A Little Bit of Coding Goes a Long Way: Effects of Coding on Outdoor Play

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Abstract

Outdoor play has known benefits for children's development, and studies show it is in decline. Heads-Up Games have been proposed as a possible solution, in some cases with an integrated coding platform to enrich play variety. In this pilot study we set out to evaluate a Scratch-based coding platform for outdoor play. The code primitives control digital features of a stick-like outdoor play object. We observed children's play patterns with the coding platform and with the play object, and report on three distinct patterns: "Basic Exploration", "Advanced Exploration", and "Game Invention". Our preliminary findings show that all children began with "Basic Exploration" and progressed either to "Advanced Exploration" or "Game Invention". With regards to outdoor play benefits, the "Game Invention" pattern was associated with more collaborative social interaction, physical activity, and "heads up" interaction. We discuss the implications for future coding platforms designed for outdoor play.

Author Keywords

Scratch; Coding; Head-Up Games; Changing The Rules; Children; Outdoor Play.

ACM Classification

K.3.1 [Computers and Education]: Computer Uses in Education Collaborative learning

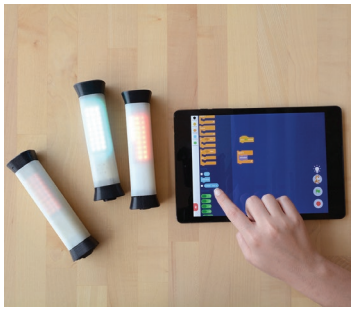

Figure 1: The Tablet runs a Scratch-inspired coding platform, and communicates with the Node devices via Bluetooth Low Energy (BLE). Code is converted into a set of events, and are sent to the Nodes. When an event occurs, the appropriate sensor data is sent back to the tablet, is evaluated, and the appropriate feedback is selected and sent back to the Nodes, generating feedback for the user.

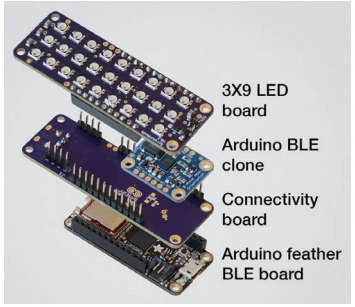

Figure 2: Hardware components stacked together using two custom PCBs.

Introduction

Outdoor play is known to have a positive influence on children's development. In the outdoors, children are given the opportunity to explore, play [9], and learn skills such as problem solving and creative thinking, all necessary for adult life [10]. Specifically, social competence is considered an important skill children can acquire from outdoor play activities [10, 7]. Playing outside also promotes engagement in physical play which is significant for physical development and supports overall health, strength, motor skills [7] and decrease of obesity [14]. There is a growing concern due to the decrease in children's outdoor play time. Compared to children in the 1970's, children today spend 50% less time in unstructured outdoor activities [8], resulting in potential health risks [14] and potential negative consequences for their social skills [3]. A possible solution suggested by the HCI community is adding digital technology to traditional outdoor play. One genre of technology-enhanced games is pervasive games, which integrates technology into outdoor play through small devices (e.g. mobile phones) [21]. However, pervasive games have also been criticized for altering traditional outdoor play patterns due to the use of screens and handles that compromise natural outdoor play patterns [20]. Heads Up Games (HUG), a subcategory genre of pervasive games, are designed as screenless-digital-devices for outdoor play, keeping player's heads "up" and not "down". HUG may promote a more natural digital outdoor play, typical to traditional outdoor activities [19]. Nevertheless, previous studies show that even when following HUG principles and integrating technology into traditional outdoor play objects in a transparent and contextual way (e.g. stick; [6]), technology may have no positive effect and in some cases can even compromise outdoor play benefits. The same study also shows a promising direction, that specific aspects in the interaction design may have a significant effect on children's play patterns, and on the associated outdoor play benefits. Hence, when integrating technology with outdoor play, it is crucial to better understand which interaction design aspects enhance rather than compromise outdoor play benefits. As coding platforms for children gain popularity, the effects of coding on outdoor play benefits become timely and must be studied. Coding platforms for children have been a long-term research goal for the IDC community, as they are considered to extend children's ability to design, create, and invent [15, 11, 16]. Many coding platforms have been developed over the last decade, with Scratch being the most influential one [15]. A coding platform for outdoor play should be carefully designed with the "heads up" principle in mind [19], and the effect on outdoor play benefits must be evaluated. In addition, although this isn't our primary goal, we believe that a coding platform for outdoor play may be a friendly introduction to the concept of programming for children that aren't naturally drawn to computer coding, and vise versa - may promote outdoor physical and social activities for children that are usually captivated by programming and other indoor activities. In this work in progress we set out to better understand the positive and negative effects of coding in an outdoor play context, as well as children's play patterns while coding and playing outdoors.

Related Work

Within the field of HCI, few prototypes have been designed to integrate coding platforms or rule making platforms into outdoor play. RaPIDO, a sensor-based prototype [18], and GameBaker, an accompanying platform for rule changing [1] have been developed specifically for outdoor play. By changing parameters in the GameBaker such as buzzing duration and the number of participating teams, children can create various outdoor games,

Hardware:

The stick-like Node devices include an Inertial Measurement Unit and a push button as inputs, and a custom 3x9 LED display as feedback. Electronics are enclosed in a robust, 3D printed inner and outer casing formation, with a rubber cap on each end.

Software:

The software implementation included a minimal virtual machine (VM) written in Java for Android-based tablets. The system is comprised of three modules: the Code Generator (based on Google Blockly, the underlying technology of Scratch 3.0); The minimal Java-based VM; And the Java-based transport layer (implemented as a star topology pub/sub).

based on their own ideas. The authors reported that children were interested in making their own rules. Hitron et al. extended this approach by presenting a preliminary prototype of a Scratch-based coding platform allowing children to change rules by modifying the feedback of a digitally-enhanced outdoor play device. Their coding platform prototype enabled children to control events and define thresholds, allowing to create their own local game experiences [5]. In this work, we extend Hitron et al.'s work by evaluating how 15 children used a coding platform in outdoor context. We used the prototype designed and implemented by Hitron et al. [5], a digitally-enhanced outdoor play object called Scratch Nodes (see technical details in the Hardware and Software Sidebars and Figure 2). The system consists of a limited amount of code primitives: two Event blocks, two Feedback blocks, and Social primitives (See Event Primitives, Feedback Primitives, and Social primitives in Sidebar). We further observed children's coding and play, and evaluated the impact on their play behavior with regards to outdoor play benefits (e.g. social interaction and physical activity).

Method

We evaluated the effect of coding on outdoor play patterns in grass-covered outdoor play areas of approximately 450 square meters.

Participants

Fifteen children (8 boys and 7 girls) participated in the study (age range 8-12) divided into 5 groups of 3. Prior acquaintance between all group members was a requirement to ensure natural social interaction. All children were recruited through personal acquaintance with the researchers or from the campus Scratch Day activity. We followed ethics guidelines including IRB, parental consents, children consent, and parental approval for pictures and videos. In addition, we followed Read's guidelines for research with children [13].

Procedure

The outdoor play areas were marked by a ribbon to encourage exploration but at the same time to keep the children in sight. All sessions were documented by camera and wireless microphones. Prior to the study, each group was given a brief introductory on the platform. Each child received a tablet and a node device in order to ensure all children have the same level of familiarity and experience with the platform. At this introductory stage, the Social feature was disabled, so each child explored the platform individually. After the 10-minute introduction and a short break, participants were given one tablet for each group, and the Social feature was activated and demonstrated. In addition, each group received three node devices, one for each participant. The children then played with the system for 10 minutes without any specific instructions.

Analysis

Data was collected and analyzed from two sources: the coding platform's log files and the video and audio recordings. We focused on 3 dependent variables: Play patterns; Social Interaction; and Physical Activity, all occuring during the activity. Play patterns were defined by a thematic coding process performed by two researchers [4]. Themes were identified, compared, and discussed by the researchers, and were contrasted with the coding activity log files. Recorded videos were coded per participant (three in each session), identifying Social Interaction and Physical Activity. Social Interaction events were coded according to "The Outdoor Play Observation Scheme" (OPOS) [2] by event sampling, and further classified to Collaborative [12] or Non-collaborative events. Physical Activity was also coded according to the OPOS scheme

Event Primitives:

Event 1: 'When throw', triggered when acceleration value exceeds a predefined threshold, automatically starting a timer.

Event 2: 'When button pressed', triggered when the push button is pressed.

Feedback Primitives:

Feedback 1: Set LED count. User can set a positive or negative integer to be added or subtracted from the LED Abacus display.

Feedback 2: Set LED animation. Sets 1 of 4 possible LED animation effects. For example a "wave" animation of lights moving up and down along the display, or a "rainbow" animation of blinking patterns.

Social Primitives:

"Me" - feedback is sent to the device that generated an event.

"Others" - feedback is sent to all devices except the one that generated the event.

"Everyone" - feedback is sent to all devices.

[2], by sampling the time children were physically active. Finally, we calculated the percentage of Collaborative out of all Social Interaction events and time spent in Physical Activity out of the total session time for each child and averaged the percentages of each variable across children.

Findings

The thematic coding revealed three distinct play patterns in the way children explored and used the coding platform: Basic Exploration, Advanced Exploration, and Game Invention. Based on our analysis, we define each pattern bellow. Basic Exploration: exploring the "cause and effect" of the code primitives by selecting one event setting and one feedback setting repeatedly. For example, one group experimented with different integers in the LED count by setting it once to 1 LED, then to 2 LEDs, and then to 100 LEDs. Advanced Exploration: testing the systems' capabilities by selecting multiple event settings, multiple feedback settings and/or multiple social settings. In this play pattern, multiple type of code primitives were integrated in one code sequence, for example, 'When button pressed' event followed by multiple animations. Game Invention: using the code primitives for a specific game-like purpose, including rules, goals, and objectives [17]. Coding became a means to an end and not an interest by itself, a tool for creating games and rules. For example, one group defined an acceleration event with animation feedback, and immediately used it to compete by throwing the Nodes as high as possible.

Different groups showed different succession of play patterns. All groups began with the "Basic Exploration" pattern, and progressed either to "Advanced Exploration" or to "Game Invention". None of the groups demonstrated both "Advanced Exploration" and "Game Invention". Two groups (6 children) showed the Basic-Advanced succession and three groups (9 children) the Basic-Game succession. Results show a difference in the outdoor play benefits measurements between these two successions: more collaborative social interaction and physical activity were observed in the Basic-Game succession (see Table 1).

	Collaborative Social Interaction	Physical Activity
Basic-Game	48.4%	35.7
Basic-Advanced	9.8%	2.8%

Table 1: Collaborative Social Interaction & Physical Activity levels in each succession.

Discussion

In this preliminary study, we set out to better understand the play patterns associated with coding in an outdoor play context and the impact of coding on outdoor play benefits. Our findings revealed that although all groups received the same instructions, the same device, and the same coding platform, two distinct successions were clearly observed in children's play patterns: progress from "Basic Exploration" to "Advanced Exploration", or progress from "Basic Exploration" to "Game Invention". The Basic-Advanced groups showed interest in exploring the coding platform itself, reflected by experimenting with coding concepts and interacting with each other in a "heads down" activity, looking at the code while planning and sharing ideas. On the other hand, the Basic-Game groups showed interest in creating outdoor games while using the coding platform as a tool for game creation. They experimented with the platform and defined the code but quickly shifted from "heads down" to "heads up" and interacted with each other in an outdoor game context by setting rules and goals. We assumed that children would use multiple code primitives (advanced coding) in the "Game Invention" play pattern to create more complex

Figure 3: Children playing with the hardware stick-like devices during the study.

Figure 4: Children exploring the different features in the tablet-based coding platform.

games, however this didn't occur. Perhaps there was a trade-off between using rule-making with code primitives and rule-making of the game itself, future work should further explore this trade-off. The outdoor play benefits measured were manifested differently in each succession. In the Basic-Game groups there were significantly more collaboration events. For example, two Basic-Game groups used the accumulated "score" feedback to collect "points" as a group, trying to reach a common goal together. A similar effect was evident in the physical activity measure. Game Invention pattern was associated with longer periods of physical activity. In contrast, Advanced Exploration pattern resulted in almost no physical activity, staying immobile for most of the playtime, possibly because they were highly engaged with exploring the advanced options of the coding platform on the tablet. Taken together, our findings imply that integrating coding into outdoor play should be further studied and thoughtfully designed as some children may be extremely engaged in the coding activity itself and miss out on outdoor play.

Conclusion

Our preliminary study revealed an interesting "Less is More" trend that should be further studied. When given a coding platform for outdoor play, children demonstrate different play patterns which are associated with different levels of outdoor play benefits. When children used less code primitives in the coding platform, they showed more "heads up" interaction, more collaborative social interaction, and more physical activity. When children used more advanced coding options they were very engaged in the coding activity, but it came at the cost of "heads down" interaction, less social interaction, and less physical activity.

Limitations

As a work in progress, this study has several limitations. The sample size of 15 children was divided to 5 groups of 3, more groups are needed to further validate the findings. In addition, a longer play period will help further validate the findings. However, even with the small sample and limited play period, this study revealed two distinct play patterns levels and different measures of outdoor play benefits, that should be further studied.

REFERENCES

1. Tetske Avontuur, Rian De Jong, Eveline Brink, Yves Florack, Iris Soute, and Panos Markopoulos. 2014. Play it our way: customization of game rules in children's interactive outdoor games. In Proceedings of the 2014 conference on Interaction design and children. ACM, 95–104.
2. Saskia Bakker, Panos Markopoulos, and Yvonne de Kort. 2008. OPOS: an observation scheme for evaluating head-up play. In Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges. ACM, 33–42.
3. Tilde Bekker, Janienke Sturm, and Berry Eggen. 2010. Designing playful interactions for social interaction and physical play. Personal and Ubiquitous Computing 14, 5 (2010), 385–396.
4. Graham R Gibbs. 2008. Analysing qualitative data. Sage.
5. Tom Hitron, Itamar Apelblat, Iddo Wald, Eitan Moriano, Andrey Grishko, Idan David, Avihay Bar, and Oren Zuckerman. 2017. Scratch Nodes: Coding Outdoor Play Experiences to enhance Social-Physical Interaction. In Proceedings of the 2017 Conference on Interaction Design and Children. ACM, 601–607.

6. Tom Hitron, Idan David, Netta Ofer, Andrey Grishko, Iddo Yehoshua Wald, Hadas Erel, and Oren Zuckerman. 2018. Digital Outdoor Play: Benefits and Risks from an Interaction Design Perspective. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems . ACM, 284.

7. James Harry Humphrey. 2003. Child development through sports. Psychology Press.

8. TF Juster, F Stafford, and H Ono. 2004. Major changes have taken place in how children and teens spend their time: Child development supplement. Ann Arbor, MI: Institute for Social Research, University of Michigan (2004).

9. Richard Louv. 2008. Last child in the woods: Saving our children from nature-deficit disorder . Algonquin Books.

10. Robin C Moore and Herb H Wong. 1997. Natural Learning: The Life of an Environmental Schoolyard. Creating Environments for Rediscovering Nature's Way of Teaching. ERIC.

11. Seymour Papert. 1980. Mindstorms: Children, computers, and powerful ideas . Basic Books, Inc.

12. Mildred B Parten. 1932. Social participation among pre-school children. The Journal of Abnormal and Social Psychology 27, 3 (1932), 243.

13. Janet C Read. 2015. Working with Child Participants in Interaction Design. In Human-Computer Interaction. Springer, 655–656.

14. CM Renders, JC Seidell, W van Mechelen, and RA Hirasing. 2003. Overgewicht bij kinderen en adolescenten. Maarssen: Elsevier Gezondheidszorg (2003).

15. Mitchel Resnick, John Maloney, Andrés Monroy-Hernández, Natalie Rusk, Evelyn Eastmond, Karen Brennan, Amon Millner, Eric Rosenbaum, Jay Silver, Brian Silverman, and others. 2009. Scratch: programming for all. Commun. ACM 52, 11 (2009), 60–67.

16. Mitchel Resnick, Fred Martin, Randy Sargent, and Brian Silverman. 1996. Programmable bricks: Toys to think with. IBM Systems journal 35, 3.4 (1996), 443–452.

17. Katie Salen and Eric Zimmerman. 2004. Rules of play: Game design fundamentals . MIT press.

18. Iris Soute, Susanne Lagerström, and Panos Markopoulos. 2013. Rapid prototyping of outdoor games for children in an iterative design process. In Proceedings of the 12th International Conference on Interaction Design and Children . ACM, 74–83.

19. Iris Soute and Panos Markopoulos. 2007. Head up games: the games of the future will look more like the games of the past. Human-Computer Interaction–INTERACT 2007 (2007), 404–407.

20. Iris Soute, Panos Markopoulos, and Remco Magielse. 2010. Head Up Games: combining the best of both worlds by merging traditional and digital play. Personal and Ubiquitous Computing 14, 5 (2010), 435–444.

21. Oren Zuckerman, Narcis Pares, Steve Benford, and Henrik Hautop Lund. 2006. Designing interactive environments for outdoors gaming and play. In CHI'06 Extended Abstracts on Human Factors in Computing Systems . ACM, 419–422.