6. GAMEMASTERS OF THE PLAYGROUND

EXPLORING CHILDREN'S LEADERSHIP ROLES WHEN PROGRAMMING HYBRID DIGITAL-PHYSICAL OUTDOOR PLAYGROUND EQUIPMENT

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ABSTRACT

In this work, we explore how programmable playground artefacts can affect social dynamics and power structures in an outdoor play setting. A set of re-programmable artefacts and a graphical programming interface were designed and developed for the study. Twenty children were invited to co-design and explore the interactivity of the re-programmable devices. They tested how they could play with them, and were asked about how they would re-design and repurpose the artefacts and the scripting interface for their way of playing. Through a thematic analysis of the

observations and group interviews, it could be seen that an implicit social role emerged, centered around the use of the programming device. This role took on a guiding and supporting role, rather than a leading role. By deliberately designing for this 'gamemaster' role, this understanding may be useful in future design of technology for public and outdoor play.

Keywords

GAMEMASTER, leadership roles, children, outdoor play, playing out, re-programmable, physical-digital playgrounds, internet of things, IoT, playful IoT.

INTRODUCTION

Digital devices and the Internet of Things (IoT) are becoming more common in many types of activities. This is not limited to professional or adult environments where there is a long tradition of looking at how work is based on technological and social dynamics (Emery & Trist 1960), as children also use technology from an early age (Manches et al. 2015, Konca 2022). By understanding how these types of technologies impact children and the social dynamics of their 'profession', their play, designers will be more able to design for these experiences. In this work, we ask how social dynamics and power structures can be shaped by IoT-enhanced re-programmable playground artefacts in an outdoor play setting. It was part of a larger project where we focused on the relation between the participants, the artefacts, and the programming device. To explore this, we developed three interactive devices, connected through a graphical programming interface, and let 20 children test and play with them in an outdoor playspace. Data was collected through observations of the tests, and interviews with the children, and then thematically analyzed. During the analysis, the themes were seen to center on a leadership role that emerged in play. A set of insights on the social

dynamics and interactions were found, which we discuss in relation to previous studies.

BACKGROUND

While research on emergent leadership is nothing new, there is still a lack of studies on children's leadership overall (Mawson 2011) and even more so on emergent leadership in smaller groups of children (Li et al. 2007, Badura et al. 2021, Cox et al. 2022). Leadership is a socially negotiated role; it is a set of emerging appropriate actions, not a predefined set of duties (McCourt 2012), that others without the role reciprocate (Coutu 1951, Newcomb et al. 1950, Turner 1962). The emergence of the appropriate actions is often a response to the perceived needs of the group (Turner 1962, Li et al. 2007). The acceptance of emergent leadership within the group can be more dependent on expertise shown in the task rather than popularity in the group (French & Stright 1991) or personal traits (Li et al. 2007, Dylan et al. 2020). Early research on emergent leadership among children found correlations between leadership ratings and acts that facilitated tasks and elicited the opinion of group members, and whether these acts were followed by others (French & Stright 1991). When children are given the space to emerge as leaders, they will take it (Li et al. 2007). Li et al. (2007) found that six of 12 groups of children had one group member emerge as the leader during discussion tasks, while in five of the remaining groups the role moved between multiple children. They also noted that most children displayed some leadership actions even if they weren't always accepted by the rest of the group (Li et al. 2007).

It may be pointed out that not all player roles are equal. In some games one player may have a greater opportunity to take a lead role, with greater effect on these framing structures (Zimmerman 2004). In games such as pen and paper roleplaying, the gamemaster is the person tasked with, among other things, being the arbitrator of both social structures and the written rules, as well as being responsible for keeping the narrative flowing (Tychsen et al. 2005). Decisions and

arbitration often end up being a balancing act between eliciting conformant engagement and immersion from the players, while creating an enjoyable experience. When these social contracts are implicit, they are just a set of framing structures to be negotiated, but in these games, the gamemaster role often includes the responsibility to moderate the negotiations of these contracts (Tychsen 2008), and, while the gamemaster and the players have different ways of interacting with the framing structures, they are still a part of the social negotiation that is playing. Similar behavior has also been seen in outdoor play. When Dylan et al. (2020) explored IoT resources in outdoor play, they noted that aside from explicit leadership roles, informal leaders emerged and took responsibility for the play experience in order to improve the experience for others. In their study, the participant with the IoT remote controller, or who created a game around it, adapted to being a temporary leader, even if that person was not assertive or collected enough to act as such otherwise.

A notable example of playful outdoor programming can be found in Scratch nodes (Hitron et al. 2017; Ofer et al. 2019). This consists of a set of graspable devices aimed at structured outdoor play that can be programmed through a Scratch interface. Through these, Ofer et al. (2019) explore how children invent rules for play when given the opportunity to enhance outdoor play through coding and reprogrammable devices. They found that children often focus more on the screens and the programming interfaces, compared to the world around them. Their work assumes a clear division between the creative process of designing explicit rules for play, and the conformant play that ensues. Similarly, other research on children's social dynamics when using screen-based interfaces tend to focus on the conformant interactions with the screen, and not transformative actions or activities that are also taking place in the physical space (e.g., Aarsand & Sørenssen 2021, Fleck et al. 2021). However, Back et al. (2019) points out that the structures that frame play are not constant, as play consists of transformative interactions and negotiations of those structures. The work of Ofer et al. can thus be argued to overlook these transformative engagements that occurs during play, as the

re- programmable devices act as a set of digital-physical framing structures for play with the goal of giving those who play the power to transform and shape their play. In this study, we focus on a less structured style of play, where the participants may transform not only the functionality of the re-programmable devices, but also play itself. By understanding playing as a constant negotiation of not only roles, but also of rule-sets and social contracts (Back et al. 2019), in this work we attempt to remove the separation between programming and playing. We want to bring the programming into the outdoor play environment, in order to let the coding process and scripted functionality be something that can be changed during play. This way we drive to make the devices a part of – and engrained in – the playspace, instead of remaining independent of, and distanced from it.

METHOD

This study is based within the field of human-computer interaction and between the disciplines of research and design (Zimmerman et al. 2007). Our design process followed value-driven design (Flanagan et al. 2008, Back et al. 2021), while the research process focused on the situated activity rather than the design (Waern & Back 2017, Kock 2011, Koskinen et al. 2008). This meant that the design process was grounded in a wide and interdisciplinary set of previous work to support its predefined theoretical values; such as playful IoT (Coulton 2015), tinkering and constructivistic learning (Harel & Papert 1996, Kay 1996, Flannery et al. 2013), social interaction and intersubjectivity (Resnick et al. 2009, Flannery et al. 2013), and appropriation (Dix 2007, DeValk et al. 2013, Flannery et al. 2013, Back et al. 2021). Following the value- driven design process, the field study was explorative to allow describing the depth of whatever activity followed. This meant that the prototype in itself was intended to be an intervention placed in the field, while the study could focus on observing and exploring the particular interactions and activities that followed within and towards the framing contexts (Koskinen et al.

2013, Waern & Back 2017, Back et al. 2019). Through this, the research methodology used the theory-driven process of design science, but without its prescriptive evaluations (Hevner and Chatterjee 2010) and the descriptive field studies of research through design, but without its primary concern with artefacts and process-focus (Zimmerman et al. 2007, Koskinen et al. 2013, Waern & Back 2017).

The design process followed an iterative approach while being grounded in the previously mentioned theoretical values, and while taking inspiration from previous similar work with children's programming (for example Lego A/S 2013, Resnick et al. 2009, Flannery et al. 2013). The early iterations used paper prototypes, which were refined with the help of insights from programmers and parents that tested it, as well as literature on the theoretical values. These were then implemented as a functional prototype through an interface developed in Unity, and the artefacts constructed from papier-mâché and Arduinos.

The design was tested by five groups of four Swedish children aged eight to ten. The children knew each other, having worked together previously as part of the same scout troop. All participants had tried some level of visual programming as part of their primary school education, and most had previously tried ScratchJr.

The participants were briefed by one of the researchers on the functionality of the drag-and-drop interface of the prototype, and were tasked with exploring the prototype and how they could play with the design. During the brief, they were framed as being co-researchers, as they co-designed how the prototype functioned and how it could be played with (Hagen et al 2012, Back et al 2017). Each group was then handed a tablet with the development environment, and given 15 minutes to explore and play with the prototype. The activity was recorded and interactions with the prototype were recorded in log-files, while the researcher observed, took notes, and solved technical issues affecting the prototypes. Lastly, the group was interviewed about their experience with, and thoughts regarding, the prototype.

The data was analyzed through an inductive thematic analysis

(Braun and Clarke 2006). The log-files were compiled to see how the prototypes were used. Interviews were transcribed and coded, using bottom-up coding. With a strong focus on the activity, video files were coded from videos rather than by first transcribing them. The field notes and log-files were used to aid the coding of videos and interviews.

DESIGN AND IMPLEMENTATION

As stated earlier, in this work, we want to explore re-programmable outdoor playground artefacts and their effect on social dynamics and power structures. To do this, a playful design was developed, consisting of a programming interface inspired by Lego Mindstorms (Lego A/S 2013), Scratch (Maloney et al. 2010), and ScratchJr (Flannery et al. 2013). Further, three wireless artefacts were created from a set of sensors and actuators (see Figure 1) that can be programmed through an interface. The programming environment is implemented as an app for a tablet. It enables users to create sequences of logic through a drag-and- drop interface (see Figure 2). These sequences control how the artefacts' sensors affect their actuators. The programming environment updates the physical devices directly, and the graphical drag-and-drop elements showed, in real time, what was happening with the actual artefacts (see Figure 3). When something is changed in the current script, this instantly affects how the physical artefacts behave. This allows the script to be updated in real time while people are playing with the artefacts, and thereby be part of the malleable structures framing the current play.

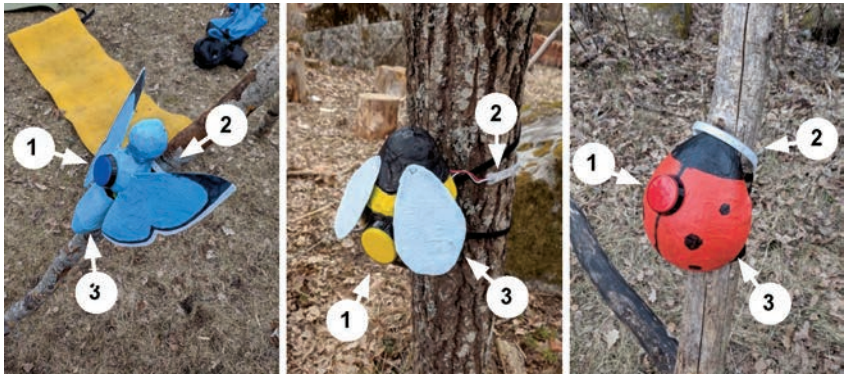

Figure 1: The three artefacts were designed to be visually distinct and reminiscent of different types of insects. Each is designed to be visually distinct, with different shapes, colors, and patterns, as well as semantically distinct by being different types of identifiable insects. Each artefact has 1) a large button on the front, 2) a LED-strip attached to its back, and 3) a buzzer within the papier-mâché shell.

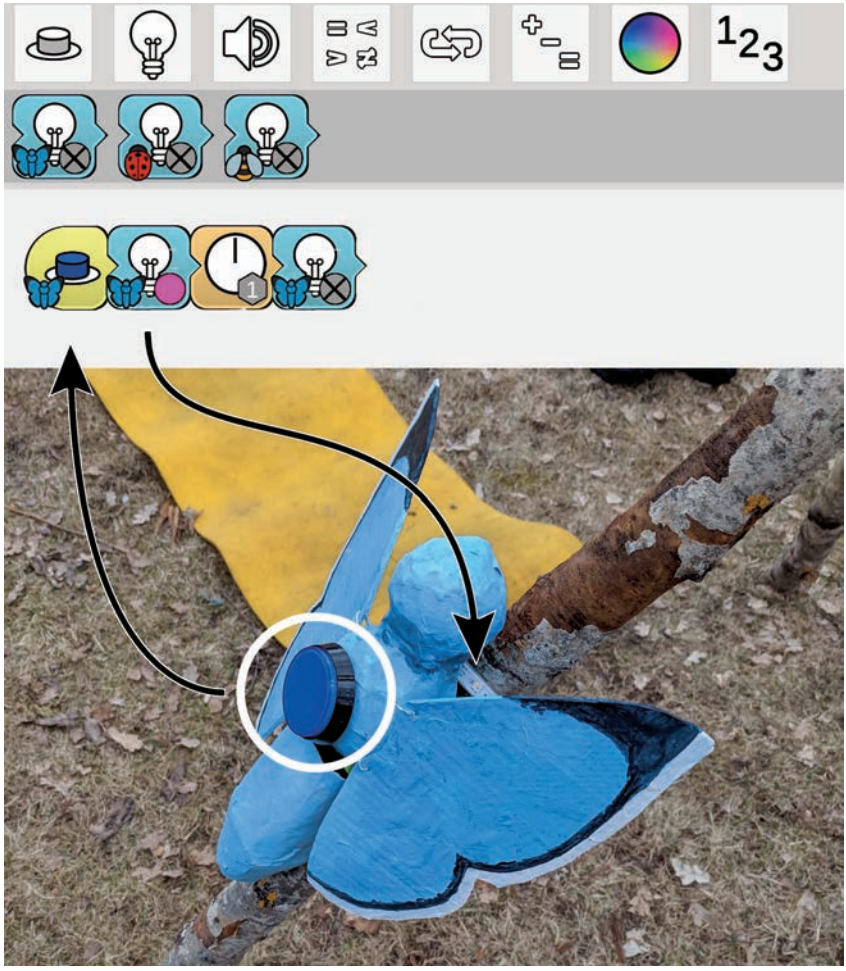

Figure 2: The interface consists of two parts; a tabbed library of logic elements on the top half, and a workspace on the bottom half. By dragging elements from the library into the workspace, it can be used and attached to a script. The bottom left icon on an element shows which artefact it affects. The icon on the bottom right is for adding parameters such as colors, or integers for durations or iterations. The current script in the workspace has two LED-elements; one with the color variable set to pink and the other to no color. Based on this, the current script in the workspace triggers when the button on the butterfly is pressed (as indicated by the leftmost yellow element). At that point the butterfly lights up in pink, waits one second, and then turns off (as indicated by the order of the three attached elements).

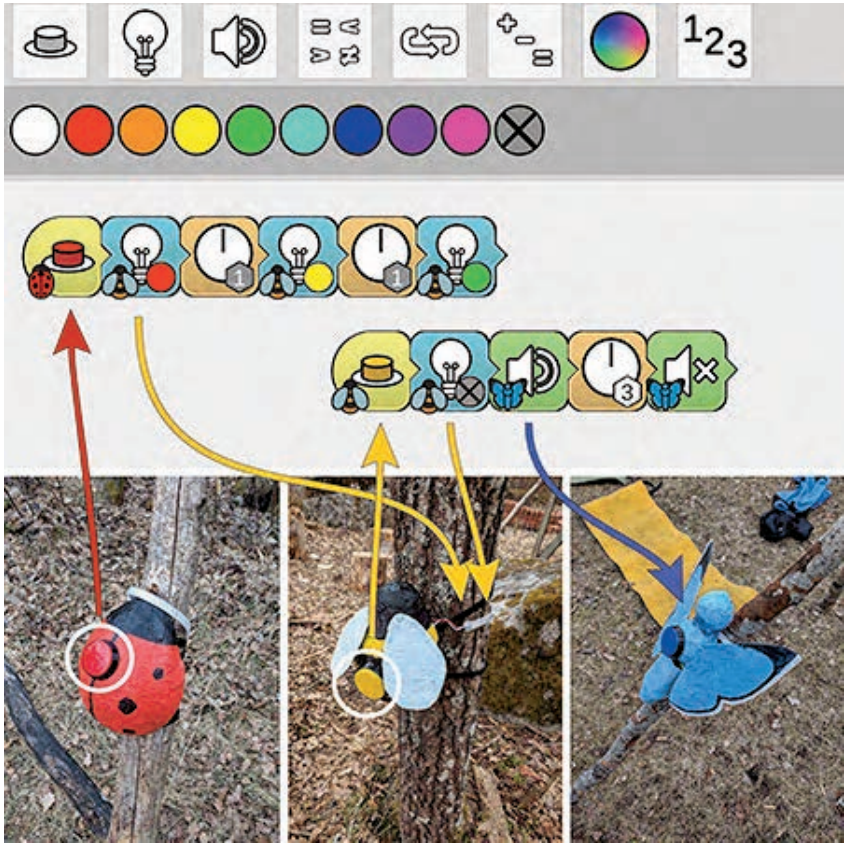

Figure 3: As the artefacts are connected to each other through the tablet, they can be programmed to affect the actuators on each other. The left script runs when the button on the ladybug is pressed. It turns on the LED on the bee and switches its color, as time passes, from red to yellow to green. As there is no element to turn the LED off, it is left on. The right script runs when the bee is pressed. It turns off the LED on the bee and makes the butterfly buzz for three seconds. As the interface only sends one step of the instructions at the time, it can be reprogramed after a button has been pressed to start a script as long as that element has not acted yet. This means that you can remove the element that mutes the butterfly before the three second delay has finished, or change the yellow and green color parameters until the delays that lead up to them finishes.

RESULTS

We observed that most participants approached the design in a similar fashion. When a participant got the device, they had a general

idea of which artefact they wanted to use and what they wanted to do with it. After achieving this by themselves or with the help of another group member, they either thought of something else to do with another artefact, or gave the tablet to another person so that they could try it. Through thematic analysis, five themes were identified; A) social dynamics and power structures around the device, B) actively supporting and including others, C) control over the prototype, D) reflect on themselves, and E) the uses of the prototype. In this work, we will focus on a specific leadership role that emerged that we refer to as the gamemaster. The role related to three of the themes; social dynamics and power structures around the device, actively supporting and including others, and control over the prototype. The last two themes had little to do with this role and will therefore only be detailed briefly. Theme D covered how the participants commonly described their experiences with the prototype in relation to their own lives and backgrounds. It also included how they expressed, or wanted to express, their likes and possessions through the prototype. Theme E covered discussions of how they could have competitions based on it, additional features they would like it to be capable of, and how they sometimes investigated and fidgeted with the artefacts.

A) Social dynamics and power structures around the device

We observed that a participant in each group took on an implicitly defined leadership role. During the field test, the gamemaster role, as well as most social interactions, were focused on the tablet. The participant that acted as gamemaster either held the tablet themselves or followed the person who had the tablet. When a participant used the application on the tablet, most of the other participants gathered around and watched what was done on it (seen in Figure 4), and ideas were sometimes suggested. Every now and then, they ran to press a button or check an actuator, either due to being asked by the participant with the tablet, or on their own accord ("The lights are

still shining!"). The leadership role stayed with the participant when the tablet was passed on, and we observed that they continued to perform actions to coordinate and support the other participants.

Figure 4: (Left) Group 5 gathers around the tablet above the ladybug artefact. (Right) Group 4 gathers around the tablet next to the butterfly artefact. (Bottom) Group 2 following the person with the tablet towards the bee.

During the observations, the tablet engendered a sense of ownership, as one of the more common topics among the participants was about who should use it next. These discussions and decisions were brokered by the gamemaster. In Group 4, as an example, one person kept nagging the gamemaster to be next, agitatedly saying things like "Can I get to do it now?" and "You are the only one to use it!", before trying to take the tablet from the gamemaster (see Figure 5). The gamemaster, instead, reset the prototype and gave the tablet to another participant who had asked for it earlier. While there were discussions about whose turn it was to use the tablet, no participant asked if it was their turn to use the artefacts. Even if each artefact

only had one button, they used the artefacts together (see Figure 3) but they saw the tablet as something that was used by one person at a time; it was either asked for or grabbed out of the current user's hands. On the other hand, the artefacts were never discussed as objects that were owned, but rather seen as a common resource. From our observations, this highlights how the tablet was handled and used differently from the three artefacts. While the artefacts were limited in how they could be interacted with, and were also rigidly placed in the environment, the tablet allowed for a wide set of interactions and was portable, allowing a user to carry it.

Figure 5: (Top) The participant on the right tries to take the tablet from the gamemaster in Group 4. The gamemaster gives it to the participant on the left who asked for it earlier. (Bottom) The gamemaster in Group 1 using the tablet while two in their group listens to the prototype.

B) Actively supporting and including others

The leadership role was not only about overseeing and directing, but also about helping, as seen in the participants' actions. This was, for example, seen in how they took responsibility when others in the group had issues understanding the programming language or proto-

type (which is further detailed in Theme C, Control over the prototype), whose turn it was to use the device next ("[Name], now you can try this one" – gamemaster in Group 1), and organized the group by instructing participants to press buttons ("Wait, wait, press THE BEE!" – gamemaster in Group 4, see Figure 6), or to check the states of the actuators. During the follow- up interviews, the role extended outside of the group as three gamemasters suggested independently that it would be good if the prototype was made available to others. The gamemaster in Group 2 suggested that it should be placed at a height where both "little children and adult children" could reach it. Similarly, the gamemaster in Group 3 also said that the placement was good, since smaller children wouldn't be able to use it if it was lower. That person also suggested that the artefacts should speak and invite people to program them ("Sort of speaking like this, 'Hi, you are sort of welcome to program me,' or something like that" – the gamemaster in Group 3). The gamemaster in Group 1 instead suggested public screens so that even children without touch devices could use it.

Figure 6: The gamemaster in Group 4 prompts the group to go press the button on the bee instead of the ladybug.

C) Control over the prototype

The leadership role was identified in the participant in each group that was first to show the group that they had enough understanding of, and control over, the prototype. In four of the five groups, it was the first participant who picked up and tried the prototype, managed to use it, and continued to act according to the role. In Group 2, the first person to pick it up didn't understand how to use it, and handed the tablet to another participant who figured it out and acted in a leadership role (see Figure 7). The participants who took the role also used their knowledge of how the prototype worked to support other participants who had difficulty, and they also assisted their fellow group members who asked them for help. This was seen in two ways. First, they helped others to use the scripting language ("We should probably remove your little butterfly [...] and add a clock" – gamemaster in Group 1), and they were asked by others to help them ("How do you remove the color?" or "How do you make it stop?" – other participants to their group's gamemaster). The second way they helped was by providing a structure of how to approach the prototype and its capabilities ("Which one do you want to press to make stuff happen?" – gamemaster in Group 1). In some of the groups, these gamemasters also sought to expand their understanding of how it worked and what it could do. The gamemaster and a participant in Group 1 tried to find the largest number that can be contained as variables ("Sorta ten times fifty, sorta five hundred or something?" – another participant to the gamemaster in Group 1, who responded, "Yes, yes! I want us to get it up to ten thousand, and we will try..." before starting to laugh at the size of the number). The gamemaster in Group 2 came to the researcher after testing the prototype and asked why the artefact didn't make any sounds as they had coded it, and curiously watched as the researcher attempted to troubleshoot the prototype to solve the issue.

Figure 7: (Left image) The person on the left is the person in Group 2 who picked up the tablet first and is seen here trying to use it. (Right image) As they didn't get it to work, the tablet is instead given to the person who started acting as a leader.

DISCUSSION

In Theme A, we present a leadership role related to the tablet. This role was implicit and related to help and support, rather than oversight. This role could be described as a gamemaster, coordinator, and lead programmer. We can compare this to how a role-playing gamemaster guides and supports the player group, rather than leading them (Tychsen et al. 2005). Further, such a gamemaster is not mainly a neutral interpreter and judge of rules, but instead works together with the group to create an interesting play opportunity. Emergent leadership requires both appropriate emergent actions towards a group (McCourt 2012), and those actions must be accepted by group members (Turner 1962). This gamemaster role had both. Emerging leaders performed timely actions as needed to support their group to structure the activity and assist with programming, to navigate turn taking and social dynamics, and by asking others to act. These actions were accepted by group members, who received the support and followed the instructions and social arbitration.

Theme A also highlights the differences in our observations of how the device was used, compared to the artefacts. Something in the tablet or the design of its interface caused individuals to take

possession of it, while the artefacts' design resulted in them being seen as communal items, and did not cause conflicts about who should use them. There are a variety of design choices and affordances that could partially explain why the different designs were used the way they were. The single device was portable with a touchscreen, which limited how many could interact with it at once without covering the screen. This forced the participants to group closely to observe what occurred on it. The complexity and possibilities of the scripting interface afforded more choices and agency in the interaction with it, which made participants choose how the artefacts would behave, and also caused them to instruct others to press buttons or check actuators. A less complex or screenless interface would likely have been less interesting for the group to gather around. Neither Dylan et al. (2020), Hitron et al. (2017), nor Ofer et al. (2019) mention participants gathering around their screen-less controllers with physical buttons. In contrast, Ofer et al. (2019) noted that participants got stuck with their heads down and eyes glued to the screen, dealing with complex scripting interfaces. The three artefacts, in comparison to the single device in this study, were mounted in place with large physical buttons and audio and LED actuators. The artefacts could not be moved, and the buttons were big enough to be pushed together, and multiple participants could listen for sound and check the color of the LED at the same time. Other than that, the artefacts lacked depth and choice in how to interact with them outside of what was decided by the participant with the device and possible rules of play. While considering these differences, it is important to remember that the design is just one of the framing structures that the play activity is situated in (Zimmerman 2004). This is even more relevant for installations in outdoor public spaces, where the designer has no control of social and physical framing structures that change over time. If non-personal, low complexity, and screen-less interfaces in playgrounds are not the center of the activity, they instead allow players of transformative play more freedom to decide what that center should be. However, personal, complex and screen-based interaction can still

be used, provided it was deliberately designed to produce the role that emerges from it.

From this study, it is difficult to know to what extent the role emerges due to a natural leader taking the tablet, or whether the tablet creates the leader. As we didn't look into the participants' personal traits or role in the group, it is not clear whether they were natural leaders to begin with. However, as access to the handheld device in this case was temporary, and it was not personally owned by the participants, the prototype appears to have affected the outcome. The person that first managed to successfully interact with the tablet emerged as the gamemaster of the group. And, they then kept this role, even when they didn't have the tablet. With only one tablet available to the group, the gamemaster gained an initial edge over both the playground and the framing structures, compared to other group members, and they retained this edge throughout the experience. They thereby continued to act as the system expert for the duration of the play session and into the follow-up interview. This is similar to findings of previous research, which showed that emergent leaders are often selected after demonstrating expertise in a group task (French & Strigt 1991). Alternatively, with their experience with the prototype, the gamemaster could have chosen to act as a leader to fill an observed need for a leader of their group's actions (Turner 1962). This gamemaster role is different to the leader role that Dylan et al. (2020) noted regarding their IoT-enhanced play artefacts. In their work, the role was temporary and only subsisted while the game controller was held, or while running a game that they themselves had created. The game controller provided agency over the game, as it directly actuated other artefacts in their play environment. In comparison, the gamemaster in this work outlasted the direct interaction with the touch device, and this persisted while the group explored the prototype and discussed it. Also, the participants did not create games, and as such it is likely they did not have the same sense of ownership of the activity. Lastly, the agency provided by the programming interface was deeper, but less direct; it controlled how the inputs of the artefacts functioned, but could not directly affect

actuators. Then, based on our findings and these differences, we would be able to design for the nature of the emerging leadership role, if the design affects its nature. As all acts of leadership require being acceptance by others for the person to be an emergent leader (Turner 1962), gamemasters in roleplaying games are accepted by the players playing along, and through explicit decisions, or the set operations of the game's rules (Tychsen et al. 2005). Similarly, the gamemaster of the playground's actions needs to be accepted by their peers as well. Without explicit decisions or formalized game rules, players need reasons for accepting the emerging gamemasters. Based on this study and the work of Dylan et al. (2020), examples of such reasons can be the gamemaster showcasing their expertise in the task, designing the game that is played, being in direct control of the artefacts in the playspace, or defining the rules on which the playspace functions. The reasons cause different leadership actions to be accepted, and only those deemed appropriate will be seen as deserving of the role (McCourt 2012; Turner 1962). The reasons are also affected by how they are supported by the design. As an example, being in direct control requires continuous use of a device, which gives control over the playspace, while only momentary use the device is needed to showcase expertise to the group. For this reason, we suggest that it is possible to design for the nature of emergent leadership roles in digital-physical playspaces.

CONCLUSION

This study looked at how social dynamics and power structures can be shaped by IoT-enhanced re-programmable playground artefacts in an outdoor play setting. When children played with the re-programmable playground artefacts, one specific dynamic came into focus; a leadership role that emerged during play. The gamemaster played a multi-faceted role as they led the game and the group, and also directed the code. By being the expert of the digital system, they applied structure to the coding practices and the digital rules, and by being a leader in the group, they also applied structure to the social

rules around the objects of the design. In this way, the gamemaster used their understanding of the design and how the device worked as the structure for how group members should use it and how to think about the coding practice. It was repeatedly seen that the other group members conformed to the gamemaster having control over the structures of play, as they listened to, and followed, the gamemaster's instructions, and at the same time the gamemaster held up their end of this relation as they continued to enact the role.

BIBLIOGRAPHY

Aarsand, P., and Sørenssen, I. K. 2021. ""And then it's my turn": Negotiating participation in tablet activities in early childhood education and care". *Journal of Early Childhood Literacy*.

Back, J., Johansson, K., and Wireband, J. 2021. "Value Driven Design for Playful Technology Enhanced Installations in Public Settings". In *Creativity and Cognition Jun. 21,* 1-14.

Back, J., Marquez Segura, E. and Waern, A. 2017. "Designing for Transformative Play." *ACM Transactions of Computer-Human Interactions.* 24 (3). 18:1-18:28. DOI:https://doi.org/10.1145/3057921.

Badura, K. L., Galvin, B. M., and Lee, M. Y. 2021. "Leadership emergence: An integrative review". *Journal of Applied Psychology.* 107 (11), 2069–2100.

Braun, V. and Clarke, V. 2006. "Using thematic analysis in psychology." *Qualitative research in psychology*. 3 (2) 77-101.

Coulton, P. 2015. "Playful and gameful design for the Internet of Things". *More Playful User Interfaces: Interfaces that Invite Social and Physical Interaction*, 151-173.

Coutu, W. 1951. "Role-playing vs. role-taking: An appeal for clarification". *American sociological review*, 16 (2), 180-187.

Cox, J. W., Madison, K., and Eva, N. 2022. "Revisiting emergence in emergent leadership: An integrative, multi-perspective review". *The Leadership Quarterly*, *33* (1), 101579.

De Valk, L., Bekker, T., and Eggen, B. 2013. "Leaving room for improvisation: towards a design approach for open-ended play". In

Proceedings of the 12th international conference on interaction design and children, New York, NY, USA Jun. 2013, 92-101.

Dix, A. 2007. "Designing for appropriation". In *Proceedings of HCI 2007 The 21st British HCI Group Annual Conference University of Lancaster, UK 21.* 2007. *Lancaster, UK, Sept. 2007*, 1-4.

Dylan, T., Wood, G., Durrant, A.C., Vines, J., Torres, P.E., Ulrich, P.I.N., Cukurova, M., Carr, A., Çerçi, S. and Lawson, S. 2020. "Designing IoT Resources to Support Outdoor Play for Children". In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems New York, NY, USA, Apr. 2020*, 1–12.

Emery, F. E., and Trist, E. L. 1960. "Socio-technical systems". *Management science, models and techniques*, *2*, 83-97.

Flanagan, M., Howe, D. C., & Nissenbaum, H. 2008. "Embodying values in technology: Theory and practice". *Information technology and moral philosophy* 322-353.

Flannery, L.P., Silverman, B., Kazakoff, E.R., Bers, M.U., Bontá, P. and Resnick, M. 2013. "Designing ScratchJr: support for early childhood learning through computer programming." In *Proceedings of the 12th International Conference on Interaction Design and Children*, *New York, NY, USA, Jun. 2013*, 1–10.

Fleck, R., Vasalou, A., and Stasinou, K. 2021. "Tablet for two: How do children collaborate around single player tablet games?". *International Journal of Human-Computer Studies*, 145, 102539.

French, D. C., and Stright, A. L. 1991. "Emergent leadership in children's small groups". *Small Group Research*, 22 (2), 187-199.

Hagen, E. S., Røsvik, S. M., Høiseth, M., & Boks, C. 2012. "Co-Designing with children: Collecting and structuring methods". In *DS 71: Proceedings of NordDesign 2012, the 9th NordDesign conference, Aarlborg University*, Denmark. 22-24.08. 2012.

Harel, I., and Papert, S. 1991. *Constructionism*. Ablex Publishing.

Hevner, A., and Chatterjee, S. 2010. "Design science research in information systems". *Design research in information systems: theory and practice*, 9-22.

Hitron, T., Apelblat, I., Wald, I., Moriano, E., Grishko, A., David, I., Bar, A. and Zuckerman, O. 2017. "Scratch Nodes: Coding Outdoor

Play Experiences to enhance Social-Physical Interaction." In *Proceedings of the 2017 Conference on Interaction Design and Children, New York, NY, USA, Jun. 2017,* 601–607.

Kay, A. C. 1996. "The early history of Smalltalk". *History of programming languages – II,* 511-598.

Kock, N. 2011. "Action research: its nature and relationship to human-computer interaction". *Encyclopedia of Human-Computer Interaction*, 43-45.

Konca, A. S. 2022. "Digital technology usage of young children: Screen time and families". *Early Childhood Education Journal*, 50 (7), 1097-1108.

Koskinen, I., Binder, F. T., & Redström, J. 2008. "Lab, field, gallery, and beyond". *Artifact: Journal of Design Practice,* 2 (1), 46-57.

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., and Wensveen, S. 2013. "Design research through practice: From the lab, field, and showroom." *IEEE Transactions on Professional Communication*, 56 (3), 262-263.

Lego A/S. 2013. *Lego Mindstorms.* Lego A/S.

Li, Y., Anderson, R. C., Nguyen-Jahiel, K., Dong, T., Archodidou, A., Kim, I. H., ... and Miller, B. 2007. *Emergent leadership in children's discussion groups. Cognition and Instruction*, 25 (1), 1-2.

McCourt, D. M. 2012. "The roles states play: A Meadian interactionist approach". *Journal of International Relations and Development*, 15, 370-392.

Maloney, J., Resnick, M., Rusk, N., Silverman, B. and Eastmond,

E. 2010. "The Scratch Programming Language and Environment." *ACM Transactions on Computing Education*. 10 (4). 16:1-16:15.

Manches, A., Duncan, P., Plowman, L., & Sabeti, S. 2015. "Three questions about the Internet of things and children". *TechTrends*, 59, 76-83.

Mawson, B. 2011. "Children's leadership strategies in early childhood". *Journal of Research in Childhood Education*, 25 (4), 327-338.

Newcomb, T. M., Turner, R. H., and Converse, P. E. 1950. *Social psychology: The study of human interaction*. Holt, Rinehart and Winston, New York.

Ofer, N., David, I., Erel, H. and Zuckerman, O. 2019. "Coding for Outdoor Play: a Coding Platform for Children to Invent and Enhance Outdoor Play Experiences." In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, *Glasgow, Scotland UK, May 2019,* 1–12.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., ... and Kafai, Y. 2009. "Scratch: programming for all". *Communications of the ACM*, 52 (11), 60-67.

Turner, R. H. 1962. "Role taking: Process versus conformity". In *Life as theater: A dramaturgical sourcebook*, 85-98.

Tychsen, A. 2008. Tales for the Many: "Process and Authorial Control in Multi-player Role-Playing Games." In *Joint International Conference on Interactive Digital Storytelling, Berlin, Heidelberg, 2008,* 309–320.

Tychsen, A., Hitchens, M., Brolund, T. and Kavakli, M. 2005. "The Game Master." In *The Second Australasian Conference on Interactive Entertainment: University of Technology, Sydney, Australia, 23-25 November 2005.* 215–222, edited by Y. Pisan, ed. Creativity & Cognition Studio Press.

Waern, A., and Back, J. 2017. "Activity as the ultimate particular of interaction design." In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, Denver, CO, USA May 2017,* 3390-3402.

Zimmerman, E. 2004. "Narrative, interactivity, play, and games: Four naughty concepts in need of discipline". *First person: New media as story, performance, and game*, 154.

Zimmerman, J., Forlizzi, J., and Evenson, S. 2007. "Research through design as a method for interaction design research in HCI". In *CHI '07:Proceedings of the SIGCHI conference on Human factors in computing systems, San Jose, CA, USA, Apr. 2007,* 493-502.