Coordinating Tools and Talk in a Tangible Tabletop Game

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Abstract: This paper discusses how children use tools with language to support their interactions in a tangible tabletop game. Using Speech Act theory as a theoretical framework, videos of dyads using the land use planning game *Youtopia* were qualitatively analyzed to identify emergent themes. A key finding is that learner's use tools and talk together to present evidence to support their position. The implication is that tangible designers can target support for specific kinds of collaborative interactions by creating tools to provide evidence for anticipated points of decision making, negotiation and conflict.

Keywords: tabletops, TUIs, multi-touch, CSCL, discourse, children, sustainable games, design

Introduction and purpose

Youtopia (Antle et al., 2013) is a tangible tabletop sustainability simulation designed to support children in collaboratively learning about tradeoffs between environmental health and human needs. Drawing on theoretically-informed tangible design guidelines (Antle & Wise, 2013), game activity is based on interdependent land-use stamps which can be used to support the food, shelter and energy needs of a population and/or preserve aspects of the environment. Two other system tools are relevant to this study: an impact tool which pauses the system and provides game state information (levels of food, shelter, energy and pollution) with the goal of prompting learners to reflect on their decision-making and the world they create; and an eraser tool that allows learners to remove land-uses (thus encouraging experimentation and exploration of the underlying interdependences between meeting basic needs and creating pollution). The current study builds off prior work around embodied interaction (Antle, 2013) to explore the ways in which pairs of children use Youtopia's tangible tools in conjunction with language to interact with each other and negotiate decisions.

Methods and participants

This study was a secondary analysis of data collected by Wise et al., (in press) which consisted of video data from 20 pairs of 5th grade children using Youtopia to build a world "they would want to live in" over 25 minutes. The videos were reviewed for episodes meeting one of the following criteria: (1) conflict; (2) "same-page" thinking (e.g., dialogue that moves learners towards shared goals or trains of thought); (3) in-depth reasoning; or (4) other particularly interesting collaborative interactions. Two to nine episodes were transcribed from each of 18 videos totaling 100 episodes of dialogue. Two videos had no episodes identified as these pairs had little verbal interaction. Episode transcription included both utterances and descriptions of actions taken as part of the pairs' interactions. An iterative data analysis of the episodes was conducted following the approach of Ziegler et al., (2013) using Speech Act Theory (Searle & Vanderveken, 1985) as a conceptual framework to examine how learners spoke in relation to tool usage (see Table 1). Speech act theory is grounded in the notion that in addition to literal meaning, utterances have an intended effect on the listener. Categories of intended effect (illocutionary force) of speech used in this analysis included: assertives (providing information); directives (providing instructions); expressives (providing personal values); commissives (committing to actions); and declaratives (redefining the reality of actions).

Findings

One key way learners used tools and talk in their negotiation was by presenting evidence to support their position on a game choice. Prototypically this would be initiated by one child engaging the others' attention via an assertion paired with physical use of a tangible tool (often the impact tool). This would be followed by a directive and/or discussion of next steps involving expressives and often also additional presentations of evidence (assertives along with tool use). An episode would conclude with decisive action by one child (based on consensus or taken unilaterally), often accompanied by an assertive or expressive to assess their decisions, or a commissive or directive as they commented on actions while performing them or planed next steps.

This pattern is outlined in the following example (see Table 1). At 9:52, Sai uses the impact tool to pause the game and draw Ben's attention to the pollution level. In response, at 9:55, Ben builds on Sai's comment and suggests they reduce pollution. Sai agrees at 9:56, and emphasizes her concern about the

pollution, reusing the impact tool to draw attention to the current level. Between 9:58 and 10:06 while discussing what to do next, Ben tries out erasing an energy source and directs Sai uses the impact tool to check what difference this made; she reports that now (only) some people have energy. At 10:11Sai recognizes and describes the core tradeoff between providing energy and creating (some) pollution. Ben considers her comment and at 10:19 suggests erasing the coal plant as an alternate strategy to reduce pollution. The analysis shows how Sai repeatedly uses the impact tool to generate evidence that helps stress her concerns about the pollution and how together Ben and Sai use the eraser plus impact tool to reason through the tradeoffs embedded in the game.

Table 1: Episode in which Sai and Ben negotiate tradeoffs between energy needs and 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	K don't let anything else that might [xxx pollution]	(Re) uses impact tool	Sai agrees with *direction*, *committing* to the plan to limit pollution
9:58	Ben	So do you think we should take out the hydro dam?	Removes impact tool	Ben asks Sai for *direction* to erase hydro dam
10:00	Sai	No, cuz, then people wl'(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 erases dam to test a theory 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 ring 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 follows through

Conclusions and implications

This analysis showed one way in which children used Youtopia tools in combination with language to support their interactions: by providing evidence to support their position. The suggests that tools that provide game state information while pausing the action can create not only opportunities for reflection (Antle & Wise, 2013) but also support for collaboration through engaging a partner's attention, directing it to particularly game aspects, and creating a common referent point for negotiating shared interpretation (and evaluation) of game goals, strategies and progress. One specific approach to generating evidence involved making a single change and then showing the direct impact of this on the game state. The main implication emerging from this work is that tangible designers can target support for *specific* kinds of collaborative interactions by creating tools that can provide evidence for anticipated points of negotiation. This suggests value in pre-identifying key decisions or areas of potential conflict and the kinds of evidence relevant to exploring and resolving them. In addition, there seems to be value in pausing (game) interaction to allow such negotiation take place.

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