

Rethinking Children's Toy Design: Physical Interaction and Open-Ended Play in the Digital Age

Anandhu Krishna PS¹, Aastha Deshpande²

Abstract

Screen-based activities are increasing in children, creating a need to explore alternative forms of active and meaningful play. This study reviews existing research papers on children's play, screen exposure, attention, spatial skills, physical interaction, and toy design. This is done to understand how product characteristics can influence children's engagement. The research review was done by identifying common findings and translating them into relevant product design considerations.

The findings suggested that physical manipulation, child-driven exploration, open-ended use, and meaningful sensory feedback can support engagement and provide opportunities for exploration, problem-solving, and spatial interaction. Research on puzzle play and spatial skills training also highlighted the value of hands-on activities. However, the literature does not completely support any claim that physical play is always better than digital. Instead, it suggests that the quality and design of the interaction are important factors in shaping the play experience.

Based on these findings, the study identified an opportunity to develop a physical, non-digital play that encourages children to actively interact, explore, and think through their physical actions. The research provides a foundation for further predicting development and concept exploration.

Keywords: Children, Physical Play, Product Design, Interaction, Spatial skills, Open-ended play, screen exposure

1. Introduction

In today's environment, where children grow up, digital technology is increasingly integrated into everyday life, including the environments in which they play and interact with adults. Istenič et al., 2023. Digital devices and screen-based media are now commonly used for entertainment, communication, and other everyday activities, which makes children's exposure to digital technology an important area of research. Santos et al., 2022. This increasing presence of screens has led researchers to examine how screen exposure relates to children's attention and other aspects of their development. Santos et al., 2022. A systematic review done by Jourden et (2023) examined 15 studies which involved children aged seven years or younger and found that all five cross-sectional studies included in the review reported significant associations between higher screen exposure and attention difficulties. Jourden et al., 2023. Among the ten longitudinal studies reviewed, six reported significant effects while four did not, showing that the output is not completely consistent across studies. Jourden et al., 2023. The review also found that several studies suggest that screen exposure may relate to attention difficulties, while children's existing attention characteristics may also affect their screen use. Jourden et al. 2023.

The relationship between digital media and children's play is also an important factor because play is one

of the main ways young children interact with physical objects and their surrounding environment. Nijhof et al. 2018 . In an experimental study involving 50 children aged 12, 24, and 36 months, Schmidt et 2008 found that background television significantly reduced the length of children's toy episodes and their focused attention during play. Importantly, the children looked at the television for only a few seconds at a time and less than once per minute, indicating that the television could disrupt play even when it was not the primary activity, Schmidt 2008.

The type of toy itself can also influence how children interact during play. Sosa, A. V. (2016). Sosa 2016 found that electronic toys were associated with fewer adult words, fewer conversational turns, and fewer child vocalisations than traditional toys and books during parent-infant play. Similarly, a survey of 306 parents conducted by Istenič et al. (2023) found that parents perceived toys as more stimulating for sensory, motor, cognitive, and socio-emotional development than the digital toy categories examined in the study. Istenič et al. (2023). The same study reported greater parent- child interaction and greater language input during analogue play than during digital play Istenič et al., (2023).

However, this does not mean that all digital play is harmful or that all traditional play automatically produces developmental benefits, because outcomes depend on factors such as type of activity, context, and the way the object is used Jourdn et al.,(2023) since 2023. This paper examines existing research on children's screen exposure, attention, digital and analogue play, and physical and open-ended play. The study can be used to identify characteristics of engaging non-digital play that can inform product design.

2. Literature Review

2.1 Children's Exposure to Digital Media

Digital toys and screen-based technologies are available to children from early childhood and have introduced forms of play that are different from traditional analogue play. Digital technologies have become an integral part of children's everyday environments and have changed the way children interact with adults in play. Istenič et al., 2023

The increasing presence of digital media has led researchers to investigate its relationship with children's attention, behaviour, communication and development. However, screen exposure should not be treated as a single uniform experience because the different forms of media involve different levels of interaction. Therefore, research on screen exposure needs to consider not only how much time children spend with screens but also how the technology is used and what activities it replaces. Santos et al., 2022.

2.2 Screen Exposure and Attention

The relationship between screen exposure and attention has been examined in several systematic reviews Jourdn et al., (2023).Santos et al. (2022).

Jourdn 2023 reviewed 15 studies that involved children aged seven years or younger and found an association between higher screen exposure and attention difficulties in all five cross-sectional studies included in the review. Jourdn et al., 2023 . But of the 10 longitudinal studies, six reported significant effects while four did not Jourdn et al., (2023).

The author also reports that seven of the studies examined show a bidirectional relationship between screen exposure and attention, which means increased screen time can impair attention spans while existing attention difficulties can simultaneously lead to higher levels of screen exposure. Jourdn et al. (2023).

In the research paper by Santos et al. (2022), the authors reviewed 11 studies and found that most of the studies reported an association between screen time and attention-related outcomes. In that research, only one study reported that children with greater screen time performed better on an attention task, which

showed that the evidence is not completely uniform. The author therefore concluded that excessive screen time can be associated with attention problems but highlighted the need for further research to understand the relationship over time.

The study by Zivan et al. (2019) showed that the difference in the attention-related measures among the preschool children can be associated with different forms of storytelling experiences. In this research paper a comparison was done on preschool children aged 4-6 years between screen based and live interactive story telling. The results showed that the children in live interactive story telling group showed better visual attention, but the screen based group did not show any improvement.

2.3 Screen Exposure and Physical Play

Schmidt 2008 performed an experiment on 50 children, aged 12, 24 and 36 months to find the effect of television turned on in the background while playing with toys. The findings of the experiment showed that when the television was turned on, the playing time and attention of the children reduced. The findings suggest that rapidly changing screen exposure can influence children's engagement with physical play environments even when children are not directly using the screen. This report is important because the evidence supports the experimental context more than a broad claim that screen exposure automatically causes developmental problems.

2.4 Digital Play Compared With Analogue Play

Istenič et al. (2023) did a survey on 306 parents of preschool children, with an average age of the children being 3.6 years. The study found differences in how children engaged with different types of toys.

For traditional toys, 1 % of the parents reported that their child paid attention to the toy, while only 36% of parents reported this for electronic toys and only 27 % for digital screen toys and technology. Similarly, 92% of parents reported that their child played independently with traditional toys, compared with 36% for electric and electronic toys and 27 % for digital screen toys.

Parent - child interaction also differed according to the category. (2 % of parents experienced and reported intense vocal or verbal communication during play with traditional toys, compared with 15 % for electronic toys and only 8 % for digital screen toys.

Based on these findings, the author concluded that analogue play with traditional toys was more connected with parent-child interaction and greater language input than digital play.

2.5 Role of Physical Play

Physical play provides children with opportunities to interact directly with objects, materials, and their surroundings. In the form of play where the primary medium is a digital screen, the process of interacting with the object through any physical movements is mostly absent. In the review of Nijhof et al. (2018) research paper, the author describes play as an important context for children's physical, cognitive, social, and emotional development. This also highlights the need to better understand the process through which particular forms of play contribute to particular outcomes. Healthy play, better coping: The importance of play for the development of children in health and disease, December 2018, [Sanne L. Nijh](#).

In the research paper by Levine et al. (2012), they observed 53 children between the ages of 2 and 4 years through repeated home observation. In the observation, the children who were involved in puzzle play activities performed better on later spatial performance. The author suggests that puzzle play may provide children with better spatial relationships, but he also added that the observation alone does not establish that it caused the later differences. Early puzzle play: a predictor of preschoolers' spatial transformation skill, Susan C Levin, March 2012.

In the report paper of Yang et al. (2020), he suggested that hands-on manipulation can be relevant to children's spatial learning. The research involved a meta-analysis of 20 intervention studies involving children from 0 - 8 years and found an overall positive effect of spatial skill training compared with control conditions. Importantly, for physical play, these interventions were based on exploration, visual prompts, and gestural activities. However, he also added that these studies investigated specific spatial training interventions rather than ordinary free play, so the findings should not be interpreted as evidence that physical toys automatically produce developmental benefits. Is early spatial skills training effective? A meta-analysis: Yang et al., 2020

Taken together, these studies suggest that the physical characteristics of a play influence the type of interaction that the child has with it. Puzzles provide spatial problems to manipulate, while loose parts provide materials that can be reorganised and used in different ways. The literature provides strong support for examining the interaction opportunities created by physical materials, particularly, and does not universally claim that it improves attention, intelligence, or any other factor.

2.6 Open-Ended and Constructive Play

Open-ended play is the type of play where there is no fixed number of ways to use the toy or complete the activity. The child can decide what to do, how to use it, and what to create; it also gives the user, in this case, children, the ability to decide how many outputs they can create. For example, blocks can be used to make a house, a vehicle, a tower, or something completely different. This gives children different possibilities rather than following a fixed sequence of actions. Research on loose parts play is relevant because loose materials can support unstructured and child-led forms of play. Gibson et al. (2017).

Constructive play is another form of play in which children use objects to make or build something. Activities such as building with blocks, assembling pieces, or completing puzzles require children to physically manipulate objects and make decisions about how different parts relate to one another. Levine et al. (2012)

Open-ended and constructive play are therefore useful from a **product-design perspective**, because they give the child an active role in determining what happens during play. Instead of the toy providing one predetermined activity, the child can experiment, change the arrangement of pieces, and create different outcomes.

A recent study by Imagination vs Marketing: Empirical Evidence on What a Child Chooses to Play? (2025) examined the play choices of 203 children between 4 and 7 years of age. The study compared children's interaction with different types of toys and examined the relationship between the openness of the toys and the children's imaginative play. The findings showed that children using more open-ended toys produced more detailed and imaginative outputs. Imagination vs Marketing. Empirical Evidence on What a Child Chooses to Play?. International Journal of Early Childhood. [Margarita Gavrilova & Ali Kemal Tekin](#) (2025).

So, the value of open play can be considered in terms of the opportunities it provides for manipulation, exploration, and other child-directed activities without claiming that these activities automatically produce specific developmental improvements. Therefore, **open-endedness and constructive play can be considered useful design characteristics for creating opportunities for child-directed exploration.**

2.7 Sensory interaction and responsive Feedback

Research on tangible and physical interaction suggests that the way a toy responds to a child's actions can influence how children engage with it. A study done in 2026, Understanding young children's physical activity levels with digital toys: lessons for the design and evaluation of tangible interactions, examined

how young children interacted with toys that involved physical and digital elements. The study showed the importance of physical affordances, meaning the actions that an object allows a child to perform, in creating opportunities for physical engagement; it also suggests that multisensory feedback can contribute to children's physical interaction with the toys.

This is relevant to the present research because it says that sensory feedback does not need to replace physical play; instead, it can respond to the child's physical action to make it more noticeable and meaningful.

Understanding young children's physical activity levels with digital toys: lessons for the design and evaluation of tangible interactions. (2026). Entertainment Computing.

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While the study of Istenič et al. (2023) shows that physical interaction with objects provides children with opportunities to grasp and manipulate materials during play, this occurred mostly during play with traditional toys. The sensory stimulation in physical toys should not be simply increased without considering its effect on attention. This is because, in the study by Schmidt et al. (2008), it was observed that when background television was present suggest that additional audiovisual stimulation can compete with children's ongoing play activity.

This creates an important design consideration. Sensory feedback can be used to make physical interaction noticeable and meaningful. But the purpose should not be to make the toy highly stimulating, but to create a clear connection between **what the child does and how the object responds**. Schmidt et al. (2008)

3. Methodology

This study followed a literature-based research approach to examine existing knowledge concerning children's screen exposure, attention, digital and analogue play, and physical and open-ended play. The purpose of the review was not to evaluate the effectiveness of a specific toy; it was to identify the recurring findings, limitations, and design - relevant characteristics within the existing literature.

The selected studies were examined based on their research objective, participant characteristics, research method, key findings, and limitations. The literature was examined across five areas: digital exposure, screen exposure and attention, digital and physical play, physical and open-ended play, and sensory and responsive characteristics.

Systematic reviews, meta-analyses and experimental studies were given greater consideration because they provide evidence based on multiple studies or controlled research conditions. Individual observational and survey studies were also considered where they provided relevant information about children's play behaviour and interaction with toys. They also help identify patterns across research rather than individual observations. The findings from the selected studies were then reviewed to identify characteristics of play that could be translated into product design considerations.

4. Results

4.1 Screen Exposure and Attention

The reviewed literature identified an association between higher screen exposure and attention-related difficulties. The strength and consistency of this relationship varied between studies. Jourden et al. (2023) found that children with higher screen exposure were more likely to have attention difficulties. However, the results from studies that followed children over time were not always the same. Santos et al. (2022) also found that most of the studies reviewed reported a relationship between screen time and attention

problems. However, the results were not completely consistent across all studies. Schmidt et al. (2008) found that background television reduced the length of children's toy-play episodes and their focused attention during play.

4.2 Digital and Analogue Play

The findings indicated that traditional toys were associated with higher reported levels of attention, independent play, manipulation, and parent-child communication than the electronic and digital toy categories examined in the study (Istenci et al., 2023).

4.3 Physical and Constructive Play

One of the important characteristics of some types of play is physical manipulation, which was also identified in the reviewed research. Levine et al. (2012) found an association between puzzle play and later spatial transformation performance, while Yang et al. (2020) found an overall positive effect of spatial-skills training across the intervention studies included in their meta-analysis. These findings indicate that activities involving physical manipulation can provide opportunities for spatial interaction and learning, although they do not establish that ordinary physical play automatically produces developmental improvements.

4.4 Open-Ended Play

The importance of allowing children to determine how materials are used has been identified in research papers on open-ended play. Gibson et al. (2017) found that loose-parts play supported unstructured and child-led forms of play. But the review did not find enough evidence to establish clear cognitive, social, and emotional development effects. The study of 2025 involved 203 children aged 4-7 and reported that more open-ended toys were associated with more detailed and imaginative outputs. These findings together indicate that open-ended materials can provide children with multiple possibilities for exploration and creation.

4.5 Sensory and Responsive Interaction

Research on tangible interaction revealed the importance of physical affordances in providing opportunities for children's physical exploration. The study on the child's interaction with digital toys in 2026 showed that multisensory feedback could contribute to physical interaction. At the same time, the data provided by Schmidt et al. (2008) demonstrate that additional audiovisual stimuli may disrupt toy play. Hence, the idea of increasing sensory feedback to make the toy more engaging should consider the potential distractions it might create.

4.5 Final Results

Overall, the results indicate that the reviewed literature does not support a simple comparison in which digital play is considered harmful and physical play is considered beneficial. Instead it shows how characteristics of the objects involved are important in how children interact with the play environment. Physical manipulation, child-directed exploration, multiple possible uses, and meaningful responses from the object were identified as relevant characteristics across the reviewed literature. These characteristics provided an initial basis for designing a product for a non-digital play experience.

5. Discussion

The findings suggest that the design of the product can influence how children engage in play with the product. It is not only the type of toy that matters, but also the way the product allows children to interact with it. Physical interaction such as moving, rotating, arranging, and connecting objects can encourage active exploration and spatial thinking. Research on puzzle play supports this. Levine et al., 2012

This proves that products for children should not be designed only for entertainment, the interaction between the product and the child itself can become a part of the learning. A product can help children to explore and solve problems rather than receiving information.

Another important characteristic is **child-directed interaction**, where the child becomes an active participant in determining how the product is used. The product provides the physical possibilities, but the child decides how to use them.

Therefore, open-ended play of toys can be considered a useful product design characteristic. Instead of designing a toy around a single decided outcome, designers can provide interchangeable parts, multiple combinations, interactive forms, or flexible rules. This will support exploration without claiming that the open-ended play has specific developmental benefits.

Sensory feedback should also have a purpose rather than simply increasing stimulation. Feedback can be closely connected to the child's actions. For example, movement, connection, or manipulation could produce a small response that shows the child that their action has had an effect.

Based on the reviewed literature, the following design characteristics can be considered

Table 1.1 Research Findings and Product Design Implications

Research finding	Design implication
Physical manipulation supports spatial interaction	Design for grasping, moving, rotating, connecting, and transforming
Puzzle play involves spatial transformation	Include spatial relationships and problem-solving actions
Open-ended play provides multiple possibilities	Avoid a single fixed method of use
Child-directed play encourages exploration	Allow the child to determine the outcome
Sensory stimulation can become distracting	Use subtle and meaningful feedback
Responsive objects can make actions noticeable	Connect feedback directly to the child's action
Screen exposure may compete with other activities	Design physical experiences that offer a different form of engagement

6. Conclusion

This review supports the relevance of the identified problem: children need opportunities for active, focused, and meaningful forms of play in a context where screen-based activities are increasingly present. The reviewed research also shows that physical play, spatial activities, and hands-on interaction can provide valuable opportunities for exploration, problem-solving, and cognitive engagement.

This review shows that the characteristics of a product can influence the way children engage with play. The study shows that the physical manipulation, child's exploration, open-ended use, and meaningful sensory feedback are important characteristics of engaging play experiences.

This supports the **design direction of developing a physical, non-screen play product** that encourages children to actively, explore, and think through their actions. However, the literature does not suggest that physical products are automatically better than digital ones. Instead, it highlights the importance of **how the interaction is designed**.

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