Chapter

Interactive Design vs. Design for Interaction: Developing Interactive Play Tools that Promote Interactions between Children

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Abstract

How do children interact with each other and how can interactive technology contribute? In this chapter, we are going to introduce two concepts that are currently present in the development of play tools for children: (1) interactive design, represented by toys that can integrate interactive sensors and actuators to promote new play possibilities, and (2) design for interaction, a new tendency focused on how children interact with each other and how new designs can contribute to these interactions. Through this chapter, existing works will be utilized to exemplify these concepts illustrating differences and connection points in-between. These will be followed by a series of studies of children's social interactions when under the influence of different game conditions. By looking into the fundamental aspects of design and interaction, we will discuss how play can promote positive interactions and how interactive technology can contribute to those. We aim to contribute to the establishment of guidelines for the development of new designs for interactions.

Keywords: children, sociability, game elements, technology, toys

1. Introduction

Children have a universal need to play, and by playing, they can learn a series of skills vital for their social and cognitive development. Playing is a self-motivating and pleasurable activity, and through gamification (the application of game elements), different tasks can become more engaging. Maria Montessori defined play as the work of children and something that must be encouraged for a healthy childhood development. Disciplines such as social game studies consider the activity of play as an important way for children to understand their surroundings, communicate, and develop affection [1, 2].

Known as play tools, toys have an important role as facilitators of children's growth and learning [3]. A toy is a dedicate artifact for the act of playing. Humans are sensory animals and toys can allow more materialized, stimulating, and easily understood play experiences. The existence of toys can date as old as 3.000 BCE, but it was only through the rise of the industrial age that they became widely available for children at a global scale. Up until the 1980s, toys were mostly represented by a highly profitable plastic industry. However, since the 1990s, the rise of

electronic technology together with the digital video game industry has reconfigured the general ideas of what a toy could be.

Nowadays, electronic games can be considered toys and the boundaries between the virtual and tangible elements are not so strict [4]. For example, the fast development of tablet computers has developed into one of the current most profitable play markets. Different tablet applications for children (be they games, dedicate programs, or play kits) gives an array of engaging and playful possibilities at little development cost. With tablets representing a big parcel of the play market, children today have become much more exposed to digital/screen media than previous generations. This extended exposure has been linked with different changes in children's behaviors. As examples, current studies are linking extended screen exposure to autistic-like symptoms, hyperactivity, and obesity rates [5–7]. The overall recommendation is that, specially at young ages, screen time should be minimized at the same pace that active play time should be encouraged. However, technology cannot be stopped and children's interest to interact with technology should not be discouraged, but rather utilized to support their development.

This context led to a series of new play tool proposal called "interactive" or "smart" toys. By combining the traditional play values with modern technologies, interactive toys can provide more direct feedback and narrative possibilities for the users. Interactive toys can also engage children through sensory stimuli such as LED lights, digital sounds, and haptic inputs for touch [8]. The "interaction" from interactive toys comes from these expanded possibilities between the user and the artifact facilitated by modern technology. In other words, the toy is interactive. Being that a new frontier, designers from all over the world are trying to develop new interactive toys that can bring unique experiences to the user.

The interaction between children with others is potentially more important to their social development than the interactions they can have with different toys. Considering that, a parallel view entitled "Design for Interaction" is rising by prioritizing children's social relationships. In the design for interaction principle, play artifacts assume a support role, mediating or facilitating social relationships between children and peers or caregivers. Moreover, technology is not the main factor in this view and interactions can arise from different play media, be they analogic, electronic, or virtual.

The present chapter discusses the definitions, differences, and similarities between the "interactive design" and the "design for interaction" views when applied for children's product. Each section will illustrate and exemplify these views with schematic and cases. We follow by comparing some performed studies where group games, mediated by different toys, were utilized to evaluate children's task impressions and group behavior. Considerations will be at the end of the chapter about how to develop interactive play tools that can better support children's social development.

2. Interactive design and interactive toys

According to the Merriam-Webster dictionary [9], the word "interactive" can mean: (1) mutually or reciprocally active or (2) involving the actions or input of a user. This definition is especially related to a two-way electronic communication system. Therefore, the word interactive design has an inherent focus on how the design interacts with the user, and how to consider these interactions. The same concept can be applied with the definition of interactive toys. Nowadays, toys and games are being constantly designed with the advancement of digital technology and the changes in consumer habits. These new toys are named "Interactive" or "smart" toys [10].

From a technology standpoint, an interactive toy differs from traditional ones by adding the interactive attractiveness of modern technologies to stimulate play. All toys can be considered interactive, but traditional toy interactions are mostly mechanical. In other words, when interacting with traditional toys, such as a football, the user receives an instant sensory feedback which might motivate them to keep playing. Emotional-level interactions and imaginary play are also possible with traditional toys, but the toy acts mainly as a physical medium for these play interactions (**Figure 1**).

The main difference between the definitions of a traditional and an interactive toy is the integration of technology to provide dynamic interactions [11, 12]. By using different sensors and actuators, interactive toys can receive children's inputs and generate different outputs to actively encourage their play. It can, for instance, identify children's play pattern through an artificial intelligence and use this information to provide direct motivating feedback such as increasing or decreasing the difficulty of game, or changing the balance of sensory stimuli such as the intensity of lights and sounds. This interaction can be seen in **Figure 2** below.

It is important to note that both traditional and interactive toys can provide the same amount of play interactions, but the interaction of smart toys can be detected or encouraged with the applied technology. The constant feedback generated by the artifact in the response of children's inputs is what would define its interactivity and where technology is more deeply inserted. The second point is that smart toys are expanded to new media and devices such as tablets, augmented-reality and virtual reality glasses, breaking the division between digital and analogic experiences.

Considering that wide range, there is no current fixed limitation in the interactive toys' category. Interactive toy can involve products such as interactive floors or walls with sensors that react when children touch them, or it could be individual portable products, such as shoes or balls with LED lights and sensors to motivate active play. It can even be an entire installation, with different products exchanging information on a network-connected server [8].

A promising subcategory of the interactive toys is the interactive playgrounds. Interactive playgrounds are integrating technology to promote more engaging ways for children to exercise and establish social relationships. Like interactive toys, the idea of an interactive playground is not limited to traditional buildings and could be either a small prop, which the user can carry with them, or a digital application that can integrate with the existing playground environment. Although it is a new concept, Sturm et al. defined the following guidelines which designers can take when designing interactive playgrounds. Interactive playgrounds should:

- focus on social interactions,
- keep the game rules and mechanics simple,
- offer challenges,
- have clear goals, and
- provide different feedbacks to the users.

By using sensory technology, children can receive different sorts of feedback such as visual lights, sounds, or haptic outputs. Many of these elements are proven to have a positive effect on children development, since it can better direct and immerse them in the activities. For example, Zhao et al. found that haptic inputs increased the immersion children had when reading and listening stories [13].

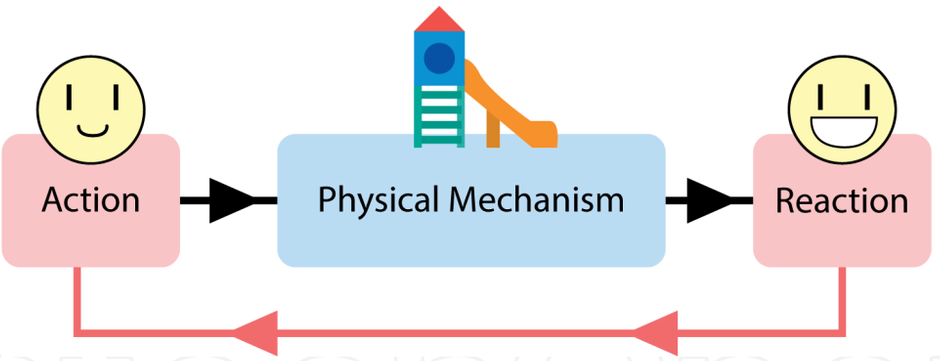

Figure 1.
Traditional toy play interaction flowchart. Users interact with the toy and the given mechanical feedback perpetuates different interactions.

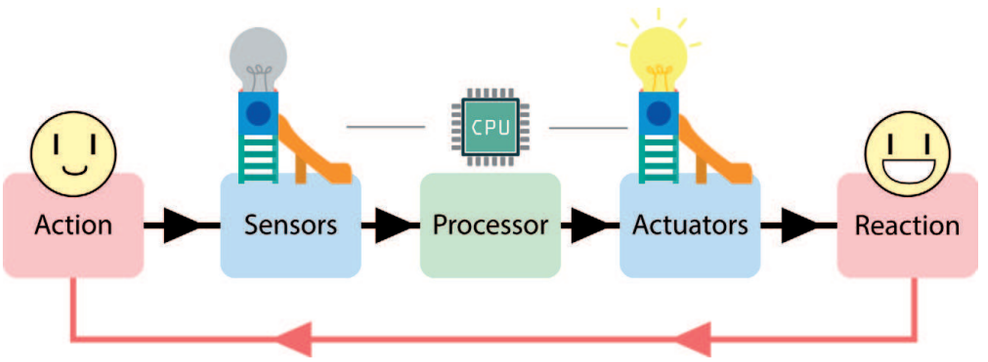

Figure 2.
Interactive toy play interaction flowchart. The user provides an interaction that is detected and processed by the toy, which then converts into a feedback through different actuators, perpetuating the interaction.

A point of caution is that a higher physiological arousal through interactive technology can also be associated with increases in user stress level [14]. With studies having yet to find the extension of these effects, this remains as an important step to responsibly design new interactive play tools. Moreover, the interaction with different technologies also affects children's social play interactions, which should be considered in the design of toy.

3. Design for interaction between children

Still according to the Merriam-Webster dictionary [15], the word "interaction" can mean: (1) the act of talking or doing things with other people; (2) the action or influence of things on one another, or; (3) mutual or reciprocal action or influence.

When comparing with the word "interactive," "interaction" carries a broader meaning involving different relationships between humans with living things and with artifacts. It is important to say that each interaction can generate different outcomes for the parties involved and that these outcomes can affect further interactions. This relationship can be seen in the scheme represented by **Figure 3**.

Likewise, the word "design for interaction" also has a more expanded meaning than the word "interactive design," involving not only the interactions between the user and the artifact but also the interactions that artifacts can foster between different people. In design for interaction, the artifact can act as a supporter for different social interactions. Considering that, this concept of an interactive toy is not only of one that provides engaging interactive feedback for children. Instead, interactive toys should facilitate relationship among children through play

interactions. Under this view, exposure to different types of interactions among children is the most important aspect of their development. This can be observed in **Figure 4** below.

According to a study requested by the Kids Design Association (KDA), Japan [16], interactive products should encourage children to create relationships instead of being alone. Game experiences can help children realize their individual limitations and perceive playing together as a more fun activity. Considering that, the following guidelines where defined for designing artifacts for interactions among children. Designs for interaction could be:

- experiences that can only be felt when together with others,
- games that produce more significant results by joining force with others,
- artifacts to facilitate communication between children, or
- toys and games that can strengthen their affective bonds.

Under these guidelines, technology is not the main aspect of "interactive toys" and any toy or game that has been designed with social interaction in mind can be considered as "interactive" [17]. Playground environments provide an important role as "design for interactions," fostering social relationships through play activities.

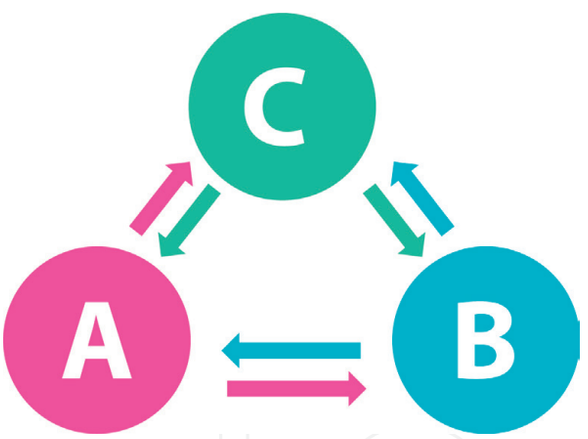

Figure 3.
Interaction scheme: the spheres influence each other, and each interaction generates different outcomes.

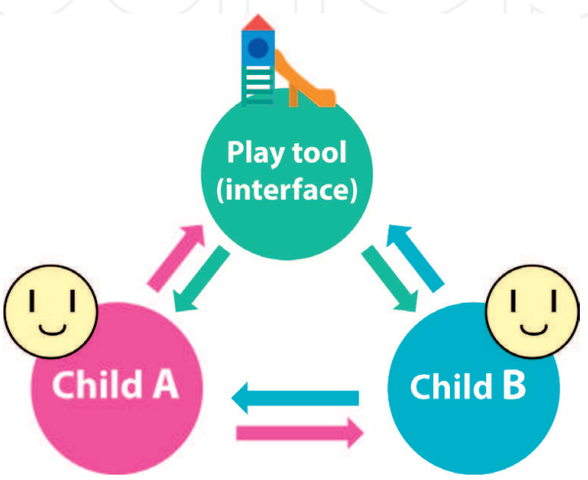

Figure 4.
Interactive play tools as mediating interfaces for different interactions among children through play activity.

Playgrounds are spaces where of different ages can get in contact with open nature, with each other and with their parents to, through dynamic play exploration, socialize, and develop different skills [18].

Considering children's sociability, a parallel field called "social game studies" seek to understand how different game elements can influence children's social development [19]. Through gamification, the application of game elements to other activities, educators can utilize the self-motivational aspects of games to encourage children's positive social behavior. This concept is widely used in "structured" or "ice-breaking" game scenarios, where the act of playing group games is linked with positive group behavior [20].

Working with social game concept, Hendrix et al. [17] developed a game to observe its impact on children's sociability. In this game, children would receive the role of architects to give instructions on how to build a structure for the other members in the group. The researchers noted that, during the game, children who often struggled with social interactions managed to more easily express their thoughts and intentions.

By looking at post effects of group games, Creighton and Szymkowiak [21] observed the classroom behavior of two groups of children after being submitted to different game conditions. While one group played games with a competitive focus for a week, the other group played cooperative games instead. Evaluating children's social behavior with an interaction frequency index, the authors observed that children who played the cooperative games displayed more positive interactions in the classroom than children who played the competitive games. These findings suggested that cooperative games may benefit the social interaction of pupils within the classroom.

Playing is an arousing activity that involves internal motivations and sensory stimuli [22]. With the body being the main channel for sensory interactions, Malinverni and Burguès [1] linked the usage of the full body during games to children's higher cooperative behavior. In their study, children played two different versions of a group game: (1) a digital version, where children interacted together through connected desktop computers, and (2) a physical version, where the game was projected in the wall and children could use their body to interact with together. Participants who played the full body game version achieved higher scores in the game, displayed better teamwork, and reported better impressions of their group members after the activity.

Considering social studies findings, we defined the following elements as possible contributors to children's social development, which should be aimed by interactive games:

- Existence of rules and attribution of specific roles
- Restriction of individual power and resources
- Challenging but achievable difficulty curve
- Excitement and novelty levels of game experience
- Rich sensory feedback
- Usage of natural body movement
- Focus on cooperativity rather than competitivity

When considering the effect of group game activities, or designing new interactive play tools, it would be of interest to further observe these elements as possible predictors of children's social behavior.

Note that technology is not directly mentioned as an important for social interactions, but that does not mean that it should be disregarded. Although society has been changing drastically, the basic structure of playgrounds has remained almost the same since 1920 [11], and traditional play tools today are not enticing the modern children as they used to. Children enjoy interacting with current technology and it would benefit their social interaction to utilize a medium which they can more easily engage. More importantly, modern technology provides an array of rich sensory feedback which can be utilized as elements to promote social interactions. As an example, Suzuki et al. [23] developed a musical device which converts each person's position into a single melodic note. When people gather to play together, the device can combine notes and create harmony, making the activity more meaningful and pleasurable. Another way of using technology to facilitate interactions would be by automatically altering the sensory stimuli or the difficulty level of a game according to the number of children or to their given feedback.

In this sense, this chapter definition of an interactive toy is of one who adopts different feedback technologies or devices to act as a mediating interface of real-time interactions between people. In this definition, while technology is still important, it is not the main factor, acting instead as a supporter of children's interactions. Considering the described elements of this section, it is important to investigate additional ways for technology and interactive toys to foster social interactions among children.

4. Case studies: how group games can promote interaction

During the years of 2017–2018, we conducted three different studies to investigate the relationship between children playing group games and their motivation to work together in a subsequent group task [24, 25]. Represented by **Figure 5**, throughout three studies, three different group games were utilized as "ice-breaking" activities: (1) an interactive building block game where the goal was to build electronic circuits, (2) a buildable tower block game, where the goal was to connect blocks together into a single standing tower, and (3) an interactive dance game, where the goal was to replicate the dance moves displayed in the game screen.

Different methods of evaluating children's impressions and cooperation were utilized between studies, limiting direct comparisons between the games' effects.

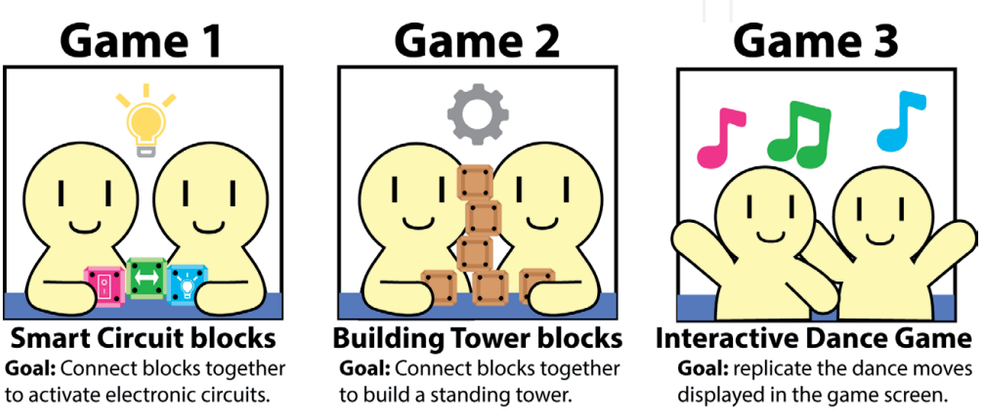

Figure 5.
Three group games utilized during different studies.

However, through observations of the three games' applications, reinforced by present guidelines in the literature, the research obtained indications on which aspects of the group games worked well and which needed further reconsiderations. Comparisons were established between these games.

The three studies worked with cooperative tasks and self-report scales where children could rate their feelings regarding the task and their group members. Overall, the main evaluations after playing or not variations of the group games were: (1) how difficult or pleasurable participants perceived the cooperative task to be; (2) how satisfied participants were with their group member and how mindful they were of each member feeling, and how well they executed the subsequent task at individual and group level (objective criteria were established). More information about the procedures and evaluations can be found in [24, 25].

It is important to mention that many unpredicted factors can happen when working with children in natural playful situations. Furthermore, the indications are about how the group sessions were administered and do not necessarily point out a certain toy or game task as more suitable to promote cooperation. A small description of each game session and the obtained results will be given.

4.1 Game session 1: smart circuit blocks

In game session 1, an interactive block toy set was selected as the game stimuli. The set was composed of circuit blocks that could be connected to activate different responses. For example, children could connect a switch to activate an electronic light, sound, or motor. Challenges were designed where 36 participants aged 6–16 divided into groups of four had to activate specific blocks in a 20 minutes time limit. Specific roles were also assigned for the challenge with one participant receiving the leader role, helping to manage their group members.

Three group conditions were formed: (1) easy game group, who played an easier version requiring simplified block combinations (e.g., activating a light block); (2) difficult game challenge, who played a version requiring more complex block activations (e.g., assembling a movable robot), and (3) no game group, who did not play the group game before performing the subsequent group task.

The subsequent group task of this study was a co-design challenge where had to design a new interactive toy together. Participants had 10 minutes to perform individual sketches and 10 minutes to perform group discussion. Video evaluation of the group discussion backed by the interaction rating scale [26] was performed to observe children social behavior. Developed sketches were collected for evaluation, and self-reports were applied after the task.

Results indicated no difference between participants who played the easy group challenge and participants who did not play the group game. This means that playing an easy game did not indicate to affect how easy or pleasurable participants perceived the group task to be, or how satisfied they were with their group members. Differences were observed, however, between the difficult game challenge and the two other group conditions. Participants in the difficult game condition also reported the design task to be more difficult, indicated to designed fewer elements in their toy sketches, and were less aware of their group members' feelings. In other words, the more difficult version of the game distressed participant's cooperation, affective impressions, and outcomes of the subsequent design task. We defined from these results that when administrating game as ice-breakers, the difficulty should not be excessively high. Games should instead seek to give a positive sense of achievement for the participants.

Other than difficulty, three aspects of the game may have influenced children's behavior: (1) the assigned roles, (2) the game complexity, and (3) time length.

Regarding the role assignment, it was noted that children who obtained the leadership role in the game task also tended to maintain the leadership position in the following design task. Through observation, it was noted that, depending on the age, this leadership position led to authoritarian behavior in the design task, with the leader not giving an equal voice for all group members.

While recommendations for group design tasks with children support the establishment of defined roles for better group work [21], this establishment indicated to be immature in the game sessions. The necessary leadership for completing a game challenge did not necessarily transpose into the necessary leadership skills for dialoguing in a group design task. Also, groups who established their roles without playing the game indicated better work dynamics. Unless due considerations are made, it is better to not establish roles during group games. Rather, group games can be good opportunities for children to explore different roles inside groups.

Regarding the complexity and time, another observation is that the interactive blocks were of high complexity and required children's extended attention. A fatigue effect might have happened from the game, reducing children's focus on the design task. Reconsiderations regarding the time length and the complexity of the game task were made to ensure children would be in good conditions for performing the following design task.

4.2 Game session 2: building tower blocks

Considering previous results, the game challenge was simplified for the game session 2. Instead of working with interactive toys and of creating two game conditions, this study investigated how playing a building block tower game could affect children's impressions and motivations for a subsequent task. About 21 participants aged 6–11 y/o were divided into groups of four. Roles were not assigned in this game session and each child had on average 20 connecting pieces to build into a single tower in under 10 minutes.

For the group challenge, participants had to design an invention to facilitate communicate among children. This context took opportunity of an existing children's design competition of the Interaction Design with Children 2018 (IDC2018) conference [27]. Participants had 10 minutes to sketch initial ideas and would then have a one-week deadline to submit their designs to the competition. Submission was voluntary.

Although no differences were observed on cooperation among group conditions, results indicated that participants who played the group game reported higher confidence with their designs and were significantly more likely to submit them to the competition. Results of this study mostly indicated that children who played the game were more motivated with the design task, associating an energizing effect of group games on subsequent activities. Compared with the previous session, game session 2 was shorter, the intention of the game was easier to understand, and children had the same initial conditions to participate.

4.3 Game session 3: interactive dance game

A third game challenge was designed to specifically observe its effect on children's group behavior. This session utilized the electronic game Just Dance 2018^{tm} as a simple interactive game. About 36 participants aged 6–14 y/o joined this study. The choice of this game was further backed by different studies which pointed positive effects of physical and energetic games on children's cooperation [1, 28]. Three group conditions were established: (1) a relaxing dance group, where participants would dance easier choreography songs with less movement, (2) an energetic

dance group, where they would dance more energetic songs with a more demanding choreography, and (3) group conversation condition, where children did not play any game.

The cooperative task of this study was simplified and focused on children's social behavior. After performing one of the three game conditions, participants were submitted to a Reward Sharing Game. Based on the prisoner's dilemma [28], participants had to decide between sharing and keeping their reward with the group. The study evaluated how willing participants were to share their rewards according to their group conditions and how much they would trust the group to share the reward.

Results indicated that participants in both game groups displayed higher trust in their group members and were more willing to share their reward than participants who did not play the game. This indicated that the physical dancing game was a successful motivator for bonding participants. However, differences between game conditions were not found at significant level. In both game conditions, there were participants who displayed high and participants who displayed lower engagement with the task. Participants who displayed higher engagement were more likely to trust the group and share the reward.

This indicates that, instead of the energy level that the game is requiring from the player, the level of involvement they will have with the task is the main factor. Additionally, there were more incidences of participants not managing to follow the choreography due to higher movement demands in the energetic game condition. This might also have prejudiced their engagement.

These observations suggest that, among two physical game sessions, having an easier difficulty entry could be safer for more participants to join and engage with the group game task. However, a different observation in the test runs of the dance game sessions was that participant who could not select which song to play displayed less engagement with the task. Considering that, we believe that giving the choice to the players to select between a more relaxed or energetic session could also be positive for their engagement. When we consider the interactivity of games, it is important to allow some flexibility to attend to different children's preferences.

4.4 Relationship and considerations between game sessions

Considering all the game sessions, three main differences were observed between game sessions:

- Game session 3 worked with physical tasks involving body movement coordination, while sessions 1 and 2 focused on constructive building and coordination skills.

- Game sessions 1 and 3 worked with interactive games, while session 2 worked with a more traditional building block.

- Game session 1 indicated negative subsequent effects of the game stimuli on children's task impressions and performance, while game sessions 2 and 3 indicated positive effects.

Game session 2 observed group game effects on children's task engagement, while game session 3 focused on children's cooperative behavior. While existing literature reinforce that physical games are more successful for positively coordinating group behavior [1, 29], the present studies cannot reach a definite conclusion

about physical dancing games being more suitable for motivating cooperation than constructive block games.

Although the smart blocks of game session 1 indicated negative effects for task impressions, these effects were not noted on the block games of session 2. We must then initially assume that block games would have a similar effect than the dancing game on children's group behavior.

When comparing with game session 1, both sessions 2 and 3 presented modifications which indicated to positively affect group behavior and task engagement. Acting as indications, these game elements can be observed in **Table 1** below:

Considering **Table 1**, we assume that the interactive dance game is possibly the best task motivator among the utilized games. The main considerations which led to this assumption were the game simplicity and the displayed engagement during game sessions. Although physically demanding, dancing is a simple group activity which does not require children to overthink situations and which can help with their movement synchronization. By leveling toward low difficulty dance, or by allowing groups to select more difficult songs according to their desires, the games can reduce children's frustrations and ensure that more group members will engage with the play activity.

Game simplicity, flexibility, and high engagement rate indicated to be the main contributive aspects of games to children's posterior impressions and behavior in the group tasks. We must also point that, if children are going to perform a group task after playing a game, they would need to be equally engaging. Therefore, if group games are meant to be utilized as ice-breakers, a balance must be established regarding the time and engagement of the session: either the game needs to be short and simple enough to ensure a smooth transition for the cooperative task, or a good rest time must be ensured with the group. Carefully considering these matters will help to ensure that group game sessions are successful in building group trust with children while motivating them for the following tasks.

It is important to mention that the presented studies only observed immediate to short-term effects of games as ice-breakers to influence children's task impression and group behavior. That said, different study designs and purposes could point

Game element	Interactive blocks	Tower blocks	Dance game	References
Rules and goals	Complex	Simple	Simple	[11]
Difficulty level	Easy/Hard	Easy	Easy/Medium	[11]
Time length	20 minutes	5–10 minutes	5–10 minutes	Study observation
Assigned roles	Different	Same	Same	[17]
Flexibility of game task	No	No	Yes	Study observation
Encourage physical movements	No	No	Yes	[23, 29]
Cooperative or competitive focus	Cooperative			[21]
Individual or group evaluation	Group			[16, 17]

Table 1.
Observations between the three administered game sessions.

to different effects of the mentioned game elements. If, for example, we consider a more longitudinal relationship of group games in children's behavior, some of the elements considered negative for ice-breaking challenges, such as conflicts and frustrations with the difficulty, can be considered as natural important elements which should not be strictly avoided.

According to LaFreniere [30] and Piaget [31], dealing with these matters during natural free-play situations can help children to develop perspective taking and learn how to control their displayed emotions, better preparing them for possible conflicts in the future. Therefore, we also consider that, regardless of its design, group games can have positive effects on children's continuous cooperation development.

5. Conclusions: what does "Design for Interaction" mean for the future of interactive play tools

This chapter discussed differences and similarities between the "Interactive Design" and the "Design for Interactions" principles when applied to the development of new interactive/smart play tools for children. In short, "Interactive Design" has a focus on the facilitated interactions between the toy and the child facilitated with the adoption of modern feedback technology. "Design for Interactions," however, focuses on the social interactions a child can have with others when facilitated by different toys or artifacts. Although the application of modern technology is not mandatory for the design of interactive toys, this does not mean it should be neglected.

Modern day technology possesses a wide range of smart detectors and sensory feedback devices that can still be better explored in new toy designs. However, under the "design for interaction" principle, technology should not be the main attraction of a toy but should rather assume a supporting role for encouraging children's social relationships. When giving the focus to social relationships, we can go beyond isolated experiences between the child and the play artifact, helping them establish meaningful bonds that can support the development of different social skills, such as cooperation.

We proceeded by introducing selected case studies which were designed to observe children's group behavior and task engagement after playing different ice-breaking group games. The games were mediated in different moments by technological and traditional toys, but technology integration did not indicate to be the main influencing factor of children's group interactions. Instead, some identified social game elements indicated to have stronger effects. Among them are the complexity of the game rules, the game difficulty, the time length, and the attribution of group roles during play activity.

While these game elements were directly manipulated by the authors of this research, they also represent possible technology integration points. Current technology can allow the adjustment of game elements (e.g., difficulty, goals, or time length) and of sensory feedback (e.g., light intensity and color, sounds, or vibrations). For promoting different interactions, modern play tools could then automatically manipulate some of these elements, recommending flexible choices for children to play according to their different inputs and group formations.

The design for interaction guidelines together with the results found in the presented studies reinforces how games should be carefully designed with social interactions in mind. Further studies are necessary to investigate both immediate and longitudinal effects of specific game elements on children's social development. With traditional playground environments serving as examples, a well-established

toy or game that can promote different interactions among children is more likely to have a longer life-spam and more thoroughly aid on their personal growth.

Therefore, the main challenge for designing interactive play tools lies in researchers successfully identifying children's dynamic interaction patterns together with designers and engineers successfully developing new technologies and artifacts to support these interactions. These open paths not only for new research lines but also for the development of ideal play tools to support childhood.

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