Using Hick's Law to Redesign the Sphero Indi Instruction Cards

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Abstract

- Educational robots can be used to teach users how to program. The Sphero Indi is a robot car that follows set paths and performs certain actions based on what color card it drives over.
- The Sphero Indi lets users learn how to program through play. Users can solve puzzles and build their own paths for the robot to follow. Each kit comes with a set of instruction and hint cards for users to follow along with while they play with the robot.
- The provided instructions come in a set of three, relying on symbols and color to communicate to the users on what each color does to the car
- Using Hick's law, a redesign was proposed to help clear up potential communication gaps
- 3 Play Workshops were set up where children of various ages could interact with the robot. Each workshop had a specific task for the participants to complete with the robot. Their solutions and insights were collected afterwards

Introduction

- The Sphero Indi is a robot designed for young learners to learn how to program. It works by users constructing a path with colored tiles and placing the car on a starting green or yellow tile, and ending on red or purple. Each color maps to a different action, shown on the instruction cards via pictures and matching symbols on the tile and card. The cards utilize colors and symbols that do not explicitly state the command they're tied to. These color and symbol choices lead to confusion amongst first time users, which can lead to frustration and failure to complete tasks with it.
- The 3 instructional cards were redesigned based off of Hick's Law (Hick 1952). The idea was to condense the instructions onto one sheet, with clear labelling and appropriate arrow symbols. Each color was given a name that matched its respective tile. The original matching symbols were replaced with arrows that show what the car would do on a given color. Then, 2 different educational activities were designs based on the findings from a different investigation (Ching 2024). Both instruction sets were given to users at the same time to see which one they would use. At the end users were debriefed and questioned on their experience.

The Workshops

- 3 different workshops activities were designed based off of different grade levels. They all were designed with the intent to teach children about the local fauna and flora found at the Rice Creek Field Station (RCFS), as a part of the summer Jr. Naturalist Program camp
- 2 pilot studies were done to see how users would interact with the robot, identifying the most common actions they would perform and how they used the instruction cards. The observations from these pilot studies and the content provided by RCFS helped shape the workshop activities
- Materials: Sphero Indi Robot kit, RCFS field guide, cut outs of fauna and flora, cut outs of labels
- Workshop 1- Simple matching game. Participants were given 3 different animals and food types, as well as a RCFS field guide. Participants were expected to show the correct animal and food matching on paper, then show how the "animal" gets to the "food" using the given tiles
- Workshop 2- Simple food chain. The car acted as a unit of energy. Participants were expected to create a correct food chain with guidance from the RCFS field guide. Participants had to plan out their food chain on paper, check for accuracy, then execute the energy transfer with a constructed path and the car. Participants can debug and adjust as necessary. The food chain needed to consist of 1 producer, 1 primary consumer and 1 apex predator
- Workshop 3- Complex food chain. The same as Workshop 2, with the addition of a secondary consumer added
- All workshops took place in a classroom setting and participants were expected to work in groups of 2-3 to plan out their solution, construct the path, debug and issues then correctly execute their solution
- Figure 2 shows examples of some of the solutions produced by participants
- Participants were recruited through the Jr Naturalist Program with parent permission

Original Instructions and Redesign

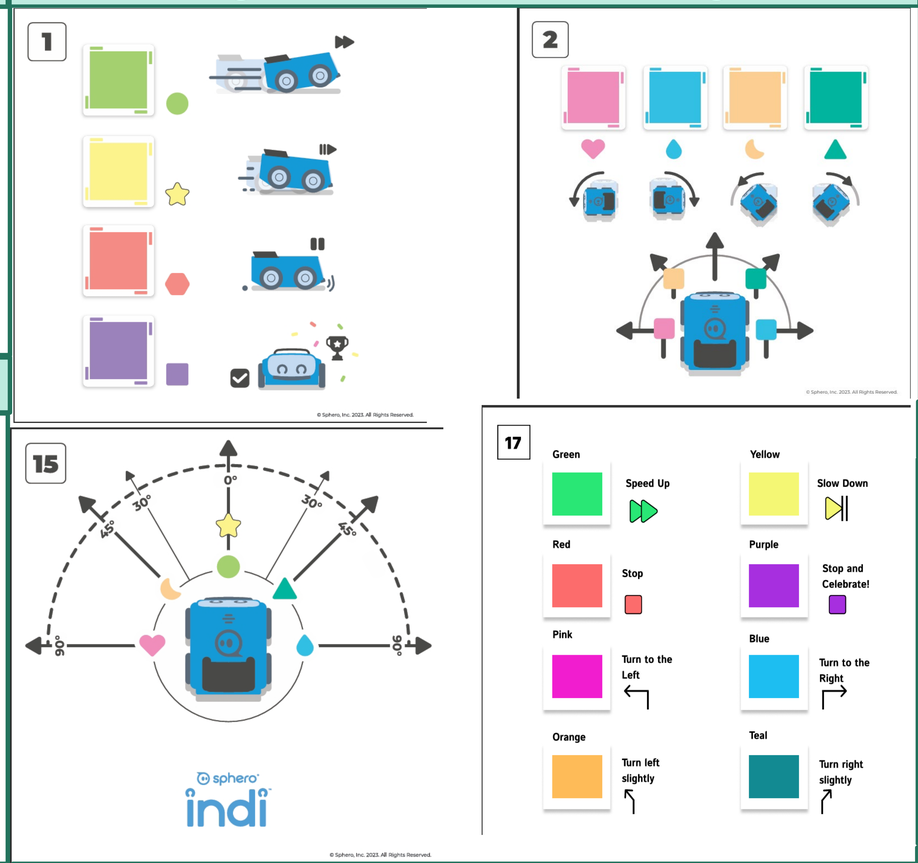

Figure 1- Instruction Cards 1,2 and 15 included with a Sphero Indi Kit. Card 17 is the proposed redesign that was tested against the original set.

Figure 2- Sample solutions produced by participants of the pilot study (left) and one of the workshops (right)

Workshop #	Original	Redesign	No answer	Participant total
1	5	22	3	30
2	3*	8	9	20
3	1	10	9	20
Total	9	40	21	70

Table 1- Results of the responses from each of the Workshops
*2 participants specified that they liked card 15 which included the turning angles
Note: Some of the participants who did not answer had to leave the experiment early

Results and Conclusions

- 57% of participants preferred the redesign, 13% preferred the original, 30% did not respond. This represents all 3 participant groups
- Note: some of the "No Answer" responses were due to participants leaving the experiment early due to being picked up by their parents at the end of the camp day
- Common responses: "The redesign was simple and direct", participants liked how the colors said what action they did, the original was too complex/difficult to read
- Those preferred the original set liked card 15 where it shows the angles of the car turns
- On average 2 out of 10 groups in each workshop used a combination of both instruction sets
- Table 2 details the breakdown of responses by workshop and preference

Successes

- The redesigned instruction sheet was received positively amongst first time users of the Sphero Indi. Overall the redesign was preferred over the Original Instruction cards
- Participants gained experience with core programming concepts such as Debugging, Loops, and Sequencing
- The workshops provide insight into how children interact with educational robots and learning through play
- Provided an opportunity for children to work together to come up with a solution to a problem, and revise their solutions when things went wrong
- Workshops 2 and 3 were open ended enough to where participants were able to produce original solutions to the same problem. Some chose to use the hints provided by the Sphero Indi kits, while others chose to come up with their own solutions

Future work

- The workshops will need further reworking to ensure that participants complete the activity goal while programming the robots. To accomplish this future workshops will be limited to 20 participants doing one activity per test run. The matching game should include more examples on its planning sheet so that participants do not become disinterested.
- These activities should be repeated to validate the results of user preference, as well as be able to determine if these activities help improve programming skills in children.

References

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