywords: Sustainability, Human behaviour in design, Social responsibility, Design education

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1 INTRODUCTION

The challenge of educating designers to think critically about environmental trade-offs is an essential one. It is crucial to look to how we educate future generations to make socially responsible decisions considering the limited resources we have, the needs of humans and environments, and the complexity of making these decisions. Doing so requires promoting conscientious choice-making based on opportunities to develop knowledge of the issues, action strategies, shifting perception on the ability to effect change as well as verbal commitment to certain actions which indicate personal responsibility (Hines et al., 1986). This study details an educational experience that allows young learners to experience the process of balancing trade-offs while making design and development decisions with real-world limitations such as limited natural resources and consequences such as pollution. It explores some of the practices and strategies that the learners used while engaged in sustainable design with a resource-sensitive activity, generating implications for the creation of future innovative environment to support the learning and practice of resource-sensitive engineering design.

1.1 Collaborative design processes with technology

Vygotsky (1978) emphasized that practical tasks can be solved with language, eyes, hands and tools and these can be used to negotiate meaning in social environments. Learning environments mediated by technology offer opportunities for enhancing: team work, communication skills, joint problem-solving, regulated learning, and the development of shared visual representations of knowledge (Chan, 2012). In this research, a table top activity was designed to explore planning for limited resource use; encouraging children to make sustainable decisions in a simulated world where they saw the immediate impacts of their decisions. Within this context learners can direct one and others' attention to key elements, regulate their own actions, and use language to share information. Language plays a key role in collaborative design processes as learners build shared experiences, refer to the same items in new ways, encounter repeated problems, and form a common dialogue around the answers and outcomes (Stahl et al., 2006). As technology continues to advance, it is important to develop collaborative and complex experiences to shape young learner's understandings, team work and critical thinking skills to favour well-thought out and sustainable decisions.

1.2 Collaboration with Tangible User Interfaces (TUIs)

TUI systems consist of a computing component (i.e. a table top touch screen) that can interact with digitally-augmented physical tools (called tangibles) (Ishii and Ullmer, 1997). These systems allow "users of computer systems to interact with digital content through the manipulation of physical objects" (Schneider et al., 2011). TUI systems offer exciting collaborative designs which are centrally-located, shared, and represent a complex problem space that: supports awareness of peers' activities (Dillenbourg and Evans, 2011), tracks activity to inform future decisions, can provide just-in time feedback and scaffolding support (Schneider et al., 2011; Falcão and Price, 2011); and support co-dependent access points to negotiate their activities (Antle et al., 2013). The TUI activity for this research is described below.

1.3 Exploring decision-making with Youtopia

Youtopia, a sustainable land planning activity supports two learners to focus on the resources and development needed to maintain a healthy population and world (based on fifth grade environment and sustainability material). Emergent dialogue (Isaacs, 1993) is an important concept in the design. In facilitating learners' shared understanding and mediate behaviour, "shared tacit thought among a group comprises a field of meaning" … "As these fields are altered in a variety of subtle ways, their influence on peoples' behaviour changes" (Isaacs, 1993). In Youtopia, the tools are used with language to support negotiation of decision-making within the system. The central design features include interdependent (resource and development) stamps, eraser tool, impact tool and info ring (Antle et al., 2013; Wise et al., 2015). The stamps are used to designate icons for resource use or development with restrictions and consequences. For example, a resource piece is used (e.g., lumber) before a development piece (e.g., house). There are four landscapes to choose from which include different combinations of rivers, forests, grasslands and mountains to be harvested for food, energy or shelter, or used as natural reserves (improving the air quality). Table 1 below describes the critical design features in Youtopia.

Table 1. Condensed Taxonomy of tools

Term	Description
Stamps/ land development tools	The wooden stamps have corresponding digital qualities and relationships with other stamps, and can be used to adjust decisions in the activity. E.g., garden, farm, house, townhouse, apartment, lumber, hydro dam, coal plant, coal mine, nature reserve, river reserve, mountain reserve
Feedback tabs	Errors/issues for tool use prompt a digital hint about one of four possible improvements: proximity to water, resource requirements, terrain placement, or the existence of a digital land use representation in the same place. All stamps can have potential error messages (including eraser and impact tool).
Impact tool	The tool measures food, housing, shelter, pollution levels of Youtopia and displace the results with impact circle displays.
Impact tool circles	The results are displayed during use of the impact tool and appear as four rings (food, energy, housing, and pollution) that can be interacted with to light up the contributing digital representations.
Info ring	The only non-stamp, circular tool displays digital information cards (info cards) when individual stamps are placed inside.
Info card	All stamps and tools have an info card which provides a full description of a digital land use representation's characteristics when a stamp is placed inside the info ring. The info card is rotatable and can be enlarged.

Learners receive feedback as they explore and use the information to decide what future actions to take. When the info ring is used with a stamp, the activity pauses and learners can find out the tool's characteristics. The impact tool provides status updates on the food, shelter and energy through multi-touch indicators. A map of the relationships of resource and development stamps is shown in Figure 1.

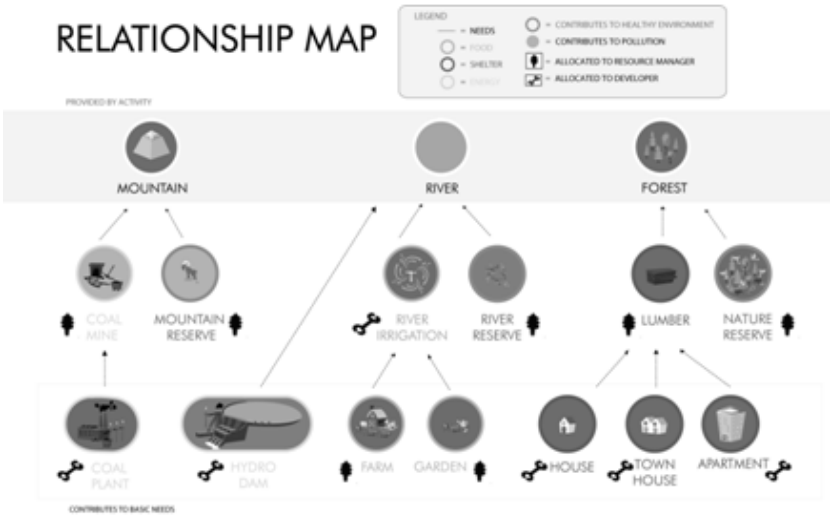

Figure 1. Relationship map between tools

Using the impact tool, the learners receive value-free feedback on their choices, (e.g. "there is some pollution"), which learners use to draw their own conclusions (i.e., whether 'some' is too much or acceptable). A question on the tool display asks 'what kind of world do you want to live in?' and learners modify their world until they are satisfied with the energy, food, housing and pollution levels. Youtopia's use of the Emergent Dialogue model in its design takes an open perspective on language and behaviours by providing opportunities to participate sustainable decisions in the "through their dialogue in the context of game play" (Antle et al., 2014) rather than providing answers designated to be correct or preferred. The system's content and mechanics "create opportunities for children to create their own interpretations and perspectives about what content and experiences mean". These experiences informed

and develop new responses to information shared, discussed and sustainable or unsustainable actions taken.

Figure 2. Learners using Youtopia's impact tool to see the effects of their decisions

Youtopia runs on Version 2.0 of a Microsoft Surface table (Samsung SUR40) developed in C# using XNA. The table top uses Infrared sensors to recognize fingers, tags, and the information ring. Physical stamps with tags that have prescribed attributes and rules are used as tools. Information and feedback was touch-enabled, rotatable and scalable. For a full description of Youtopia, see (Antle et al., 2013).

1.4 Research Question

This study seeks to explore how the Youtopia system was used with language in learners' interactions to better understand how to support collaborative design with TUIs. The main research question of the study is: How are speech and tools used together by learners in their interactions to build a shared world in Youtopia? This informs a follow-up design inquiry about supporting collaborative learning with technology. For the purpose of this paper, findings about collaborative design that have opportunities to support sustainable decision-making will be highlighted.

2 METHODS

2.1 Research Design and Participants

This research was based on the secondary analysis of a previous study using Youtopia in a private school. The earlier work collected video data of 20 pairs of 5th grade children using Youtopia to build a world “they would want to live in” over a 25-minute period. Compatible working pairs were assigned by the teachers. All pairs were mixed gender except for two girl-girl pairings. The sessions took place during regular hours in a separate room, distributed across the span of a week. For this study, each of the 20 videos was carefully reviewed with relevant sections transcribed and analysed in depth as described below.

2.2 Analysis Process

This qualitative study started with review of the coding methods and outcomes. As a member of the design team but not the quantitative study, this author engaged in discussions and reflections with the team members of the past research with Youtopia. The 20 video studies were then examined and notes were made about the varied use of tools, followed by a thorough examination of the interesting instances of dialogue and actions. One hundred segments of dialogue were transcribed and analysed, that fit into one of these categories: 1. conflict, 2. same-page thinking (e.g. dialogue moving learners towards shared goals) 3. in-depth reasoning, or 4. other interesting aspects of collaboration. Given its ability to analyse the purpose of speech, Searle (1985)’s Speech Acts was used as conceptual framework to examine how learners spoke in relation to how tools were used. By reviewing Ziegler et al. (2013) use of Speech Acts, a working transcription and analysis template was developed to capture: utterances, actions, speech acts and design ideas. Five speech acts were used to provide an analytical lens into the intent of language and tool use: assertives, directives, declaratives, expressives and commissives (Searle, 1985). Episodes were transcribed beginning when a major contribution was spoken and then followed the conversation until the topic completed. Emerging patterns were identified through a combination of micro themes

and speech act thematic analysis which looked at the cross section of tool and talk use. Examples were used to describe the themes with interpretations of the processes.

3 THEMATIC FINDINGS

The process uncovered 16 subthemes of how tools used with language could support learners in decision-making using tools and speech. Of these, specifically three themes supporting decision-making around sustainable choices were found: 1. advocating for issues using evidence or 2. sharing values to convince a partner, and 3. engaging a non-attentive partner. Learners were found to use particular features of the system with language to: assert information, direct next steps, commit to plans and express their opinions. For example: learners used the impact tool to pause the activity and describe what issues (housing, food, energy and/or pollution) needed improvement. The info ring was used with stamps to identify relationships between the land use icons and point out concerns. Learners could try their tools and explain concepts by showing how a stamp caused an outcome, and the shared tools, info cards and feedback tabs helped learners share information and compare the trade-offs.

3.1 Advocating for issues using evidence

One important behavioural pattern found was where learners used the allocated tools to advocate for what should be done. This could be done using a specific tool (e.g., using the garden stamp) or by trying to set up a plan (e.g., improve food supply). The pattern began with use of one of the stamps or tools to engage their partner (e.g., showing a stamp to their partner) with a directive to use the stamp. One way learners advocated for a sustainable action (e.g., reducing pollution) was by showing or demonstrating evidence for their case. This included using the impact tool or info ring (with a stamp inside) with an assertive, often with the impact tool and then directing next steps. From a design perspective, the system's different kinds of tools to helped learners create/show evidence, and the tools stopped the system's actions so their partner couldn't ignore when the other was advocating. An episode concluded with a decisive action (by consensus or unilaterally), sometimes accompanied with a speech act while performing or planning their next steps (see example in Table 1).

Table 2. Episode in which a learner provides evidence to focus on reducing pollution

Time	ID	Dialogue	Action	Speech acts to interpret events
9:52	Sai	There's some pollution	Uses impact tool	Sai asserts the pollution level
9:55	Ben	We need to cut down the pollution		Ben directs them to lower pollution
9:56	Sai	'Kay don't let anything else that might [xx pollution]	(Re) uses impact tool	Sai agrees with directive, committing to limit the pollution level
9:58	Ben	... do you think we should take out the hydro dam?	Removes impact tool	Ben asks Sai for direction to erase the hydro dam
10:00	Sai	No, cuz, then people (will not) have energy		Sai expresses concern against Ben's suggestion
10:02	Ben	Now wait (.) check that	Uses eraser tool to delete hydro dam	Ben commits to erasing the hydro dam and directs Sai to check the impact tool
10:06	Sai	Some [people have energy]	Uses impact tool	Sai asserts the energy level
10:11	Sai	[So] if we add one of this (hydro dam) then many people have energy (.) but there'll be pollution	Points at energy circle on impact tool	Sai asserts that adding energy sources will contribute to pollution
10:19	Ben	I think we should take out (.) the coal stuff	Removes impact tool, erases coal plant	Ben commits to erasing the coal plant as he acts on reducing pollution

Table 2 analysis showed how Sai used the impact tool to help stress her concerns about the pollution, which her partner then considered and supported. At 9:52, Sai used the impact tool to pause the activity

and draw Ben's attention, "there's some pollution." In response, Ben supported Sai to "cut down pollution." Sai emphasized more concern about the pollution, reusing the impact tool. Ben questioned if they should remove a hydro dam in order to lower the pollution, and Sai disagreed: "then people (will not) have energy." Ben erased an energy source (hydro dam) and directed Sai to use the impact tool to check the result difference. She then used the impact tool and reported that "some people have energy," indicating their population had lost some power. Sai recognized and described the trade-offs between providing energy and creating pollution. Ben removed the impact tool to resume the activity and Sai strategically erased the coal plant (in the activity coal plants create more air pollution). In this episode, the impact tool was used to assert learners had something to say, pause and point out the energy circle's information. The display of the four impact tool circles also encouraged learners to focus on what they thought was in greater need of work, as well as develop a shared understanding of what was acceptable and not acceptable.

3.2 Sharing values to convince a partner

Learners also expressed their values and interpretations to try to influence their partner's decisions. This theme was similar to the previous theme (*Advocating for issues using evidence*) in that there was an intent to influence a partner's buy-in, but in this case it was based on learners' expression of emotions and values rather than on what could be shown with evidence. This involved one partner providing a directive about an action, and their partner reflecting on the potential impact of a decision via an expressive (or an assertive). This could be tied to use of any stamp or tool, or sometimes without a stamp or tool. One or both partners would provide additional insight, potentially modifying a previous statement and a new directive after the information was shown. This is interesting because of the opportunity for learners to develop relationships, rationale, and shared agreement on values or actions. The example below (see Table 2) provides an example of one learner's effort to express how they felt to influence a particular decision.

Table 3. Episode where learner expresses disproval about placing animals near coal plants

Time	ID	Dialogue	Action	Speech acts to interpret events
11:22	Nora	...this is effective for electricity for people to have. But it create a lot//	Hands coal plant to Ian	Nora begins to assert pros and cons (pollution) to using the tool
11:36	Ian	… let's put the coal plant ...	Walks around table, moves to stamp	Ian tries to commit to stamping the coal plant
11:41	Nora	There's nothing over here		Nora directs Ian to place in an area by a mountain reserve
11:44	Ian	But you don't want to put it near a mountain goat because I think it'll kill the goats		Ian expresses his disapproval in putting a coal plant near animals
11:46	Nora	That'd be sad		Nora concurs with Ian's expressive and makes another directive
11:50	Nora	How about here? [cuz]	Points at a corner	
11:54	Ian	[Near] the city?		Ian aims to confirm Nora's directive
11:55	Nora	I guess 'cuz cities usually have [electricity]		Nora asserts information about electricity
11:58	Ian	[A coal plant]	Stamps coal plant	Ian takes Nora's understanding as a direction and commits to stamping a coal plant

In Table 3, a learner's disapproval about placing animals near coal plants caused their partner to reconsider the icon placement. Learners also summarized their understanding of relationships in the activity and shared what was important to them. At 11:22 Nora directed Ian to use the coal plant as she handed it to him "this is effective for electricity," (energy for a large population) which prompted their partner to be more invested. However she also cautioned Ian about the pollution: "but it (will) create a

lot.” Ian began to consider a location, but then Nora directed Ian to stamp the coal plant near a mountain reserve. Ian reasoned not to place the coal plant next to a mountain reserve: “it’ll kill the goats.” Nora shared empathy “that’d be sad,” and pointed to an option (placing the plant by the city). When Ian questioned, “near the city?” she reasoned that “cities usually have electricity.” This presented good enough reasoning for Ian to stamp a coal plant. This analysis showed that learners' own interpretations helped attach emotional value to the animals, influencing the decisions they made. Although this wasn’t a decision directly related to sustainability, Youtopia features allowed learners to form empathy for their world as they used the impact tool results to verify their partner's words.

3.3 Engaging a non-attentive partner

Learners were also able to use tools and language to gain influence in the activity, particularly if they found that their partner was not considering their ideas. In a few interesting cases, the learner was able to impede the control of a partner by using the impact tool or info ring (usually with an assertive) to pause the activity and give them a chance to gather their partner’s full attention. They would then assert information, express concerns, participate with the use of stamps, or direct their partner to an action. As a design strategy, use of the impact tool and info ring paused the activity to create learning spaces "apart" from the main activity, and provide evidence at the same time in order to "formulate new plans" (Antle, 2015). The example below (Table 4) illustrates a learner influencing their partner’s actions.

Table 4. Episode in which learner uses info ring to get partner's attention

Time	ID	Dialogue	Action	Speech acts to interpret events
4:05	Jen	How about garden?	Grabs garden stamp	Jen directs Tom to give input on stamping a garden
4:07	Tom	..tool hydro dam		(non-responsive)
4:12	Jen	Food for small people	Puts garden tool in info ring	Jen asserts the information most valuable to her
4:13	Tom	Okay. What do you need for that?		Tom agrees and directs Jen to explain what is needed to follow the new plan for making a garden
4:16	Jen	One of these	Gestures and passes garden stamp	Jen directs him to do so using the tool
4:18	Jen	So... you have to put some of these ‘cuz those are in use	Presents river irrigation and stamps it	Jen asserts information about how the plan will be carried through and commits herself to the plan by stamping irrigation first
44:25	Tom	Ehh. Ehh	Uses the garden stamp	Tom utters sounds (acting as commissives to announce actions)

In this episode (Table 4), a learner used tools to redirect their non-attentive partner to their plan. A stamp was used to direct them to an activity, while the info ring was used to stop their partner’s actions. At 4:05, Jen suggested, “garden?” however Tom’s focus was on the hydro dam. Recognizing that Tom was not listening, Jen put the garden tool in the info ring (pausing the activity) and asserted "food for small people" (small population). Tom’s gaze was then averted to her tools, “what do you need for that?” Jen replied, “these” handing him the garden stamp, “‘cuz those (river irrigations) are in use.” Tom (understanding her instructions) complied by stamping gardens. As a quieter learner in collaborative activities can often be overpowered, a tool was useful to leverage her directives. This example highlighted a need to consider ideas for less vocal partners to lead discussions with tools, such as: allowing them to pause activities, and refocus on new issues. It became a valuable ability in teamwork to allow learners to speak up about their concerns, especially when it came to decisions about meeting human and environmental needs.

3.4 Summary of tool usage with language

Interdependent tools were instrumental in supporting an iterative process of design that required the involvement of both participants, and encouraged the sharing of evidence and values to gain the other person's buy in (e.g., stamping resources by each participant to produce an agreed-on effect and then

checking and discussing the impact on the world). The eraser tool, stamps and impact tool helped learners to make joint informed decisions about the environment and resource trade-offs. Other features such as the info ring and feedback tabs allowed learners to check information without creating lasting consequences on the world. By touching and pointing to the feedback tabs and the impact tool display, learners could identify how their decisions affected the world and negotiate desired choices. Learners also used tools to prompt evidence and value-based reflections to try to convince their partner what actions to take.

4 DISCUSSION

4.1 Implications for collaborative design

These findings generate new understandings about designing tools for collaborative design which leverage simulations/activity systems and TUIs to encourage sustainable and accountable decisions. This study identified the ways the system tools afforded visibility and interdependency, and influenced partner awareness and buy-in. Supporting the findings of Schneider et al. (2011) and Rogers et al. (2004) about adequate time for reflection; participants used pausing and discussion to support idea sharing, debriefing and coordinating plans. Testing out ideas was found to be important in the collaborative design processes (also see Falcão and Price, 2011) and further development test spaces could support designers to make low-risk experiments, and further advocate for decisions. Additionally, tools which prompted verbalization, reflection and accountability helped learners to understand more about each other's ideas and plans and articulate the reasoning and justification behind their own. Pausing was important in the impact tool's ability to create space for reflection and discussion, and additional prompts for negotiation could further elicit the explanation of goals and tradeoffs (Wise et al., 2017). Through the review of these examples, some principles of designing features and tools have emerged which can be transferable for any value-sensitive, open, trade-off understanding collaborative task.

Table 5. Themes Linking to Design features

Theme	Sample Behaviour	Design feature	Design/Tool Affordance for Learner
Providing evidence	Participants used tool to stress concerns, causing partner to think, then act	Impact tool	pauses activity/draw attention/emphasize
			provides results/review/resume activity
		Eraser tool	supports non-consequential/low-risk testing
			can use shared tool with other's approval
			allows learners to undo previous decisions
Sharing values to influence partner's decision	Participant used reflection and passing a stamp to prompt partner to consider a direction and act	Stamp	physical stamp passed (in-hand) to use
			learner presents a case why to use it
		Digital representation (animal)	learner comments on feeling/values about animals, which shaped their decisions
			visual of living things may influence how connected/ they relate to these items
Engaging a non-attentive partner	Learner used tools to get partner's attention and participate	Info ring	pauses activity/ specific things can be pointed out while they have partner's focus
		Stamps	passes partner a stamp to focus partner's attention of what is in their hand

Summarizing principles from Table 5 for designing collaborative tools/features show:

- Pausing encourages joint attention, reflection and discussion.
- Distributing control across tools supports information-sharing and explanation.
- Information provided in the activity can be used to convince or advocate.
- Spaces for low-risk trials enhance informed decision-making.

An important consideration for resource-sensitive design activities is to create opportunities for learners to jointly reflect on their actions aloud and make iterative adjustments to improve their design decisions. Promoting the externalization of evidence, expression of their values, reflection and accountability helps inform learners of available options and explore their effects on the available resource ecosystem. Visuals of living animals seemed to evoke empathy; prior work has shown that system users can be

encouraged to take on the perspective of the world's habitants through assigned roles (Wise et al., 2017), visuals of healthy/sick humans may be another way to do this.

4.2 Supporting sustainability behaviour and decisions

The creation of Youtopia allowed for the system designers to explore the actual use of the kinds of speech, interactions, learning opportunities expected from the guidance of learning and design theories. Two of the learning objectives built into the system design included making informed and sustainable decisions and understanding the notion of resource limitations and effects on people and environment (Antle et al., 2014). These were designed into the system by: developing a series of needs and interconnectedness of options that have effect on other balances in the activity (e.g., using a hydro dam limits the amount of water that can be used for other purposes such as food). Active feedback was also available to learners by presenting up to four error messages if the development choice logistically could not work (e.g., placing river irrigation away from a water source), and complexity of resources were shared between learners with their interdependent tools. According to Antle (2015), in supporting sustainable decisions, some of the following considerations should be taken: address motivation (the reason and means to collaborate) and the objects of negotiation for learners to discuss and collaborate together (e.g., interdependent tools), referential anchors and metacognitive tools (e.g., shared tools to support mutual understanding and evaluation like the impact tool).To support learners' sustainable behaviour, these design qualities should be included: shared areas for learners to pause and reflect away from the main activity, optimal placement and accessibility to see and engage with shared and individual features, an understanding of the relationships between the tools available (and how they are likely to be used), and how information can be shared in the activity. Discussion of learner's discoveries, values and concerns are reliant on their ability to access information, and tools or features can serve as referential anchors. Providing opportunities for learners to assess their decisions, make commitments and then follow through (Hines et al., 1986) provides learners opportunities to explore complex decisions and practice environmental stewardship.

4.3 Future design practices for sustainable environment activities

Based on the findings about learners' speech and interactions, design plays a role in learners' opportunities to: assert and teach each other about sustainability through information-sharing tools, use directives informed by evidence, express personal reasoning to convince team members of decisions, and use commissive acts to plan shared approaches. Antle et al., (2014) used of Emerging Dialogue in using design markers such as: content, interpretation, goals, game paths, motivation and communication being leveraged when developing collaborative systems. Referring to some of these markers, below are few ideas to improve social learning designs:

- **Content and interpretation informing decision-making:** Youtopia used value-free information and result tools to present information to the learners. This allowed them to develop and share their own ideas on the development and outcomes of the world. Tools such as the info ring, impact tools and stamps provided shared focus through referential anchors and features to support joint attention (Antle et al., 2014). Future designs should consider both how to allow learners discuss their own understandings and biases, as well as the ability to draw focus on key items and actions that learners must perform together.
- **Allowing goals and paths to support values:** In Youtopia, the learner's mission was to develop a world they were satisfied with, they had to "determine their own game goals were in line with their personal values" (Antle et al., 2014), and were able to explore the activity as they wished (erasing previous activity as they wanted). Through this came conflict, which learners had to mutually resolve by stating their case and showing or describing evidence of their reasoning. Use of the tools that pause the activity, feedback tabs, or (erasable) demonstrations allowed them to explain their values. Verbalization of designers' values can be encouraged via tools that offer opportunities (or require) them to convince their peers of design choices using information, graphics and features to help learners make empathetic decisions, or experimenting in low-risk testing which work as referential anchors to promote accountabilities to their values and peers.
- **Communication and reward as part of the buy-in processes:** Antle (2015) described the importance of "attending to each other" which can be impacted by motivation to work together, as well as making the negotiation process feel authentic in achieving shared outcomes. By splitting

interdependent Youtopia tools between learners, motivation and reward was tied into joint-decisions-making with fluid information exploration from the activity (i.e., through the use of tools and inquiry as opposed to a scripted experience) (Antle et al., 2014). Mutual buy-in decisions are significant when developing an activity, particularly to improve the way that learners share participation or perform particular actions. Therefore elaborate buy-in processes should be designed to prompt rationale for learners to better explain and assess their biases towards sustainable decisions before they request their peer's support.

5 CONCLUDING REMARKS

For optimal collaboration around resource-sensitive design, technical activity designs should help learners to form strong arguments, express values, and develop shared understanding and decision-making. Tool qualities in the Youtopia activity were found to support collaborative behaviours via: 'pausing' to encourage attention and reflection, encouraging partners to seek buy-in through multi-step (interdependent) tools, supporting low-risk simulations to enhance their understanding of decisions, and providing tools to access information that can be used to advocate for certain actions. This exploration of Youtopia's design in use documents new understandings about how studying the relationship between speech and technology use can potentially enhance interactions with systems which allow participants to explore the effect of their decisions in resource-limited environments.

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