A Healthy Future Starts with Movement

Supporting Motor Skill Development in a Critical Phase of Early Childhood

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Industrial Design Engineering, TU Delft

Master Integrated Product Design (IPD)

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Abstract

This graduation project investigates the development of a modular play system aimed at stimulating motor skill development in children aged 3 to 6 through open-ended and intrinsically motivating play. The project addresses concerns about reduced physical activity and increasing motor delays in early childhood. Literature study, expert interviews, and field observations confirmed that unstructured, spontaneous, and socially engaging play offers valuable conditions for motor learning in this age group.

The design process followed an iterative approach, involving multiple cycles of prototyping, user testing, and evaluation. Each iteration focused on exploring how design features influenced physical interaction, social engagement, and developmental challenge. Findings from each cycle informed adjustments in form, material, and functionality. This iterative development process formed the foundation for translating movement goals derived from the Athletic Skills Model and five core subdomains of motor skill development: balance, coordination, ball skills, fine motor control, and movement variety into concrete play experiences.

The final concept, Movemates, consists of six soft, geometric elements made of PU foam with a TPU shell. Each element affords different types of movement, such as balancing, coordination, throwing, or assembling. User tests indicated that children engaged with the elements across all targeted motor skill development domains. The design also enabled social collaboration and imaginative use, even within a limited set.

Material experiments demonstrated the technical feasibility of combining thermoforming and foam casting as a production method. This approach met requirements for safety, softness, and durability, while allowing variation in form and surface.

The project provides insight into how iterative design methods can support the translation of developmental objectives into tangible, engaging play elements for early childhood motor development.

Foreword

The reason I want to carry out this project is that during my Bachelor End Project (BEP), I designed toys for children and I realized that this process energized me and was genuinely enjoyable. Throughout my BEP, I also had many conversations with people about sports. As someone who loves sports and practices various types thereof, I discovered that many people do not engage in sports. A common reason for this was the lack of certain motor skills (e.g., "*I don't have ball control*", "*I don't have hand-eye coordination*" etc.).

This got me thinking. After conducting some research, I learned that the foundation for these motor skills is established early in life and continues to benefit people throughout their lives. Therefore, I want to design products that allow children to improve their motor skills in a playful way from an early age, so that society can benefit in the long term.

Through this project, I aim to lay the groundwork for my future career in which I want to work in the field of sports and motor skill development. I also want to develop myself in various areas, including:

- conducting co-design sessions with children;
- improving the visualization of my ideas through more appealing renders;
- conducting interviews;
- gaining a deeper understanding of motor skills and the best ways to train them.

My project will be successful if I achieve these goals and if my product has a tangible impact on society by improving children's motor skills at an early age.

Acknowledgments

I would like to express my sincere gratitude to everyone who supported and guided me throughout this project.

In particular, I would like to thank my supervisors, Mathieu Gielen and Maurizio Filippi, for guiding me through this process. Their feedback and encouragement helped me grow both personally and professionally. They also supported me in expanding my network and reaching my personal goals. Thanks to their involvement, I was able to build a solid foundation for my research and gain useful insights along the way.

I am also grateful to Delft voor Elkaar and the Egelantier School for their collaboration, especially in helping me find suitable locations for observations, user testing, and interviews. I would also like to thank the Athletic Skills Model team for allowing me to attend one of their workshops.

Lastly, I would like to thank all the individuals I interviewed. I appreciate the time you took to speak with me and the information you shared.

As I am dyslexic, I experience difficulties with writing. For this reason, I used the AI tool ChatGPT to assist with grammar correction, text structuring, and language clarity throughout the writing process. I also used it to support the creation of some visual materials included in this report.

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1. Introduction

In today's society, children are increasingly distracted by screens, such as iPads, game consoles, TV, and social media. This increased screen time displaces outdoor play and physical activity, negatively impacting motor and social development (Iyer et al., 2021).

Research shows Dutch children's motor skills have been declining for decades (Hoofwijk et al., 2020). In 2022, 43.2% of children aged 4 to 12 did not meet the Ministry of Health, Welfare, and Sport's physical activity guidelines (Nederlands Jeugdinstituut, 2023). Developing motor skills at a young age supports a healthy Body Mass Index (BMI), increases physical activity, and enhances social-emotional and cognitive development (Hoeboer, 2022). A solid motor skills foundation reduces injury risk, fosters accomplishment, and supports neurological development, making it easier to learn new sports (De Vries & Post, 2021). Consequently, many children quit sports if they don't excel, leading to decreased physical activity. This raises concerns about how early setbacks and inactivity can accumulate over time and have lasting effects.

Since fundamental motor skills develop between ages 3 and 6, early interventions, such as physical play-based learning, can improve skills and set the stage for healthier lifestyles and better mental health. A variety of activities, from structured physical education to playful physical activity and learning, can reduce future mental health interventions and enhance overall development (Aadland et al., 2017; Alleen-Herndon et al., 2019; Hoofwijk et al., 2020).

1.1. Problem Statement

Motor skill development in young children in the Netherlands is declining. Increased screen time and reduced outdoor play contribute to lower physical activity levels, weakened muscle tone and poor coordination, which can impact long-term health, learning and social participation.

1.2. Objective and Main Design Question

How can a product support children aged 3–6 in developing their motor skills through play, in both individual and group settings?

Sub questions

1. What is the optimal age for motor skill development?
2. What is currently on the market?
3. What trends and developments are currently there?
4. Who are involved in child development?
5. What is play?
6. What is the importance of motor skill development in children aged 3–6?
7. What effect does screen time have on children aged 3–6?
8. Which motor skills often lag behind in children aged 3–6?
9. What encourages play and activity?
10. What is the importance of playing together?
11. Are there differences between boys and girls?

1.3. Design brief

Design a play-based product to improve motor skills, to be used in different settings by children ages 3-6, both alone and with others.

2. Research Approach

2.1 Introduction

To lay a foundation for the design process, a research strategy was developed that combined both theoretical and practical methods. Through desk research, literature review, interviews and field observations, relevant insights were gathered about motor development in young children, existing products and user needs.

2.2 Context Analysis

To understand the current market and environment related to motor skill development in children aged 3–6, a combination of desk research, interviews and observations was conducted. These methods supported a comprehensive benchmark study, trend analysis and stakeholder mapping to guide the design process.

2.3 Desk Research

The desk research focused on identifying existing trends and evaluating toys currently available for the target age group. Additionally, companies and experts involved in child development were investigated to understand their offerings, philosophies and approaches. This background provided foundational insights into current market gaps and opportunities.

2.4 Literature Review

The literature review was conducted using academic databases such as Google Scholar, ResearchGate, and other relevant platforms. Articles were selected based on targeted keyword searches that aligned with the key themes of the research. Furthermore, expert interviews contributed to this review by suggesting relevant studies and resources that may not surface through standard academic search engines.

2.5 Interviews

Both formal and informal interviews were used as qualitative research methods:

- **Informal interviews** were conducted during observations or activities, allowing for spontaneous conversations with participants to gain authentic insights into the behaviors and preferences of the target group.
- **Formal interviews** were held with professionals selected for their expertise and relevance to the research domain. These were conducted in a semi-structured format guided by predefined questions, but also allowed for open, conversational input. Interviews took place either online via Microsoft Teams or in person at the expert's location to also observe their context.

All interviews, both online and physical were recorded and transcribed to ensure accurate analysis and retention of critical information.

Interviewed participants included (Appendix: E-P):

- two experts in motor skill development;
- an expert in motor skill assessment;
- an expert Rehabilitation Physician from Rijndam Rehabilitation;
- engineers and employees from Bosan (sport-equipment), Nijha (infrastructure), Lü (interactives) and Griekspoor (dance-tech): companies providing innovative movement-oriented solutions;
- a representative from the ASM Skill Model and NOC*NSF;
- two industrial designers (Jantje Beton and Peppy Agency);
- a researcher on cooperative play;
- two child physiotherapists;
- parents of children within the target age group;
- children aged 3–6 and slightly older;
- a primary school gym teacher;
- two neighborhood sports coaches;
- two preschool teachers.

2.6 Observations

O bservational research began with exploratory visits to understand the broader context, followed by more targeted, in-depth observations. Locations were selected through personal and professional networks and included both planned and opportunistic settings. Observations took place in family environments, public playgrounds, primary schools (including both outdoor areas and gymnasiums), and sports fields in Utrecht, Poptahof, Delft-Zuid, and DVV Delft.

These sessions involved approximately 40 children and used field notes, checklists, and informal interviews to document behavior, interaction and engagement. This method was essential to capture natural play behaviors and ‘’real-world’’ dynamics within different environments.

Figure 1: Summary of the Research Approach

3. Literature Review

3.1. Introduction

T This literature review explores the sub question:

"What are the optimal timing, testing methods and influencing factors for interventions aimed at improving motor skill development in children, and how can these interventions maximize individual and societal benefits?"

To make sure the analysis was complete, relevant studies were chosen using keyword searches and ideas from news sources and TED Talks were added. All research that was cited was checked for scientific validity. Recent publications were prioritized to maintain accuracy.

This review first examines why early childhood is a critical period for motor skill development and explores methods for measuring these skills. It then addresses the role of genetics and various environmental factors in shaping motor development. The review continues with an analysis of interventions, as well as the challenges and barriers to improving motor skills. Finally, the review concludes with a summary of key findings

The full literature review can be found in Appendix A (Literature review). The sections that directly influenced my research have been integrated into the relevant sub-sections throughout this report.

Figure 3: Literature Review

3.2. Optimizing Motor Skill Development in Early Childhood: A Critical Period for Intervention

During infancy (0–2 years), children develop foundational gross motor skills such as crawling and walking; however, effective interventions at this stage remain limited (Newell, 2020). **Early childhood (ages 3–6)** marks the *symmetrical phase*, a critical period in motor development when movements become more coordinated and balanced between both sides of the body. The brain is especially receptive to learning new motor patterns during this time, making it an optimal window for intervention (Lloyd et al., 2014).

In early childhood, varied physical movement plays a key role in shaping motor skill development, which in turn influences long-term physical activity levels (Stodden et al., 2014). Low levels of physical activity increase the risk of poor motor competence (Koolwijk et al., 2024). Given this evidence, early childhood has been identified as the ideal period for intervention, making this the **target group**. Early interventions at this stage not only enhance motor skills but also support broader physical, cognitive, and social development. Skill acquisition during this phase has a profound and lasting impact on a child's overall growth, helping to prevent developmental challenges later in life (Newell, 2020; Piek et al., 2012).

From a psychosocial perspective, it is suggested that the main emphasis of any program at this stage of development should be on promoting fun and social interaction to help young children enjoy the learning of new skills and to encourage the interaction process with their peers (Lloyd et al., 2014).

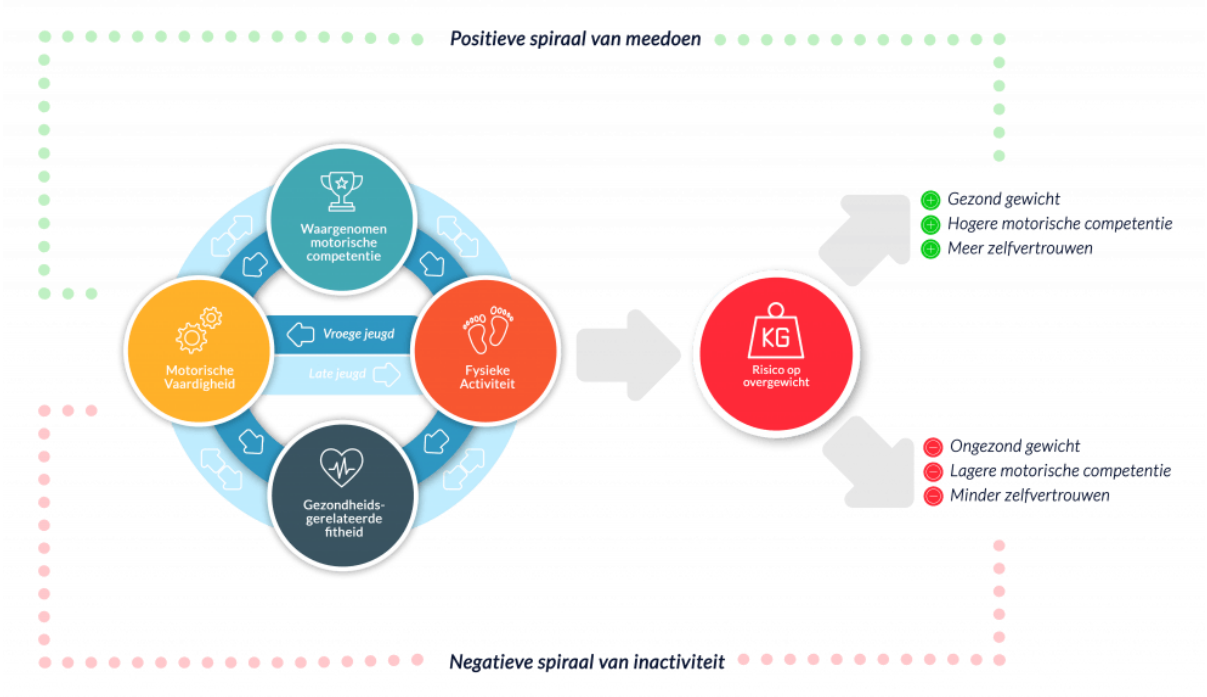


Figure 4: Motor skill in relation to physical activity model of Stodden (Kennis centrum sport & beweging, 2023)

3.3. Conclusion

The literature review has clarified that children aged 3-6 form the ideal target group for motor skill interventions, as this period is marked by rapid neurological development and high receptiveness to movement-based learning. It provided direction in answering the central question for the literature review: what are the most effective methods, conditions and timing for improving motor skills in early childhood? The review not only provided theoretical grounding but also acted as a strategic filter for selecting methods, defining the research scope and structuring the design process around evidence-based, context-sensitive motor skill interventions. It ensured that all subsequent research activities such as the formulation of sub questions, context analyses and fieldwork remained aligned with the goal of creating inclusive and impactful solutions for young children's motor development.

Based on these insights, several relevant design implications can be identified:

- Early childhood (ages 3–6) identified as a relevant period for motor skill intervention.
- Emphasis on play-based, non-competitive methods may be relevant for product direction.
- Broader developmental impact suggests potential value in supporting varied movement experiences.

4. Context analyses

4.1. Introduction

T This section provides an in-depth context analysis to understand the current landscape of motor skill development products and play experiences for children aged 3-6. The analysis is divided into three key areas: a benchmark of existing products, an exploration of relevant trends and an identification of key stakeholders. By examining the competitive landscape and current market offerings, we can assess what is currently available and identify gaps in the market. Trends in child development, play patterns and product design provide a forward-looking perspective on how play products can evolve to meet the needs of modern children.

Additionally, the involvement of stakeholders ranging from experts in child development and motor skills to product designers and parents, helps to frame the design process in real-world contexts and ensure that the resulting product aligns with the needs and expectations of both children and their caregivers.

4.2. Benchmark Analysis – Motor Skill Development Products for Children (Ages 3–6)

This section explores the sub question:

"What is currently on the market?"

This benchmark analysis evaluates a variety of existing products designed to support motor skill development in children aged 3 to 6. By comparing strengths, weaknesses, use contexts and motor skill targets, this analysis aims to identify gaps and opportunities that can inform the design of a new, inclusive and adaptable product, suited for both individual and group play in settings like homes, schools and therapy environments.

Findings

A total of **16 products** were analyzed in Appendix B, ranging from low-tech physical toys to technology-enhanced systems. Each was assessed across six key dimensions: description, targeted motor skills, setting, suitability for individual or group play, strengths and weaknesses. Some key insights:

- **Fine motor skill-focused products** include *LEGO DUPLO*, *Melissa & Doug Lacing Beads*, and *Kinetic Sand*, which encourage grasping, hand-eye coordination and dexterity;
- **Gross motor skill development** was a primary focus in products like *Montessori Climbing Sets*, *PlaSmart PlasmaCar*, *Step-a-Trail* and *Trailblaze Ninja Slackline*, which emphasize balance, strength, and coordination;
- **Dual-use flexibility** (individual and group) is offered by most products; however, *Montessori Climbing Sets*, *PlaSmart PlasmaCar* and *Toniebox* lean more toward individual engagement;

- **Technology integration** is typically limited. Products like *Yoto Mini*, *Toniebox* and *GoNoodle Games* incorporate guided movement or audio without screens, appealing to screen-conscious parents;
- **Modular and open-ended play** was most strongly represented in products like *Magnetics*, *Fat Brain Squigz*, *Step-a-Trail* and the *Nugget Play Couch*, all of which allow children to create their own experiences;
- **Safety and storage issues** appear as common drawbacks. For instance, *Magnetics* pose potential hazards if damaged, while *Nugget Couch* and *Step-a-Trail* require significant space.

Analysis

This benchmark underscores a lack of truly versatile products that support both fine and gross motor development in modular, open-ended and screen-free formats. Many products excel in specific areas, such as *GoNoodle* for guided gross motor activity or *Magnetics* for creative construction, but fail to integrate broader developmental support or adapt seamlessly to both solo and social play. Products like the *Kube*, *Bilibo* and *Stepping Stones* offer strong potential due to their simple, imagination-driven designs and flexible usage, but often miss out on deeper engagement through challenge or guided development.

Parents and educators show a clear preference for safe, space-efficient and non-digital products that still promote physical and cognitive growth. Yet most tools are either too niche (e.g., focused solely on fine motor skills) or require special conditions (e.g., magnetic surfaces, outdoor trees).

Conclusion

The current market shows a divide between products that are either highly structured or completely open-ended, often neglecting balance across skill types and play settings. A well-designed product should combine modularity, safety and imaginative engagement, while remaining suitable for both individual and group play without relying on screens or complex setup.

4.3. Trends and Developments

This section explores the sub question:

"What trends and developments are currently there?"

To design an effective product that supports motor skill development in children aged 3–6, it is essential to understand the societal and educational trends shaping their environment and play behavior. By doing interviews, desk research and observations some interesting trends and developments are gathered. This section investigates three key areas influencing children's physical development: *space and accessibility*, *play and learning approaches* and *technological engagement*. These domains reveal opportunities and constraints relevant to the development of a play-based, inclusive and motivating solution.

4.3.1. Environment & Accessibility

Findings

There is a dual movement visible in Dutch society regarding children's physical activity**.** On the one hand, schools and municipalities are increasingly transforming public spaces into movement-rich environments. Examples include multifunctional schoolyards and outdoor gyms (Nijha, 2024), IKEA's rooftop sports field in Utrecht and the growing use of *buurtsportcoaches* (Haaglanden Beweegt, 2025) who organize structured play during school breaks or in local neighborhoods. These developments aim to create more opportunities for guided and accessible physical activity during and outside school hours.

On the other hand, urban densification and increasing parental concerns about safety (Kalish et al., 2010) are reducing access to informal outdoor play. As a result, spontaneous and self-directed movement is declining, especially in densely populated areas. This shift increases the importance of designed play tools that are adaptable, space-efficient and suitable for both structured and free play in diverse environments.

Figure 5: Outdoor gyms (Nijha, z.d.), Rooftop sport fields (Nophadrain, 2023), Structured play (Haaglanden Beweegt, 2025)

Analysis

These findings highlight a shift in where and how children engage in physical activity. Spontaneous, self-directed play is becoming increasingly inaccessible, particularly in urban environments. As a result, children rely more on structured settings for movement, placing greater demands on the design of play tools. These tools must be versatile, portable and adaptable to both indoor and outdoor spaces, as well as suitable for use across a range of settings, including homes, schools and childcare organizations.

Conclusion

Motor skill opportunities are expanding in structured environments like schools, but shrinking informally due to urbanization and safety concerns. A new product must therefore be adaptable across diverse, space-limited settings and offer both structured and free-form play.

4.3.2. Learning Design & Play Approaches

Findings

Two seemingly contrasting approaches to motor skill learning are growing:

- On one hand, **structured multisport programs**, such as the Athletic Skills Model (ASM, 2022), focus on teaching children a broad foundation of versatile movement patterns within schools and sports clubs.
- On the other hand, **risk-inclusive and loose parts play** encourages autonomy, imagination and problem-solving. In these environments, children are given the freedom to explore and manipulate found objects - such as sticks, crates, or stones - to create their own games and movement scenarios (VeiligheidNL, n.d.; De Avonturen Speeltuin, n.d.). This approach supports decision-making, creativity and non-linear motor skill development through open-ended play, often in natural or unstructured outdoor settings like forests or adventure playgrounds.

In addition to these two paradigms, new **interactive learning environments**, such as movement walls, are emerging in educational settings. These installations integrate physical activity with cognitive development, challenging children to combine movement with memory, planning and problem-solving (Sport Vlaanderen, n.d.).

Figure 6: Multisport program (Athletic Skills Model (ASM), 2022), Loose parts play (VeiligheidNL, z.d.), LU interactieve muur (Sport Vlaanderen, z.d.)

Analysis

There is a clear pedagogical need for **balance** between structure and freedom. **Structured play** ensures foundational skill development, while **open-ended** play supports creativity, resilience and self-confidence. A single product should ideally accommodate both, offering clear challenges (e.g., balance beams) and flexible, reconfigurable elements (e.g., loose parts). Adding a cognitive layer, such as learning through movement can further enhance engagement and learning value.

Conclusion

Motor skill development is best supported through a combination of structured and unstructured play. The ideal product should offer both guided challenges and flexible configurations that stimulate creativity and problem-solving through movement.

4.3.3. Technology & Motivation

Findings

Digital trends are shaping how children engage with movement:

- **Exergames and motion-based tools** are rising in popularity for their feedback and reward mechanisms.
- **Gamification** increases motivation through levels, badges and challenge-based design.
- At the same time, **screen time is rising**, even among toddlers, contributing to sedentary behavior and motor skill delays.
- Educators and therapists emphasize the need for **measurable progress** and **data-informed tools**.

Figure 7: Motion based tools (Journal, 2024), Gamifaction of walking (Lodi, 2025), Increased screentime (Ravensbergen, 2023)

Analysis

The findings indicate that technology is increasingly used to stimulate movement and provide feedback through gamification principles such as rewards, progression and challenge. At the same time, rising screen time in early childhood is associated with reduced physical activity, prompting caution among educators and caregivers. Interview and observation data suggest a preference for screen-free or low-tech tools that still offer motivational value and allow for visible progress. This highlights the potential of incorporating physical elements such as tokens, colour-coded components, or task-based variations to provide feedback without relying on screens. Tools that enable caregivers or educators to observe and interpret progress through physical interaction align more closely with the current expectations and constraints described in the field.

Conclusion

Technology can enhance motivation and feedback, but should avoid excessive screen reliance. A smart, low-tech system with gamified progress tracking can promote physical activity while supporting long-term motor skill development goals.

4.3.4. Conclusion Trends and Developments

The trends reveal a growing awareness of the importance of motor skill development in early childhood, alongside new challenges such as urban space limitations, increased screen time and parental restrictions. At the same time, both structured movement models and unstructured play approaches are gaining ground. This duality highlights the need for play tools that are safe, screen-free, adaptable and stimulate both guided and spontaneous movement. These insights form a strong foundation for designing versatile, future-proof play concepts that respond to real developmental needs.

4.4. Stakeholder Analysis

This section explores the sub question:

"Who are involved in child development?"

To design an effective product that supports motor skill development in children aged 3–6, it is essential to understand the perspectives and needs of those who influence or are affected by this development. A stakeholder map was created based on desk research, observations and interviews to identify these key individuals and groups. This analysis helps guide targeted interviews and data collection, ensuring the final product addresses real-world challenges and priorities.

Findings

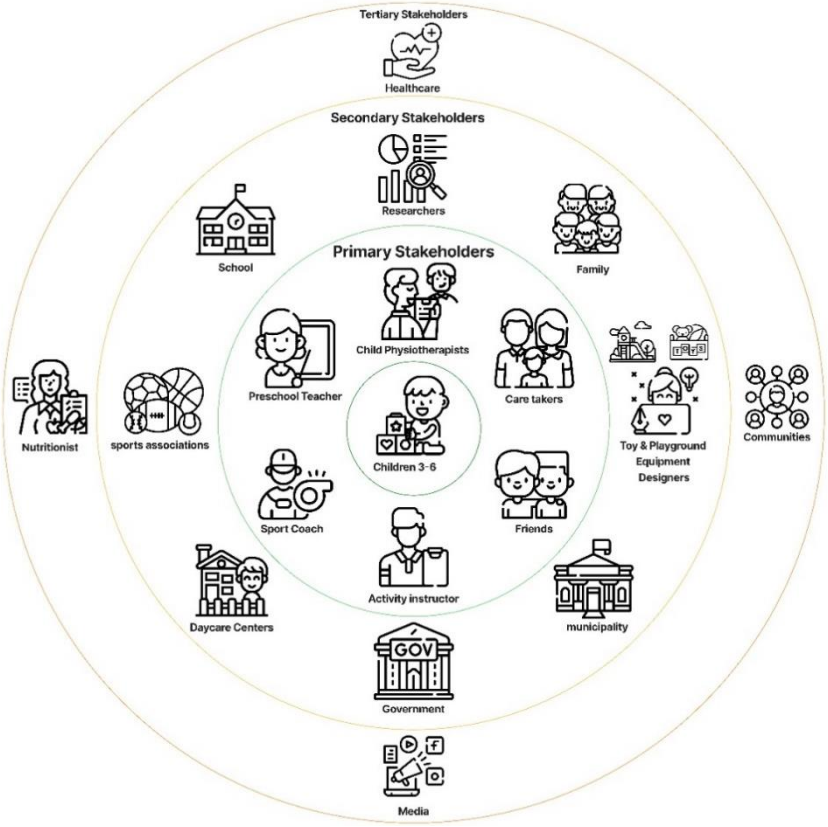


Figure 8: Stakeholders map

The stakeholder map highlights both direct and indirect stakeholders involved in shaping motor skill development:

Primary Stakeholders (directly influencing or observing development)

- **Parents and caregivers**: Gatekeepers of home play and screen time.
- **Preschool teachers and educators**: Responsible for daily movement activities and early learning.
- **Physical education instructors/motor skill specialists**: Offer structured physical training and development assessments.

- **Child therapists (e.g., physiotherapists, occupational therapists)**: Provide support for children with motor delays or developmental needs.

Secondary Stakeholders (influencing policies, environments, and long-term outcomes)

- **Policymakers and educational administrators**: Define curriculum standards and allocate resources for play and physical education.
- **Urban planners and school facility designers**: Shape physical environments where children play.
- **Toy designers and product developers**: Create tools that enable or limit certain types of movement and engagement.
- **Researchers and child development experts**: Contribute evidence-based insights into what methods are effective.

Interaction Analysis

In addition to identifying individual stakeholders, a visual interaction map was developed to analyse how these stakeholders functionally relate to each other (Figure 9: Stakeholder Interaction Map). These relationships are categorized into three types: health-related, movement-stimulated and policy-related, alongside a fourth category for indirect connections.

This interaction map reveals meaningful dynamics across the ecosystem. It uncovers multiple zones of alignment, such as the shared emphasis on safety and usability by parents, educators and therapists. These stakeholders collectively support simple, modular and child-safe design principles. It also reveals areas of friction, for example between therapists' need for individualized, adaptive tools, and teachers' preference for products that are easy to apply in group settings. Furthermore, toy designers and policymakers may experience conflicting priorities, as creative freedom must often be balanced with regulatory compliance and budget constraints.

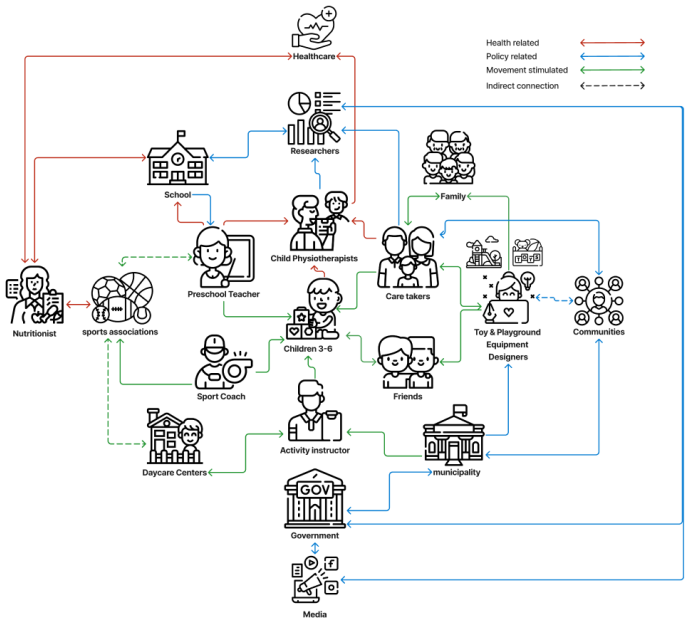


Figure 9: Stakeholder Interaction Map: This map visualizes functional relationships among stakeholders: health-related (red), movement-stimulated (green), policy-related (blue), and indirect connections (dashed).

Analysis

The stakeholder map and interaction analysis provide insight into the structure and influence of the network surrounding motor skill development in early childhood. It shows how primary stakeholders such as parents, teachers and therapists are directly connected to the child and to one another, while secondary stakeholders such as policymakers, designers and researchers operate at a greater distance but shape the broader conditions for development.

The visualization of these relationships clarifies how influence and decision-making flow through the system. It also shows that some stakeholders act as connectors between different domains. For example, educators link everyday practice with institutional frameworks. Within this network, even a small design intervention can influence multiple layers. This systemic understanding informs where the design can be positioned to create consistency across use contexts. A product that functions in both educational and therapeutic environments, for instance, can support coordination between stakeholders and strengthen continuity in the child's development.

Conclusion

This stakeholder analysis offers a structured overview of the actors involved in early motor skill development and the relationships between them. By mapping how stakeholders are positioned and connected, it becomes clear where influence is concentrated and where collaboration occurs. This understanding provides a foundation for a design that can operate across multiple settings and engage with different stakeholder groups in a coherent way. It ensures that future design decisions are not only contextually grounded but also aligned with the dynamics of the broader developmental system.

4.5. Conclusion

The context analysis outlines how motor skill development in children aged 3 to 6 is shaped by existing products, societal trends and the network of involved stakeholders. The benchmark reveals a lack of versatile products that support both fine and gross motor skills in a modular, open-ended and screen-free manner. At the same time, trends indicate that opportunities for spontaneous play are decreasing in urban environments, while structured play in schools and public facilities is expanding. Within this shifting landscape, there is a clear need for adaptable solutions that facilitate both guided and free-form play.

Pedagogical developments also emphasise the importance of balancing structure with freedom in motor skill learning. Children benefit from play that offers both challenge and creativity. The stakeholder analysis highlights a broad and layered system of influence, involving parents, educators, therapists, policymakers and designers. By mapping their relationships and roles, it becomes evident where collaboration is possible and where priorities may conflict, such as between the individualised needs of therapists and the practical demands of educators working in group settings.

These insights do not only define the constraints, but also point toward specific opportunities for design. There is clear potential for a physical product that bridges structured and unstructured play, makes progress observable without relying on screens and adapts to both group and individual contexts. This opens a space for modular, intuitive design elements that support varied movement, fit within shared environments like classrooms and therapy rooms and align with the diverse needs of caregivers, professionals and policy-level actors.

Based on these insights, several relevant design implications can be identified:

- Versatile functionality across structured (school, therapy) and informal (home, outdoor) settings may increase product relevance.
- Modularity and adaptability could help accommodate different environments, user needs, and developmental levels.
- Addressing key stakeholder requirements such as intuitive use, safety, and inclusivity may contribute to broader usability and acceptance.

5. Child Development Through Play and Movement (Ages 3–6)

5.1. Introduction

In this section, the core aspects of early childhood development, specifically from ages 3 to 6, are explored through the lens of play and motor skill development. Understanding the role of play in fostering physical, emotional, and cognitive growth is essential for designing effective tools and environments for young children. This section delves into how play supports motor skill development, the impact of screen time on physical activity, the importance of social play, and how gender differences may influence activity preferences. Additionally, it looks at which motor skills are often lagging behind in this age group and explores the factors that encourage children to engage in active play. By examining these elements, we gain valuable insights into how to promote healthier, more active lifestyles for children in this critical developmental phase.

5.2. Understanding Play in Early Childhood

This section explores the sub question:

"What is play?"

It identifies which forms of play are most (commonly) used by children aged 3–6. The research was conducted through literature review, expert interviews and observations in various settings, including playgrounds, homes, gymnasiums and classrooms.

Findings

Play is a broad and subjective concept; there is no single universally accepted definition (Gray, 2013; Van der Bijl, 2000). For this project, a working definition was constructed by integrating elements from both Gray and Van der Bijl, as these sources emphasize intrinsic motivation, spontaneity and imaginative action as central features of play. These elements were particularly relevant for this project, as they align closely with the design goal of fostering open-ended, self-directed motor activity in young children. For this project, play is defined as:

"A voluntary, intrinsically motivated activity involving enjoyable or imaginative actions, often within self-imposed or agreed-upon rules, with the goal of having fun."

Across literature Gray (2013) and Van der Bijl (2000) and field research, several common characteristics of play were identified: it is free and voluntary, intrinsically motivated, unstructured, fun, process-oriented, imaginative, spontaneous and both personal and social.

Additionally, five key domains help support and stimulate meaningful play: **freedom, socialization**, **challenge**, **variety** and **safety** (Magnano, 2023). Observations and interviews revealed that *socialization* and *challenge* were especially significant. Children often expressed a desire to play, but lacked peers to do so with, particularly in the case of an only child. As one parent noted, *“My child wants to play outside, but when nobody is there, they return home very quickly.”* Experts emphasized that play must be *challenging* to hold interest and promote development.

With regard to *safety*, it became clear that children must be able to interact with a product without the risk of injuring themselves or others. In relation to *variety*, observations highlighted that children typically have short attention spans and frequently seek to try something new, reinforcing the importance of designing play experiences that offer diverse possibilities.

In terms of *freedom* **''Loose parts play''** stood out as the most impactful form observed. Children used natural or found objects creatively, such as turning fallen trees into climbing structures, sticks into swords, or construction debris into tunnels. Interviews confirmed that children often repurpose products in ways not originally intended, especially in open-ended play environments like the loose parts playground in Utrecht.

Outdoor play often involved ball games, tag and throwing activities, also the most offered games in schools (Ministry of Education, Culture and Science, 2023). Indoors, play leaned more towards dancing, building, running, climbing and role-playing with toys or people like parents.

Analysis

These findings are essential because they show that children develop best in environments that promote freedom, creativity, and social interaction. *Loose parts play*' is especially valuable as it encourages both motor skill and cognitive growth by allowing children to create their own play experiences. The strong need for social interaction points to the importance of designing for both individual and group play. **Safety** also plays a growing role **parental concerns** and stricter safety standards increasingly **restrict play freedom**. A well-designed product that meets safety requirements while preserving play value can increase parental trust and broaden usage.

Conclusion

Play is a multifaceted, yet vital activity for child development. Especially open-ended, social and imaginative types like ‘’loose parts play'' support motor skill growth. A product that allows for freedom, social interaction, challenge and safe exploration is most likely to engage and benefit children aged 3–6.

Based on these insights, several relevant design implications can be identified:

- Open-ended and imaginative play may contribute positively to motor skill development and sustained engagement.
- Support for both individual and group interaction could help reflect the social nature of play in early childhood.
- Safe and intuitive product features may increase accessibility and parental trust, particularly in diverse play settings.

Figure 10: The 5 Key domains of play + important principle (loose parts play)

5.3. The Role of Motor Skill Development in Ages 3–6

This section explores the sub question:

"What is the importance of motor skill development in children aged 3–6?"

To answer this question, interviews were conducted with two pediatric physiotherapists, two motor skill development experts and one motor skill development expert from Rijndam Rehabilitation. These insights were supported by informal interviews and direct observations of young children during play. The goal was to understand how motor development contributes to broader physical, emotional and social development in early childhood.

Findings

Motor skill development between the **ages of 3 and 6** is foundational for children's lifelong physical health and participation in social activities. According to interviewed experts, this period is when fundamental gross motor skills, such as running, balancing, jumping, throwing and catching are developed. These skills form the building blocks for fine motor skill development in later stages of childhood. A crucial insight from the expert interviews is that until around age 6–7, physical activity *drives* motor skill development. In other words, the more children move, the more their motor skills improve. After age 7, this relationship flips and motor competence begins to influence how physically active a child becomes. Children who lack motor skills are more likely to withdraw from physical activities, creating a negative spiral of inactivity and skill stagnation (Koolwijk & Krajenbrink, 2024).

Additional key findings include:

- **physical activity and skill development are mutually reinforcing**: Movement enhances motor skill acquisition, and better motor skills lead to more engagement in physical activities;
- **motor competence impacts emotional and social development**: Children who move with confidence are more likely to participate in group play, which fosters communication, collaboration, and resilience;
- **variation in movement is critical**: Diverse (*wide range of movements patterns; jumping, throwing, balancing and moving in different directions or environments*), playful movement, rather than repetitive or structured exercise, supports broader skill development (Wormhoudt et al., 2017; Krajenbrink, 2024);
- **play is primarily social, not competitive**: Observations confirm that at this age, children are more interested in playing together and having fun than in winning. Examples include a child sharing the last game piece just to continue playing, and others enthusiastically demonstrating new abilities with the phrase "*Look what I can do!";*
- **revalidation practices**: In rehabilitation settings such as pediatric physiotherapy and Rijndam, games are often created and used as part of the recovery process. A transition can be observed from play-oriented approaches in younger patients to more exercise-focused methods as individuals grow older. The focus for effective rehabilitation is not placed on which specific physical ability needs improvement, but rather on the sport for

which recovery is aimed. For example, in football, balance exercises are performed using a ball to maximize the effectiveness of the rehabilitation process (expert at Rijndam Rehabilitation).

Based on insights from pediatric physiotherapists, motor development experts and literature (e.g., Wormhoudt et al., 2017; Koolwijk & Krajenbrink, 2025), motor skills in early childhood can be categorized into four primary motor domains, each with its own subskills:

- **locomotive skills** – whole-body movements that involve transporting the body through space, such as *running*, *jumping*, *hopping* and *climbing*;
- **manipulative skills** – object control actions that involve control and coordination, such as *throwing*, *catching*, *striking*, *kicking* or *stacking*;
- **balance and stabilizing skills** – skills related to *maintaining posture*, *shifting weight*, *core control* and *reactive balance* during dynamic activities;
- **fine motor skills** – precise, small-scale movements of the hands and fingers, including *grasping*, *arranging objects*, *threading* or *handling small items*.

The domains will be used throughout the project to evaluate how play-based interactions support motor skill development. It serves as a consistent reference for analyzing movement potential across research findings, design decisions and user testing, enabling a structured interpretation of how different activities contribute to foundational motor competence.

Analysis

Motor development in early childhood significantly influences not only physical functioning but also confidence, autonomy and social integration. Children with stronger motor skills tend to engage more frequently and effectively in group play, which contributes to improved emotional wellbeing and cognitive development.

The emphasis on varied, non-competitive, and socially engaging movement activities highlights the need for a **play-based approach** that prioritizes:

- a wide range of **gross motor skills** (balance, object control, coordination, locomotion);
- opportunities for cooperation over competition;
- environments that allow for freedom of movement and expression;
- accessible activities for children with varying motor skill abilities.

These insights are essential for developing a product that supports healthy development while remaining engaging and inclusive for both individual and group use.

Conclusion

Motor skill development between the ages of 3 and 6 is a critical driver of children's physical, emotional, and social growth**.** In this phase, physical movement shapes ability, the more children move, the more competent and confident they become. To prevent withdrawal from physical activity later in life, this window must be used to build foundational skills through play.

To support this growth holistically, a play product should address all four primary motor domains:

- *locomotive* skills: enabling large, dynamic body movements;
- *manipulative* skills: encouraging control through object interaction;
- *balance and stabilizing* skills: challenging posture and coordination;
- *fine motor* skills: supporting precision and dexterity through small-scale tasks.

A successful product must therefore encourage varied, joyful, and socially engaging movement. It should prioritize gross motor experiences over structured tasks, enable cooperative over competitive play and remain accessible to a wide range of abilities. These principles will ensure the design supports meaningful development, both individually and within group dynamics.

Figure 11: Core principles of motor skill development 3-6

5.4. The Impact of Screen Time on Young Children

This section explores the sub question:

"What effect does screen time have on children aged 3–6?"

It will examine how screen time affects children aged 3–6 and what this means for their motor skill development. As young children in the Netherlands show declining motor skills, understanding the role of digital media use in this trend is crucial. The analysis draws on large-scale surveys (Nikken et al., 2023), recent cohort studies and interviews with pediatric physiotherapists.

Findings

On average, children under 6 spend about 100 minutes per day on screens; primarily tablets, phones and televisions. This displacement of real-world interaction has significant ripple effects. Language development suffers first: an Australian study found that each additional 1 minute of screen time at age 3 corresponds to 7 fewer spoken words from caregivers (Brushe et al., 2024). Observations and informal interviews confirm that when a device interrupts face-to-face engagement, even toddlers will call for attention when a caregiver is on the phone. When a kid is looking at a screen it is hard to reach him since he is speaking less overall and using fewer conversation, until the screen is turned off.

Social and emotional skills also take a hit. Infants exposed to high levels of screen media show delays in social reciprocity and problem-solving by age 2 and still lag behind in communication at age 4 (Takahashi et al., 2023). Moreover, toddlers with heavy screen use are more prone to hyperactivity, impulsivity, anxiety and social withdrawal (Heffler et al., 2024).

Meanwhile, the health consequences accumulate. Prolonged screen exposure disrupts sleep patterns, increases the risk of myopia, and contributes to **childhood obesity** through **reduced activity**. Pediatric physiotherapists have noted a **rise in neck** and **back complaints** among young screen users. Crucially, all this sitting around takes away important chances for young kids to move their bodies through running, jumping, balancing and climbing, which are key to building the foundation for lifelong coordination.

Analysis

These findings illustrate that screen time is far more than harmless entertainment: it actively undermines development at an age when movement is the engine of motor skill learning. Before about age 7, children's motor competence is propelled by physical activity; after that point, motor skill levels begin to dictate how much they choose to move. Excessive screen use therefore initiates a downward spiral, less movement leads to underdeveloped skills, which in its turn discourages further activity.

Experts stress two key strategies to reverse this cycle. First, co-viewing adults watching and discussing media alongside children can preserve some of the lost interaction and vocabulary exposure. Second, deliberate substitution of screen time with movement-based play ensures that children experience the varied, joyful physical challenges they need. By replacing even short digital sessions with simple balance games, obstacle courses or dance breaks, caregivers can help children reclaim those critical movement minutes.

Conclusion

Unrestricted screen time diminishes language, social-emotional growth, health and motor development in 3–6 year olds. Because movement drives motor skill learning during this stage, shared media experiences and purposeful replacement of screens with play are essential to support children's physical and social-emotional development.

Based on these insights, several relevant design implications can be identified:

- Screen-free interaction may be important to support motor skill development during early childhood.
- The product could offer an engaging physical alternative to passive screen time through varied, motivating movement tasks.
- Visible progress or feedback mechanisms without screens may help sustain attention and reduce reliance on digital media

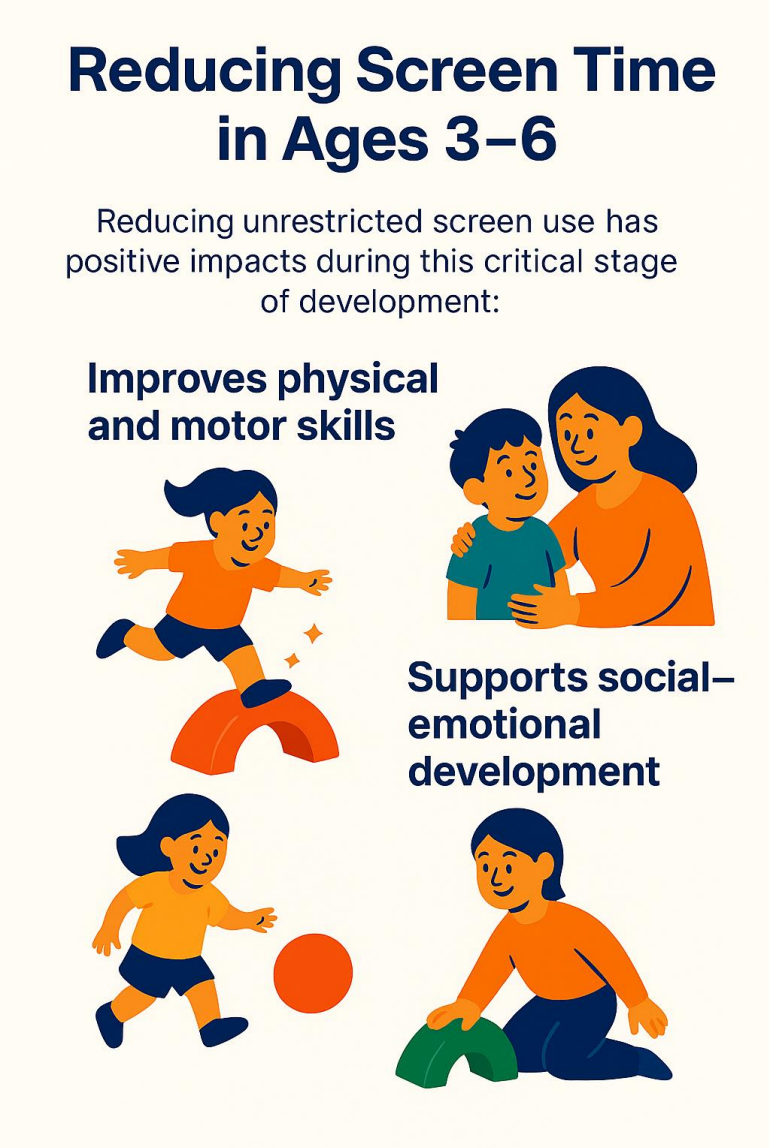


Figure 12: Effect of reducing screen time

5.5. Motor Skill Delays in Early Childhood

This section answers the sub question:

"Which motor skills often lag behind in children aged 3–6?"

Through interviews with two pediatric physiotherapists, one expert from Rijndam and a gym teacher, as well as informal observations, this investigation explores the areas of motor skill development where children most frequently experience delays. The aim is to identify which skills require targeted support, and how play-based products can accommodate developmental diversity and individual growth patterns.

Findings

Interviews with child physiotherapists reveal a consistent trend: young children increasingly struggle with both gross and fine motor skills due to reduced physical activity and prolonged screen exposure. Specific deficits include **low muscle tone**, **poor core stability** and **imbalanced coordination**, which manifests in everyday activities such as cycling, swimming and self-care.

- **Gross motor skills:**

  While pre-schoolers rapidly develop their large movements, many still struggle with **balance**, **strength** and **spatial awareness**. By age 5 or 6, most children can cycle without training wheels and stand on one leg for about 10 seconds. Yet tasks such as hopping, jumping sideways or landing in a controlled way remain difficult. Observations during physical play, like balancing on beams or jumping from heights, show that many children misjudge their abilities, leading to frequent instability.

- **Ball and movement coordination:**

  Skills such as throwing, catching and kicking evolve gradually. Most young children can catch large balls at close range but have difficulty with **smaller** or **fast-moving objects**. Games involving running, dodging or striking, like tag or soccer, reveal ongoing difficulties in **timing** and **coordination**, where repetition is crucial for mastery.

- **Fine motor skills:**

  Fine motor development becomes more visible during structured activities like drawing, cutting or building. Around age 4–5, children begin writing their names, threading beads and cutting basic shapes. However, many still exhibit unstable pencil grips, still color outside the lines and require help with zippers or buttons. Indicating delayed **precision** and **control**, which can lag behind without regular practice.

- **Movement variety:**

  Experts highlight a decrease in the **variety of movement** that children experience in everyday contexts. While total activity levels may vary, it is the lack of diversity that limits their motor repertoire. This has direct consequences for how children adapt to new movement tasks, develop motor planning and build confidence.

- **Contextual observations:**

  Across school environments including gym classes, classrooms and playgrounds, motor skill delays are visible. Children benefit from **step-by-step support**, **repetition**, and **guided practice** to build control and confidence.

In addition, physiotherapists and motor skill experts occasionally noted signs of Developmental Coordination Disorder (DCD), a neurodevelopmental condition that affects motor skill planning and execution. Although DCD has a genetic basis, its impact can be significantly reduced through early and targeted training. The high plasticity of the young brain allows children to develop compensatory strategies such as finding alternative ways to perform tasks, particularly when supported through playful repetition and movement variety. This emphasizes the importance of designing adaptive play environments that support a broad spectrum of motor skill abilities.

Analysis

The findings highlight a growing need for play-based solutions that accommodate a broad range of motor skill development profiles. Children aged 3 to 6 show variability in their ability to perform both gross and fine motor tasks, often influenced by environmental constraints, reduced physical activity and limited movement variety. These delays are not uniform but instead reflect a wide range of developmental readiness, making it essential to design with adaptability and inclusivity in mind.

Importantly, the development of **balance**, **coordination**, **ball skills**, **fine motor control** and **movement variety** emerges as a recurring concern across interviews and observations. These domains require repeated practice, playful engagement and an environment that invites challenge without discouragement. Structured gym lessons and therapy settings confirm that children benefit most from open-ended tools that allow self-paced exploration and gradual skill building.

The analysis also affirms that for supporting **movement variety** not just the quantity of movement is essential. Many children are not exposed to a diverse set of physical actions. This limits their motor skill planning, confidence, and overall coordination. Movement tools should therefore not be overly prescriptive, but instead modular and intuitive, encouraging experimentation and non-linear development paths.

Finally, the mention of Developmental Coordination Disorder (DCD) reinforces the importance of creating inclusive tools. While DCD cannot be prevented, its impact can be minimized through the right types of repetitive, playful movement experiences. This insight calls for a

product that not only supports children that are typically developing but also those who need alternative pathways to learn and grow.

Conclusion

Children between the ages of 3 and 6 frequently experience developmental delays across five key subdomains of motor skill development: balance, coordination, ball skills, fine motor control and movement variety (Figure 13: Movement goals). These delays are influenced by a combination of biological and environmental factors, including low muscle tone, core instability, limited access to outdoor play and reduced diversity in daily movement experiences.

Based on these insights, several clear design implications emerge:

- The product must support multiple subdomains of motor skill development in an integrated, rather than isolated, way.
- Interaction should be adaptive and scalable, allowing children to engage at their own level and progress through repeated use.
- The design should be modular, offering flexibility in use and arrangement to accommodate different abilities and learning environments.
- All components should support open-ended, inclusive play, promoting engagement without competition or judgment.
- The product must offer sufficient variation in motor skill challenges, encouraging movement diversity that supports the development of compensatory strategies, particularly for children with coordination difficulties such as Developmental Coordination Disorder (DCD).

By addressing these design requirements, the product has the potential to serve as a developmental tool that bridges physical, cognitive and emotional growth. It supports not only physical engagement, but also fosters self-confidence, creativity and resilience, laying the groundwork for inclusive and meaningful motor skill development in early childhood.

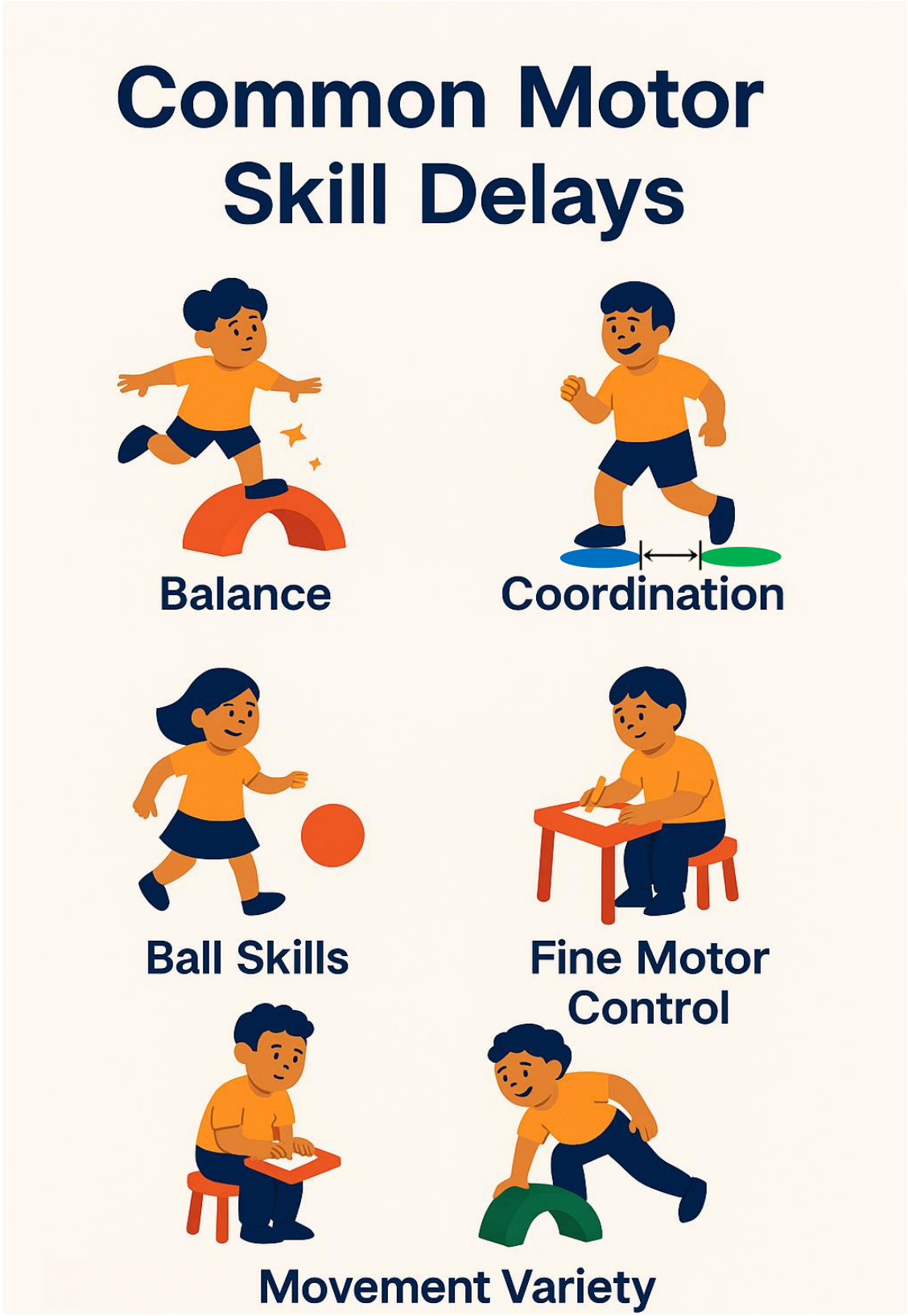


Figure 13: Movement goals

5.6. Key Drivers of Play and Physical Activity

This section answers the sub question:

"What encourages play and activity?"

To design an effective play-based product that supports the development of motor skills in children aged 3 to 6, it is crucial to understand what stimulates children to move and play in the first place. The motivation to engage in physical activity is not only driven by the object or game itself, but also by the social, physical and emotional environment surrounding the child. This section explores factors such as visual appeal (e.g. color), personalization, the influence of parents and peers, as well as the role of the environment and educational settings. These insights are essential to inform the design of a product that is both engaging and developmentally supportive.

Findings

1. Color as a Visual Trigger for Play

Young children are naturally drawn to **bright** and **contrasting colors**. Research shows that children aged 3–6 are particularly responsive to primary colors like *red, yellow, blue* and *green* (Xu et al., 2021). This preference starts to become more differentiated and less intense around age 6–7 (Zentner, 2001). These colors attract attention, spark curiosity and can even influence mood. Yellow is often associated with happiness, while blue has a calming effect. Observations during play sessions supported this: children consistently chose the brightest-colored objects, and games involving color prompts (e.g. "step on the red circle") saw higher participation rates**.**

Additionally, children are familiar with **high-saturation colors** through screen-based media (e.g. TV shows and apps), which means that colorful physical objects can compete for attention in a similar way. Color also provides intuitive cues; different colors on Stepping Stones or play mats, for example, can guide movement and stimulate coordination (Samimi & Tabatabaei, 2021). However, overly complex or patterned visuals can overwhelm younger users, so the use of contrasting, yet simple, color schemes is advised.

2. Personalization Increases Engagement and Ownership

Children are more motivated to participate in activities when those activities feel personal. Studies show that preschoolers learn more effectively and are more talkative when they engage with personalized storybooks (e.g. with their name or photo included) compared to generic versions (Kucirkova, Gattis, et al., 2020). In play, this concept translates into greater interest when children can choose their favorite colors, decorate objects, or see their name represented on a toy or in an app (Kucirkova et al., 2020).

From a developmental point of view, personalization enhances children's autonomy and sense of identity as core principles in Self-Determination Theory, which links autonomy and competence to **intrinsic motivation**. Observational data showed children became more excited and invested in play when allowed to make choices (e.g. selecting colored cones for an obstacle course or placing their own stickers). Personalized elements transform a task into "their" activity, fostering both motor skill repetition and emotional connection.

3. Parental Presence and Encouragement Are Critical

One of the strongest motivators for physical activity in children is **adult involvement**. Multiple studies (Ku et al., 2020; Zi et al., 2023) emphasize that parental support can account for 30–60% of the variance in physical activity levels, particularly in children with developmental challenges. Highly educated parents, especially mothers, also tend to have a stronger influence on their children's motor skill development (Zi et al., 2023).

Observations in gyms and playgrounds confirmed this influence. For example, when a teacher or adult stood near the ping pong table, the area was bustling with activity. Once the adult left, children quickly lost interest. Similar effects were seen with basketball, where children gathered **when an adult joined** or **encouraged play**. Children frequently looked toward adults for validation or approval, and they eagerly demonstrated skills ("*Look what I can do!*"). These behaviors underline the importance of designing a product that facilitates or invites adult participation even in small ways to sustain motivation.

At the same time, **overprotective parenting** has physically restricted the range in which children can move. In the past, children were often allowed to roam up to 2 kilometers from home; today, their average range is closer to 100 meters (Sutapa et al., 2021). This significant decrease in freedom of movement limits opportunities for spontaneous outdoor activity. Products that are safe, intuitive and easy to use in or around the home, and that encourage cooperative play, can help counteract this restriction.

In addition, interviews with parents and specialists such as Koolwijk revealed that some parents struggle to know how to support their child's motor skill development. This **lack of knowledge** or **confidence** can lead to missed opportunities for guided movement experiences, especially during critical developmental windows. As a result, play-based tools that offer simple entry points and clear interaction cues can serve as valuable support, not only for the child but also for caregivers who wish to be more actively involved.

4. The Role of Peers and Social Environment

Children are more inclined to play when other children are present. The social component watching others play, joining group activities or simply being in a **playful environment increases the likelihood of participation** (Sutapa et al., 2021). Observations revealed that when one child began using a piece of play equipment, others quickly joined. Peer presence acts as a strong *"social trigger"* that normalizes activity and creates a sense of belonging.

This also aligns with research showing that goal-oriented social environments lead to stronger motor skill outcomes (Vrieswijk et al., 2021). When play involves teamwork, turn-taking or simple imitation, children repeat motor skill actions more often and in more varied ways, which helps build both gross and fine motor skill control.

5. *The Broader Environment Shapes Opportunities*

The physical environment significantly affects motor skill development. According to Koolwijk and Vrieswijk et al. (2021), children living in rural or well-designed urban neighborhoods (with accessible, nearby play areas) show stronger motor skills than peers in less play-friendly environments. In contrast, children in high-density areas, where playgrounds are further than 100 meters away, tend to be less active and show delayed development.

Interestingly, socio-economic status (SES) does not directly determine motor skill development, but it influences access to sports clubs, safe outdoor spaces and equipment (Ku et al., 2020). This means that even in lower-SES contexts, high-quality play environments can significantly boost outcomes. The design of a product should therefore account for **flexibility** and **ease-of-use** across different physical and economic contexts both **indoors** and **outdoors**, at school and at home.

6. *Schools as Equalizers in Motor Skill Development*

Schools offer structured opportunities for children to engage in physical activity and play. Aadland et al. (2017) found that **structured physical education** can improve both academic outcomes and motor skill competence. Additionally, schools play a crucial role in identifying motor skill development issues early on. Research by Remmers et al. (2024) revealed that during school days, roughly half of all moderate-to-vigorous physical activity occurred in school settings. In the aftermath of COVID-19**,** group 1 and 2 children were notably less physically competent than cohorts before the pandemic (Vrieswijk et al., 2021), underlining the need for consistent motor skill development opportunities in early education.

Discussion

The findings clearly indicate that motivation for play arises from a mix of **internal** (identity, preference) and **external** (social, environmental) factors. Visually stimulating features such as color are necessary to attract attention, but must be complemented by personalization options to retain interest. Social presence, particularly of parents, teachers or peers, elevates participation and increases the depth of motor skill engagement. A successful product must accommodate these different layers of motivation.

The role of the **environment** is also essential. If a product can be used both indoors and outdoors, and is adaptable to different group sizes and developmental levels, it becomes accessible to a wider range of users and settings, including urban families with limited space or educators managing diverse classrooms. By encouraging co-play and providing options for customization, the product can foster sustained motor skill engagement and repeated practice, which is key for skill acquisition.

Conclusion

Motivating children aged 3 to 6 to engage in physical play depends on a combination of visual, social, and environmental factors. A product alone is not enough it must respond to how children are drawn into, guided through and sustained in movement-rich experiences. These insights point toward a design that is both stimulating and accessible, enabling joyful, repeated and developmentally meaningful play.

To effectively encourage physical activity and motor skill development in children aged 3–6, the play product should:

- use bright, high-contrast color schemes that align with children's visual preferences;
- offer personalization options to increase ownership and emotional investment;
- be designed to invite adult and peer participation through intuitive co-play features;
- be flexible and safe for use in various environments; homes, classrooms and outdoor spaces;
- include elements that support repeated movement and motor skill planning, such as modular setups or evolving challenges.

In short (Figure 14: Summary of Key Drivers): combining visual appeal, social dynamics and environmental adaptability will result in a product that motivates children to move, explore and develop their motor skills consistently and joyfully.

Figure 14: Summary of Key Drivers

5.7. The Value of Social Play in Child Development

This section answers the sub question:

"What is the importance of playing together?"

To design an effective product that supports motor skill development in children aged 3–6, it is crucial to understand how **playing together** influences their growth. Although section *5.6.3 Parental Presence and Encouragement Are Critica*l & *5.6.4 The Role of Peers and Social Environment* also highlight the importance of playing together, this section will focus on social interaction of the children playing together. During early childhood, play is one of the primary ways children develop physically, socially and emotionally. This section explores the role of group play in stimulating motor skill development, based on interviews with researchers and child experts, informal conversations with parents and children and field observations in playgrounds and schools.

Findings

1. Group Play Encourages Physical Challenge

When children play with others, they are more likely to challenge themselves physically. Observations showed that children were more inclined to try new actions, such as climbing, jumping or balancing, when other children were around. A researcher specializing in motor skill development explained that social play introduces natural imitation and competition, prompting children to explore beyond their comfort zone. One expert noted, *"Children lift each other to a new level when they play together"*.

2. Social Presence Increases Motivation to Go Outside

Both parents and experts reported that children are more motivated to go outside and stay active when other children are present. Parents of only childs often mentioned that if no one else was outside, their child would quickly return indoors. Social interaction acts as a key motivator for physical activity. This means that a lack of peers nearby can become a barrier to movement and play.

3. Collaborative Play Builds Emotional and Social Skills

Playing together not only enhances physical abilities but also develops emotional resilience, communication and teamwork. Cooperative play helps children learn to take turns, handle frustration and resolve conflicts. Importantly, children with better motor skills are more likely to participate in group activities, which further strengthens their social inclusion, self-confidence and perseverance.

4. Gender Differences in Play Preferences

Interviews and observations suggest that boys often engage more in solo or unstructured physical activity, while girls tend to prefer shared and cooperative play. While this is a generalization, it highlights the importance of offering both independent and group play options to support the motor skill development of diverse users.

5. *Parental Presence Boosts Engagement*

Children are more likely to engage in physical play when a parent or adult is nearby. Observations showed that when adults participated or simply watched, children became more enthusiastic and persistent. Parents serve as role models; many children were seen repeatedly looking at their parents for approval or attention during active play. As one parent quoted: *"If I sit on the bench, my child wants to show off every move"*. This mirrors previous research (Chapter 5.6 3. Parental Presence and Encouragement Are Critical) that underscores the value of parental involvement in supporting motor activity.

Analysis

These findings confirm that **social play** is a strong driver of motor skill development. Children challenge themselves more when they are in the company of others, making group play an essential ingredient for enhancing physical activity and skill acquisition. In addition, social play boosts motivation, particularly in outdoor settings, and supports the development of key social-emotional skills that go hand-in-hand with physical competence.

For a product aimed at supporting motor skills, this means the design should not only encourage individual movement but actively promote **interaction**, **collaboration** and **peer involvement**. The product must be flexible, usable by one child, but equally stimulating and fun when used by a group. It should offer features that encourage cooperation, turn-taking, or shared goals (e.g., team challenges, interactive components that require multiple users).

Additionally, the design should consider ways to include or involve parents and caregivers, whether through guidance, co-play or simple observation. Adults are a strong influence in motivating young children to stay active.

Conclusion

Playing with others plays a vital role in motor skill development during early childhood. It encourages children to try new movements, moivates them to engage in physical activity and helps them develop important social and emotional skills. Motor-competent children are more likely to take part in group activities, which reinforces their development and inclusion.

Design Implications:

- the product must support both solo and group interaction to accommodate different play preferences;
- features that foster teamwork, imitation and shared goals can increase physical engagement;
- inclusion of parents either through play or presence can strengthen the product's impact;
- gender-based differences suggest the importance of offering multiple modes of play, both cooperative and free-form.

Figure 15: Summary of Key Drivers

5.8. Gender Differences in Play and Motor Skills

This section answers the sub question:

"Are there differences in play preferences and motor skill between boys and girls?"

In the context of designing a product to support motor skill development for children aged 3–6, it is crucial to understand how **gender influences play preferences and behavior**. Although children of this age share many developmental traits, such as curiosity, imagination and a natural drive to move, there are also notable differences between boys and girls in terms of motor skills, play style and social dynamics. These differences are shaped by a combination of biological factors, social influences and cultural expectations. Understanding these patterns helps ensure that the final product is inclusive, balanced and supports **both genders equally** in their motor development journey.

Findings

1. Shared Interests Across Genders

Children between the ages of 3 and 6 (regardless of gender) enjoy **exploration, imaginative play and physical activity**. Both boys and girls are enthusiastic about role-playing games like "shop" or "doctor", enjoy building with blocks, creating with clay and playing outside. Activities such as running, climbing and interacting socially are common across genders and essential for motor skill development (observations and expert interviews).

2. Differences in Motor Skill Strengths

There are specific trends in how boys and girls develop motor skills:

- **boys** generally show more advanced **object control skills**, such as throwing, catching and kicking;
- **girls** tend to excel in **locomotor skills** like hopping, balancing and walking (Pluimers, 2020).

While both sets of skills are essential, this distinction suggests that boys may be more drawn to structured, sports-like play, while girls may gravitate toward activities involving movement flow and rhythm.

3. Play Preferences and Social Dynamics

Differences in play preferences were observed and supported by observations and interviews:

- **boys** often prefer **solo or physically active competitive play**, like chasing games, building structures or mock battles;
- **girls** are more inclined toward **cooperative and imaginative play**, often in smaller groups, with verbal interaction and role-playing at the center.

Girls also tend to remain in a single play scenario for longer periods, while boys often switch between different activities more frequently. These are general trends many children deviate from them, but they are useful in shaping inclusive designs.

4. Disparity in Outdoor Play Participation

One of the most striking differences lies in outdoor play participation. According to Pluimers (2020), **54% of the boys regularly plays outdoors**, compared to only **7% of the girls**. Though this research is for a broader age group, field observations confirmed a striking absence of girls on playgrounds.

This lower participation may be linked to:

- lack of features that appeal to girls (e.g., dance areas, interactive benches, social zones);
- dominance of stereotypically "male" elements in playgrounds (e.g., football fields, climbing towers);
- greater sensitivity among girls to being observed or judged, leading to a preference for **safe, social and creative** play environments. There is highlighted attendance on girls only activity's organized by Delft voor Elkaar.

5. The Role of Socialization, Parenting and Culture

Gender differences are not purely biological, they are also reinforced by environmental influences:

- **toy availability**: boys are often offered construction toys, vehicles and action figures. Girls receive dolls, care-related toys or dress-up kits. Children typically choose from what's available, which shapes their interests and skills;
- **adult expectations**: [hysical, active behavior is more accepted (even encouraged) in boys, while caring and social behavior is more supported in girls;
- **media portrayal**: TV shows, books, and advertising often present gender-stereotyped models: boys as bold and technical, girls as sweet and nurturing;
- **peer pressure**: from the age of 4–5, children become aware of what is considered "appropriate" behavior for their gender and may avoid certain play to fit in.

These influences shape children's self-image, confidence and willingness to engage in certain types of play or motor activity (Endendijk et al., 2024).

Analysis

The observed gender differences underscore the need for designing products that are inclusive, flexible and neutral in their messaging and appearance. If a product aligns too closely with traditionally male-coded play styles, such as competition or physical dominance, it risks alienating girls, who may prefer more social or creative approaches.

This is particularly critical because girls participate less in outdoor play, not due to lack of interest, but because current environments and toys often don't reflect their needs. Creating a play experience that feels open, imaginative, and socially inviting can help bridge that gap.

At the same time, it's important not to reinforce stereotypes. Providing varied types of play, such as physical, social, cooperative, competitive, and creative modes allows children to participate according to their own preferences and strengths, rather than being limited by gender norms or stereotypes. A gender-neutral design that avoids cliché color schemes or symbolic markers (e.g., pink for girls, blue for boys) can further support this goal.

Conclusion

Yes, there are notable differences in how boys and girls between the ages of 3–6 play and develop motor skills. Boys are generally more physically competitive and solo-oriented; girls often prefer social and imaginative play. However, these are average trends, and individual preferences vary widely. Social factors like parenting, media and peer pressure strongly influence these differences.

Design Implications:

- the product should include both active and imaginative elements;
- it must be gender-neutral in design, avoiding color and role-based stereotypes;
- it should support different play styles, from solo exploration to social collaboration;
- the product should offer creative, expressive elements (e.g., music, storytelling, cooperative movement) to appeal to broader user groups and increase participation among girls;
- parental education or awareness could be embedded subtly into the product's use or communication to help reduce unconscious bias and encourage a wider range of play.

By acknowledging differences without reinforcing them, the product can truly support the motor skill development of all children (regardless of gender).

Gender Differences in Play and Motor Skills

Shared Interests Across Genders

Both boys and girls enjoy imaginative play and physical activity.

Differences in Motor Skills

Boys often excel in throwing and kicking, while girls tend to excel in hopping and balancing.

Play Preferences and Social Dynamics

Boys often prefer more competitive play, while girls often prefer more cooperative play.

Disparity in Outdoor Play Participation

Fewer girls than boys regularly play outdoors, highlighting a need for more inclusive spaces

Influence of Socialization and Culture

Toys, adult expectations, and media contribute to differences in play behavior

Figure 16: Gender Differences in play and motor skill

5.9. Conclusion

Between the ages of 3 and 6, children's motor skill, cognitive and emotional development is strongly influenced by their daily movement experiences. This development is shaped by a range of interrelated factors, including the availability of diverse play opportunities, the presence and involvement of caregivers, and broader lifestyle trends such as screen exposure and limited access to outdoor environments.

Unstructured or loose parts play appears especially valuable, as it allows children to engage freely with their surroundings, explore their physical abilities and create imaginative scenarios that support motor skill development. These open-ended forms of play stimulate locomotion, coordination and balance, while also fostering creativity and problem-solving. Nevertheless, children increasingly show developmental delays in core strength, object control, balance, movement variety and fine motor precision, often linked to inactive daily habits and reduced physical autonomy.

Parental presence significantly affects children's motivation and engagement. When adults are present to observe, guide or participate, children are more likely to initiate and sustain physical activity. At the same time, protective behavior and passive digital consumption can limit spontaneous movement and reduce critical opportunities for motor learning.

To support healthy and inclusive development, the design must account for these dynamics. A well-considered play product should actively support the development of primary motor domains including locomotion, object interaction, postural stability and fine manipulation. It should promote varied movement, invite social interaction and offer autonomy in a safe and stimulating setting that encourages both individual and shared exploration.

6. Summary of Key Insights and Design Vision

6.1. Designing for Motor Development Through Play

This research was guided by the central question:

"How can a product support children aged 3–6 in developing their motor skills through play, in both individual and group settings?"

The findings drawn from an extensive literature review, expert interviews, contextual observations and market analysis indicate that a product can meaningfully support motor skill development when it integrates movement into engaging, developmentally appropriate play experiences. To be effective, such a product must not only stimulate physical activity, but also respond to the cognitive, emotional and social needs of young children.

The research underscores that children aged 3 to 6 develop best in environments that are:

- **playful and open-ended**, encouraging exploration and creativity;
- **physically diverse**, providing a wide range of movement opportunities to build gross and fine motor skill competence;
- **socially interactive**, promoting collaboration, imitation and co-play with peers and adults;
- **non-competitive and inclusive**, ensuring all children feel safe, motivated and capable of participating, regardless of skill level;
- **flexible and contextually adaptable**, usable across a variety of settings, from homes and schools to therapeutic environments supporting both individual and group engagement;
- **screen-free and sensory-based,** encouraging physical interaction and reducing reliance on screens;
- **gender-neutral,** avoiding stereotypical cues and enabling universal access through open-ended movement-based play.

Furthermore, the study highlights that adult involvement, both as role models and co-players, significantly enhances children's motivation and engagement in physical activity. Simultaneously, growing concerns over excessive screen time, urban limitations and restricted play opportunities emphasize the need for a product that actively encourages movement and social interaction in everyday environments.

Five key subdomains of motor development have emerged as central to developmental delay in this age group: balance, coordination, ball skills, fine motor control and movement variety. These domains will form the foundation of the upcoming design phase. While all five are important, the emphasis will be placed on gross motor skills, as they are most responsive to development in the 3–6 age range. Fine motor skills, which typically evolve more fully in later years, will be supported indirectly through interactive elements and grasp-based play.

Conclusion

This research provides a grounded direction for the design phase. The product should be modular, screen free and gender neutral, supporting motor development in children aged 3 to 6 through varied, joyful, imaginative, socially and physically engaging forms of play.

It is important that the design addresses key motor skill domains such as locomotion, object control, balance and stabilizing and fine motor function by including activities that stimulate underlying abilities like coordination, ball control and movement variety. The product should be suitable for both individual and group use across different settings, including the home, school and therapeutic environments, while offering flexibility through scalable challenges and open-ended interaction.

Adult involvement positively influences children's engagement. As such, the product will support shared experiences with caregivers without requiring constant facilitation.

It should support both structured and unstructured movement, foster social connection and provide developmentally meaningful challenges that grow with the child. By using movement as a driver for growth, the design will lay the groundwork for a healthier, more active and socially confident future.

6.2. From Research Insights to Design Vision

The preceding research has provided a comprehensive understanding of the developmental needs, behavioral patterns and environmental factors that influence motor skill development in children aged 3-6. Through literature analysis, field observations, stakeholder interviews and market benchmarking, it became clear that young children benefit most from play that is active, imaginative, social and self-directed, yet supported by structure, adult involvement and adaptability.

From these insights, five core design principles were identified. They summarize the essential conditions under which a product can effectively foster motor skill development through play:

Figure 17: Summary of the Key Desing Principles

Together, these five principles (Figure 17: Summary of Key Desing Principles) provide a robust framework for the design vision that follows, ensuring the product is not only developmentally grounded but also joyful, adaptable and inclusive in every aspect of its use.

6.2. Design Vision

As a designer, the aim is to develop a modular, inclusive and movement-rich play system that supports motor skill development in children aged 3 to 6. The focus is on facilitating physical growth through structured yet open-ended play. The design responds to common challenges in early childhood, such as limited movement opportunities, increased screen time and reduced outdoor activity. It offers child-led experiences that promote exploration, collaboration and physical engagement, entirely screen free and rooted in real-world interaction.

Based on insights from interviews, observations, literature and context analysis, the product targets five key developmental subdomains: *balance, coordination, ball skills, fine motor control* and *movement variety*. These areas reflect the most frequently observed delays in this age group and inform the design approach.

While all five domains are addressed, the emphasis will lie primarily on gross motor skills, which show the most variability and need in the 3-6 age group. Fine motor skills, although relevant, typically develop more significantly after this stage and will be supported in a secondary, incidental way through object interaction rather than as a primary goal.

The play system should be intuitive, adaptable and portable, suitable for both indoor and outdoor use. It will encourage repeated engagement through non-linear, imaginative and self-directed play. The design will use a gender-neutral approach, avoiding stereotypical color choices or themes, and will focus on the developmental subdomains and creative exploration.

Caregivers also play a key role. Parents and educators are not only users but also facilitators and decision-makers. Their involvement is essential to creating meaningful and shared experiences. The product will support adult-child interaction without dominating it, offering playful inspiration rather than rigid instruction.

Ultimately, the vision is to empower children to embrace movement as a source of joy, confidence and growth. It lays the foundation for a lifelong connection to physical well-being and a positive relationship with their bodies, while remaining accessible, inclusive and free from digital distractions.

Design Vision

To create a modular play system to supports motor skills in children aged 3-6, fostering physical and social growth

Address Today's Challenges

- Respond to issues like increased screen time and limited outdoor play opportunites

Promote Fun, Non-CompetititiveActivity

- Enable children to develop motor skills in a stress-free way

Foster Deeper Connection

- Involve parents and encourage inclusive, social collaboration

Movement Goals





Balance | Coordination | Ball Skills | Fine Motor Control | Movement Variety

Figure 18: Summary of the Design Vision

7. Design process

7.1. Design methods

Brainstorming

To generate a wide range of ideas, the brainstorming process will follow a custom product-based approach, inspired by SCAMPER but adapted into a personalized design tool that aligns with the way I work best. This method involves taking an existing product and brainstorming how it could be applied to address my specific design challenge. Techniques such as How-Tos (Hoe Kan Je (HKJ's)) will support rapid idea generation, while morphological cards will be used to explore unexpected combinations and stimulate creativity. These methods have consistently proven to be effective and intuitive for me, helping to unlock original ideas in a structured yet flexible way. Insights from interviews will also feed directly into the ideation process, as they provide real-world context, user needs and expert perspectives that help generate relevant and meaningful ideas.

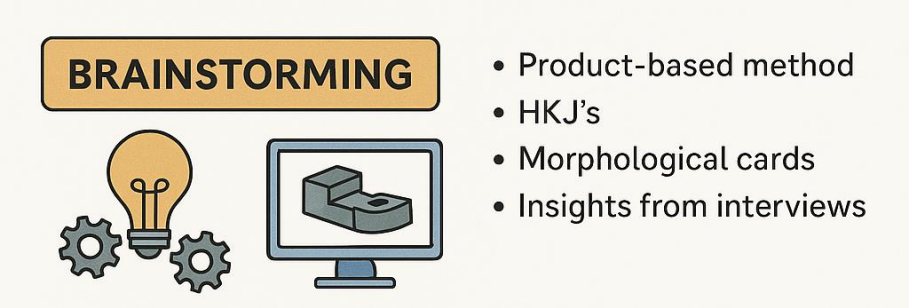


Figure 19: Brainstorming

Visualization

To bring ideas and concepts to life, they will be visualized through a combination of 3D CAD modeling, prototyping and sketching. These methods are used to clearly communicate design ideas to stakeholders and test users, while also enabling iterative development and early evaluation of form, function and user interaction. This approach ensures that ideas become tangible and understandable at every stage of the design process.

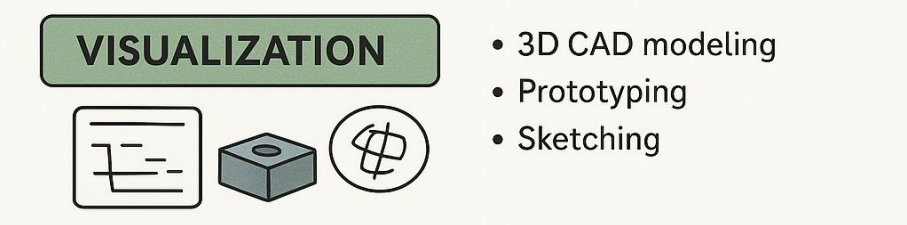


Figure 20: Visualization

Co-Design Sessions

To gain a better understanding of children's needs and preferences, co-design sessions will be conducted. These sessions will prioritize playful and engaging formats tailored specifically to young children. Data will primarily be collected through observation and informal interviews, with a focus on body language, facial expressions, verbal responses and decision-making processes. Open-ended questions will be used to encourage creativity and reveal authentic insights. Interviews with experts and prior experience with co-design sessions have provided valuable guidance on how to plan and facilitate these sessions effectively. This knowledge has shaped the approach within this project, ensuring that the sessions are both enjoyable and appropriate for the developmental needs of the children (see Appendix D: Doing Co-Sessions with Children).

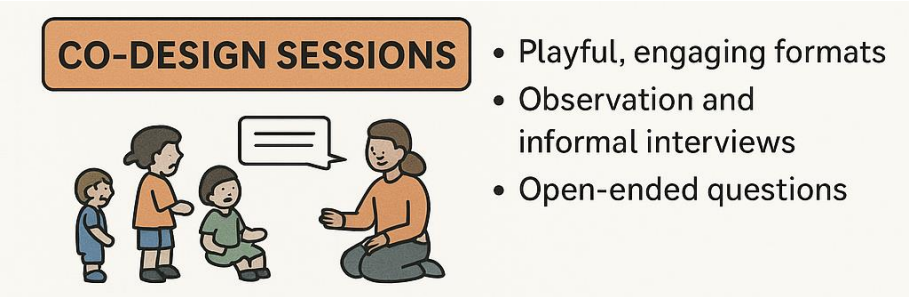


Figure 21: Co-Design Sessions

User Testing

User testing will mirror the approach in co-design sessions, relying on observations and informal interviews to identify user preferences, frustrations and areas for improvement. Sessions will be short and interactive to maintain engagement, particularly with younger participants. Attention will be given to non-verbal cues as well as verbal feedback. This approach was chosen to ensure that the test setting feels natural and intuitive for children, allowing their genuine reactions and behaviors to surface without the pressure of formal questioning.

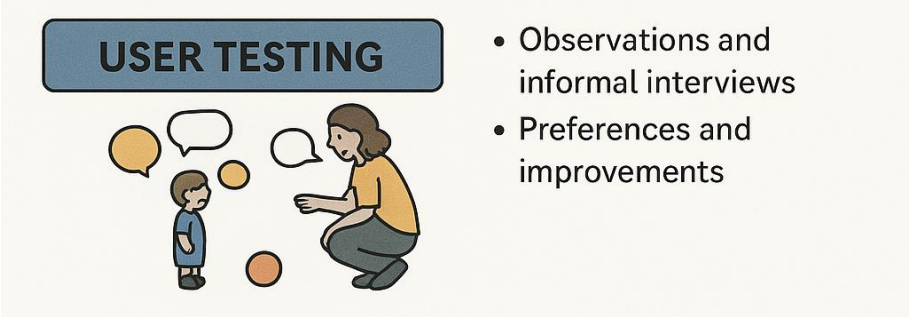


Figure 22: User Testing

7.2. Program of Requirements (PoR)

Requirements *(Ranked by priority – must-have features to ensure product safety, core functionality and developmental impact)*

1. **Promote motor skill development**
   The product must stimulate motor development by addressing delays in balance, coordination, ball control, fine motor skills and movement variety through varied and engaging physical activities.

2. **Screen free**
   The product must be entirely screen free, encouraging real-world physical interaction without the use of digital displays or devices.

3. **Safety**
   The product must be safe for daily use by children aged 3–6 and comply with all relevant safety standards and certifications.

4. **Age-Appropriate Design**
   All dimensions, forms and materials must be suitable for the motor skills and cognitive abilities of children aged 3–6, based on ergonomic and developmental principles.

5. **Parental Involvement**
   The design must enable and encourage shared play between children and caregivers, promoting motivation and bonding.

6. **Long-Term Engagement**
   The product must provide variation and evolving play possibilities that hold children's attention over time and encourage repeated use.

7. **Multi-Use Functionality**
   The product must support both individual and group play, promoting motor skill development in both self-directed and collaborative settings.

8. **Inclusivity and Gender Neutrality**
   The product must be universally appealing and accessible, avoiding stereotypical features and supporting equal play opportunities for all children.

9. **Durability and Outdoor Suitability**
   The product must be made of robust, weather-resistant materials and maintain functionality over a minimum of two years of frequent use indoors and outdoors.

10. **Adaptability to Various Environments**
    The product must perform reliably across different physical environments such as classrooms, playgrounds and homes.

11. **Flexibility and Portability**
    The product must be easy to move, store or reconfigure, making it usable across multiple settings and contexts.

12. **Ease of Cleaning**
    Surfaces and materials must allow for hygienic cleaning by wiping or washing without loss of performance or material integrity.

Movement focused wishes *(Ranked by priority – features that enhance developmental value, usability and product appeal)*

1. **Stimulating Motor Variation**
   The design should invite diverse gross motor skill activities such as crawling, balancing, jumping, rotating and reaching, encouraging full-body engagement.
2. **Imaginative Role Play**
   The product should support the creation of personal narratives or scenarios, fostering imagination, story-building and self-expression.
3. **Developmental Versatility**
   The product should be usable across developmental stages, offering appropriate levels of challenge and engagement as the child grows.
4. **Promotion of Social-Emotional Learning**
   The design should provide opportunities for children to develop skills such as empathy, cooperation and communication through play.
5. **Collaborative Play Emphasis**
   The product should support shared experiences such as turn-taking, teamwork and collective goal setting, independent of winning or losing.
6. **Role Model Involvement**
   The design should allow familiar figures (parents, siblings, teachers) to actively engage, serving as positive role models during play.
7. **Support for Loose Parts Play**
   The product should enable reconfiguration, combining or arranging elements in different ways to stimulate creative exploration.
8. **Visual and Tactile Appeal**
   Colors, textures and shapes should be used to attract attention, support intuitive use and enhance sensory engagement.

Product focused wishes *(Ranked by priority – features that enhance developmental value, usability and product appeal)*

9. **Space-Efficient Storage**
   The product should be compact or easily stackable for convenient storage in limited-space environments.
10. **Affordable Production and Accessibility**
    The product should be designed with materials and methods that ensure affordability and commercial feasibility while maintaining core values.

7.3. Idea Generation

To develop a wide range of potential solutions for movement-based play, the ideation phase focused on generating a large volume and wide variety of ideas. Rather than beginning with a fixed outcome, the goal was to diverge broadly, to explore as many directions as possible through intuitive thinking, physical exploration and structured tools.

A key design intention from the start was to develop a screen-free product. In an age where digital play is increasingly dominant, this project deliberately chose to create an alternative: **a physical, tangible and unplugged play experience** that would engage the whole body and stimulate real-world interaction. This constraint helped sharpen the focus of ideation and ensured that all ideas emphasized **movement, touch and imagination**, rather than passive digital feedback.

To support this, a range of creative methods was used to stimulate and guide the ideation process:

1. HKJ Method

A rapid ideation exercise in which numerous ideas are sketched within a limited time frame. This method emphasizes speed and quantity over detail, helping to bypass perfectionism and stimulate early-stage exploration.

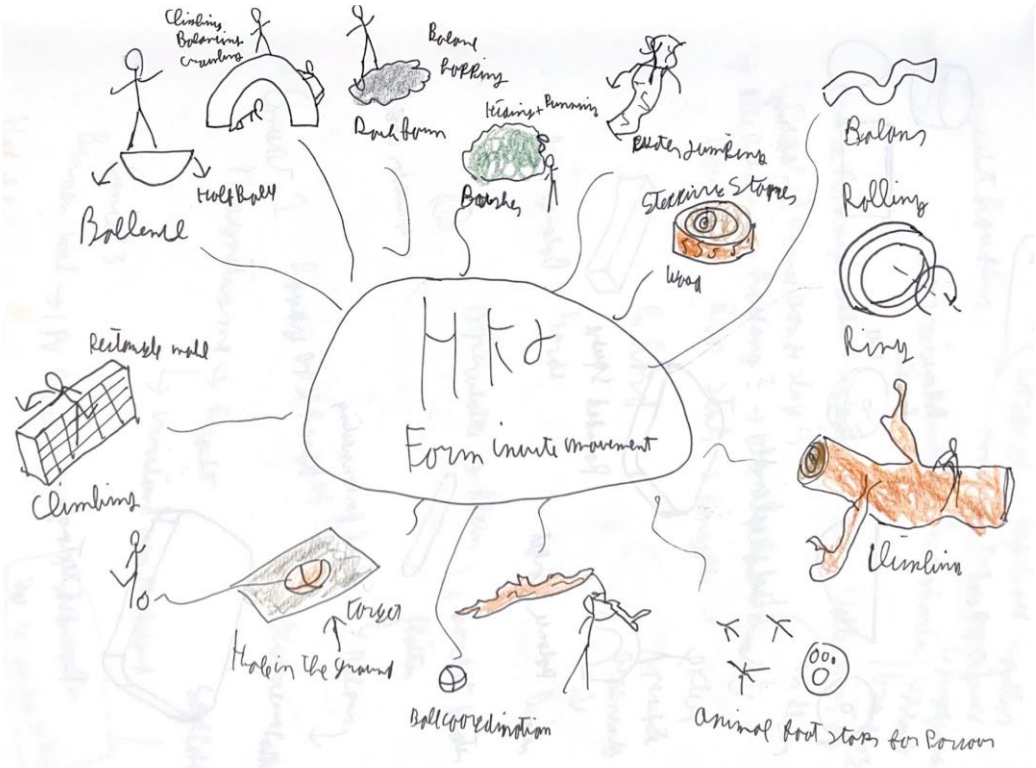


Figure 23: HKJ

2. *Product-Based Ideation*

Existing products were used as a starting point to rethink function, form or context. By deconstructing familiar objects and reimagining their use, new and unexpected play opportunities were uncovered to spark fresh solutions.

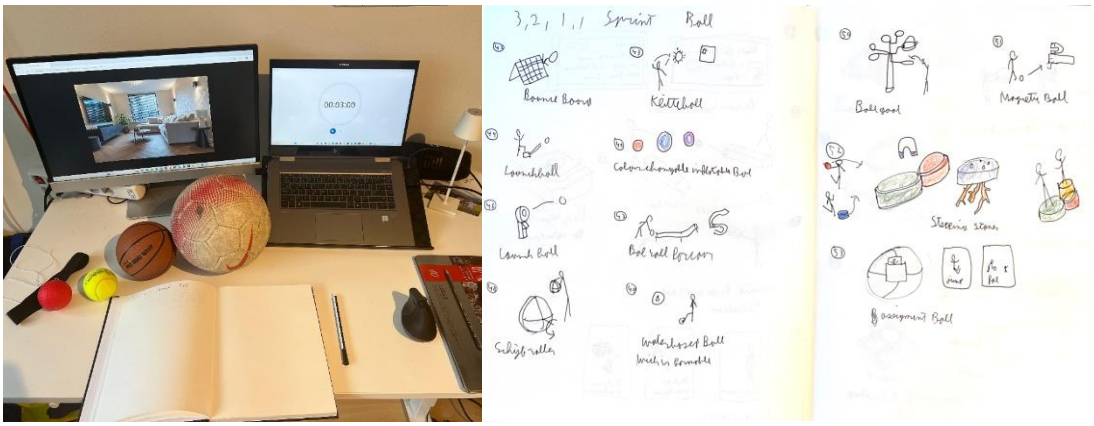


Figure 24: Product-Based Ideation

3. *Morphological Chart*

This tool was used to break down various motor skills, such as balance, coordination, strength and agility into their core components. By combining these with different material interactions and play forms, the chart enabled a structured exploration of how movement could be encouraged in diverse and creative ways.

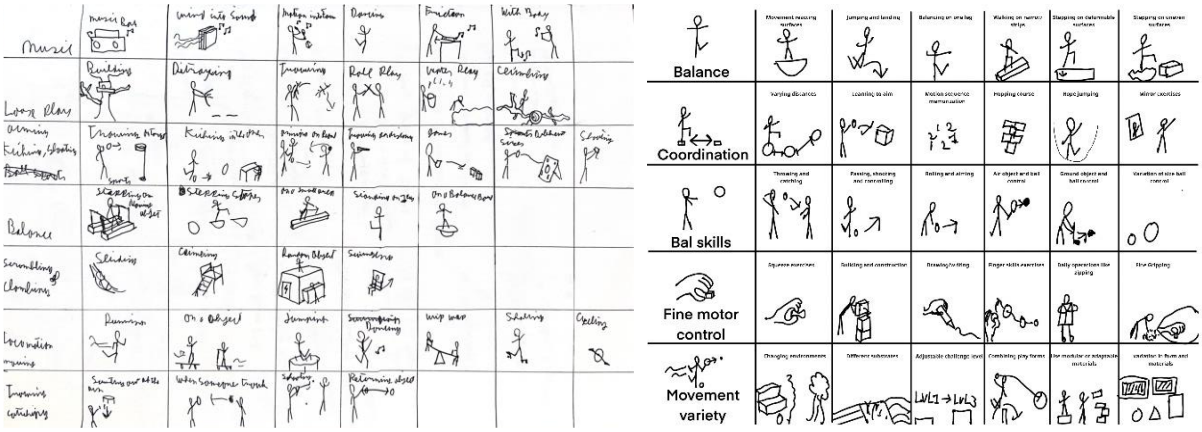


Figure 25: Morphological Chart

4. *Designing Through Prototyping*

Physical and sketch-based prototypes were used not only to test, but also to generate ideas. This hands-on approach enabled direct engagement with material properties and spatial relationships, leading to insights that would not have emerged from sketching alone.

Figure 26: Designing Through Prototyping

5. *Interview and observational -driven Ideation*

Insights and quotes from interviews and observations inspired targeted solutions that addressed specific needs, frustrations and motivations of the users.

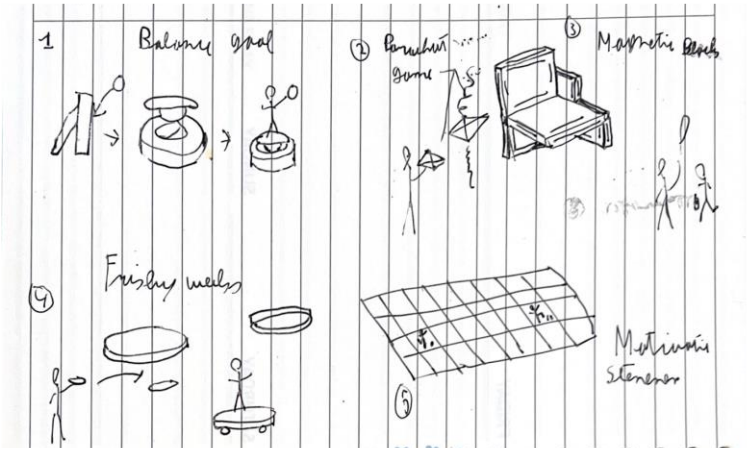


Figure 27: Example of an observation notes sheet, about children who enjoyed throwing things and chasing after them together to catch them.

Figure 28: Sketch based on quote/activity with child: "Let's play the color game, whoever gets there first, wins!"

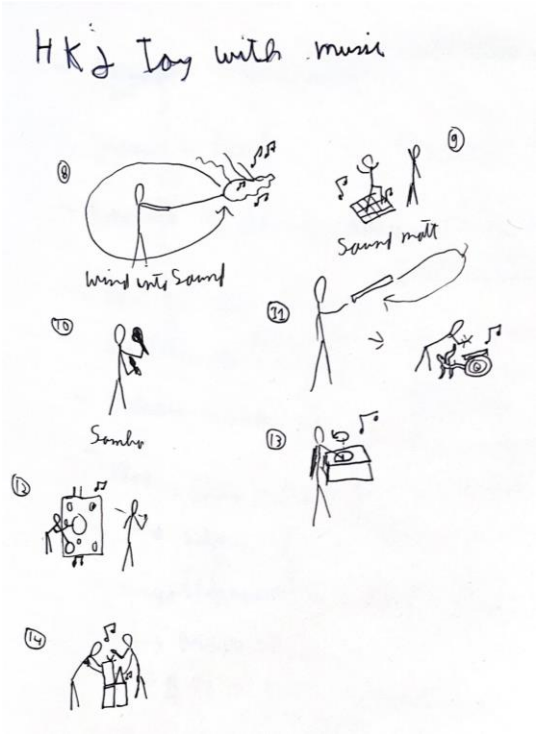


Figure 29: Ideation based on quote expert: "Girls like to dance on music"

6. Co ideate session

A collaborative session was conducted with a designer outside the fields of child development and motor skill learning. After presenting the design vision and problem framing, ideas were jointly developed and discussed. This external viewpoint brought fresh perspectives and challenged discipline-specific assumptions.

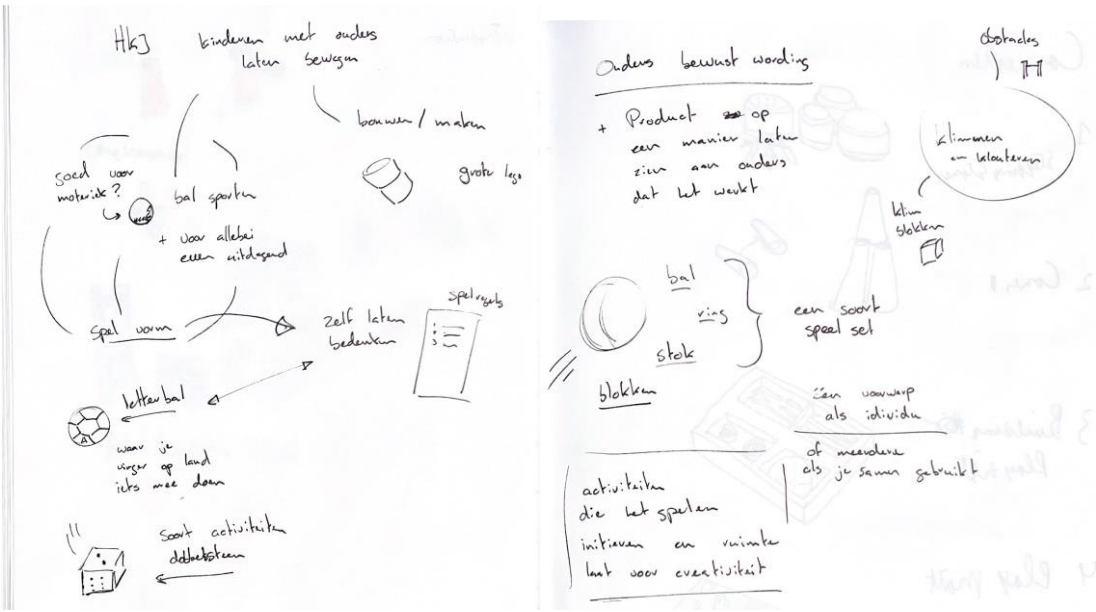


Figure 30: Brainstorm idea directions co-ideation session

Conclusion

The ideation phase resulted in a wide and varied set of concepts, shaped by diverse methods but unified by a shared goal: to create a **screen-free, movement-rich play experience.** Every idea was designed to support physical expression, stimulate imagination and contribute to motor development, offering children an alternative to passive, screen-based entertainment.

By combining intuitive creativity with user-centered structure, the ideation process resulted in a robust and varied foundation of potential solutions. Some ideas remained conceptual, while others began to take shape through quick sketch models and early physical prototypes.

The next step was to test how these ideas would function in real play. Would they invite movement? Would they inspire curiosity? To answer these questions, a first user test was conducted placing selected concepts directly into the hands of a young child, within a natural, spontaneous play environment. This moment marked the shift from idea to experience, from drawn possibilities to lived interaction.

7.4. Co-design session

Objective of the Test

This user test aimed to explore which types of play and materials encourage physical activity in young children. By presenting a variety of simple, tangible prototypes, I investigated how a child responds to different forms, materials, and play possibilities. Central to this test was the question:

''Which objects invite movement, improvisation and creative play?''

An underlying objective was to examine the principle of **"loose parts play"**. The test sought to uncover to what extent open-ended components encourage interpretation and varied physical play.

Test Setup

The test was conducted with a three-year-old child. Due to his young age, I expected spontaneous physical interaction rather than extensive verbal feedback. The setting was simple: I laid out multiple prototypes on the ground and observed which materials he picked up, how he interacted with them and what types of play behavior emerged.

The materials varied in size, form and intended interaction. Each prototype had a different assumed play function:

- **Small coin-like object**: designed for hiding or inserting into containers; encourages fine motor skills and discovery.
- **Ball with rope**: intended for throwing and reaction (coordination); suitable for solo or cooperative throwing games.
- **Cones**: intended for creating a parcours, throwing activities and stacking exercises.
- **Rope**: meant to create a path; triggers planning and gross motor skills like balancing or jumping.
- **Soft, bouncy material**: intended to test reactions like sitting, jumping or pushing; invites exploration of material behavior.
- **Rolling object**: designed to provoke movement through rolling, chasing or pushing, requiring coordination and locomotion.

Figure 31: Child using the Prototypes

- **Homemade shooter ('catapult')**: a low-pressure device to launch objects, inspired by the observation that children enjoy throwing or chasing projectiles.
- **Magnetic ring with magnetic sticks** (Figure 26: Designing Through Prototyping): intended to test how kids react to the use of magnetic elements and for throwing and building.

After the play session, the child was asked which prototypes were liked the most. The child's direct and honest answer was: "*This one (the magnetic ring) and the cones you can throw at*". When asked about the others, the child simply replied, "*I don't like them*". This was fun, interesting and insightful. The clarity and spontaneity highlighted where the child play enjoyment truly lies. Although it was only one user, it confirmed that aiming and throwing physical, goal-oriented actions were the most appealing.

Observations and Insights

- **Free and spontaneous play behavior**
  Several objects were used differently than I, as the designer, had anticipated. For instance, cones were not arranged as a course but used as targets to throw at. This highlights the power of *loose parts play*: children assign their own meaning and create their own rules of play.
- **Physical activity and motor skills**
  Throwing, pulling, running, grasping and balancing all emerged naturally during interaction with the prototypes. The catapult led to throwing and chasing; the lines to walking and jumping; the soft material triggered movement through sitting, pushing and jumping.

Figure 32: Child is using the Prototypes

- **Sensory appeal**
  Bright colors, softness and the ability to set objects in motion (e.g., the rolling or shooting of items) were key factors in maintaining engagement.
- **Social component**
  When I joined the play, the activity became more intense and sustained. This confirmed that **adult-child interaction** plays a significant role in generating meaningful and lasting play.

Conclusion

This co-design session and observations during the research fase showed that children are most engaged by objects that give them the freedom to invent their own play. Materials that balance **familiarity** (like balls or cones) with **abstraction** (like soft shapes or flexible lines) have the highest potential to spark movement, creativity and social interaction.

The principle of loose parts play proved to be a powerful design approach: when children are free to use materials in their own way, physical and imaginative actions emerge naturally.

The insights gained from this test will inform the development of three further design concepts, all of which will combine physical stimuli, open-ended play structures, and parent-child interaction. The goal is to design play that is not only fun, but also contributes to the development of key motor skills such as throwing, jumping, balancing and coordination.

7.5. Concept Directions

Concept Exploration and Selection

Out of all the initial ideas generated during the ideation phase four concepts (Figure 34: The 4 chosen concepts) were selected for further development, guided by design criteria (7.2 Program of Requirements (PoR)). The aim was to identify concepts that aligned with the project goals and showed the greatest potential for success. Key selection factors included: **feasibility**, based on buildability, safety and durability of the product, multi-environment usability, screen free, portability and independent use by young children; **desirability**, defined as the ability to engage children through sensory and visual stimuli, encourage co-play with caregivers, easy to clean, gender neutral and Multi-Use Functionality and the potential to stimulate motor skill development. Observations from the research phase, along with feedback from the co-design session, helped determine which ideas intrinsically motivated children to move and engage physically (Figure 33: C-BOX).

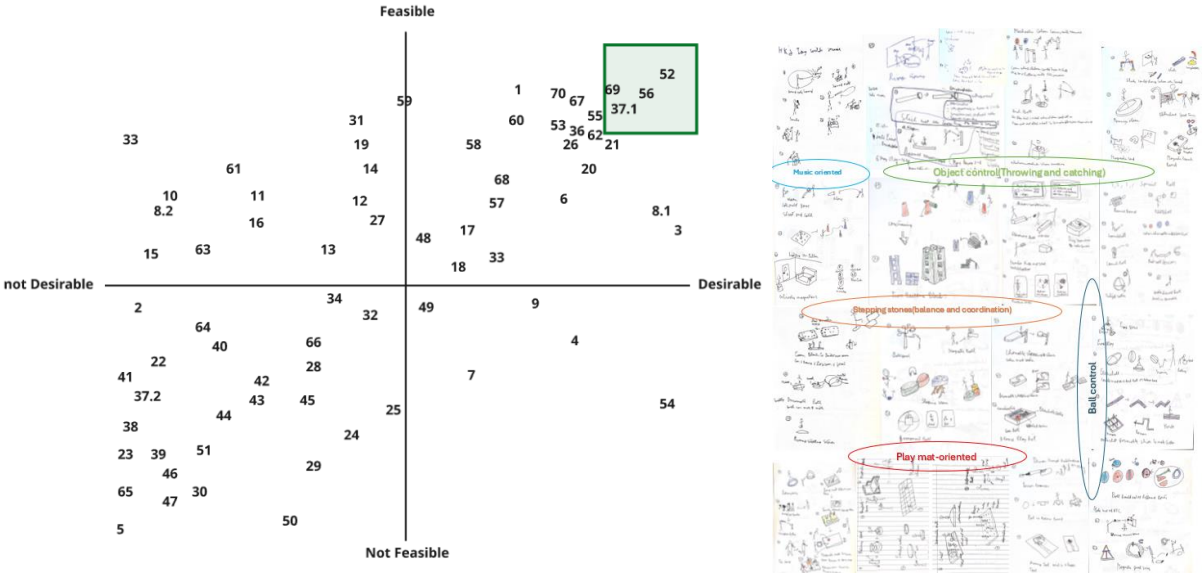


Figure 33: C-BOX & Cluster of idea's full preview in Appendix P (Ideation clusters)

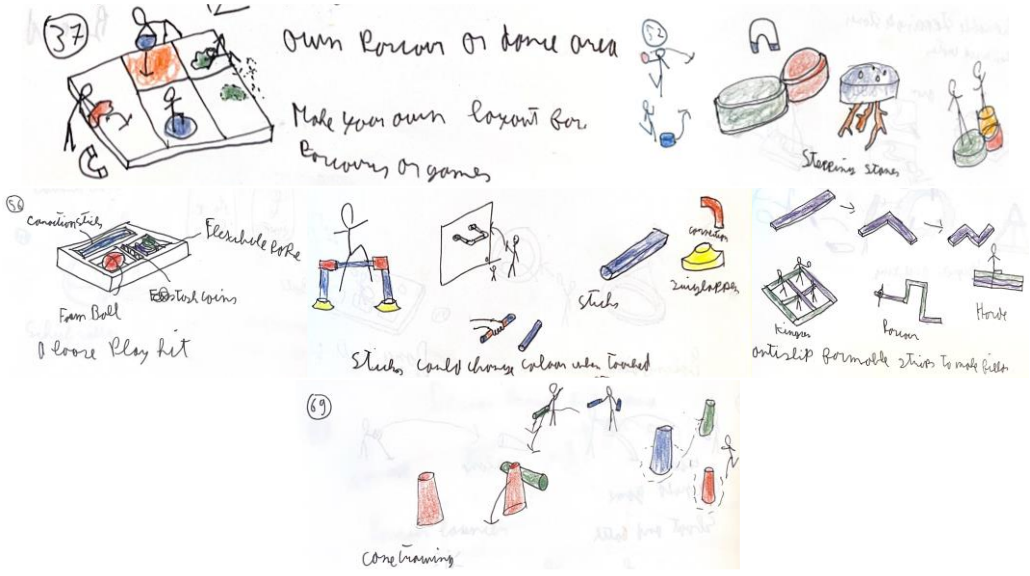


Figure 34: The 4 chosen concepts number 37,52, 56,69

In consultation with **motor skills expert Pim Koolwijk**, all four concepts were reviewed and refined. He saw strong potential in Stepping Stones (Concept 1) and the Play Mat (Concept 4), particularly for their tactile variation and ability to support a wide range of movement. He also advised against the inclusion of magnetic elements, pointing out potential risks such as product failure or user frustration if the magnets didn't work as expected. Based on this feedback, the magnetic feature was removed from all concepts before continuing to the prototyping phase.

As a result, four refined concepts: **Stepping Stones**, **The Throwing Game**, **The Modular Movement Kit**and **The Play Mat** were developed into physical prototypes and will be evaluated in the next user test to determine which concept best supports enjoyable and movement-rich play.

Concept 1 – Stepping Stones

The **Stepping Stones** concept introduces a series of soft, lightweight and multifunctional play elements, designed to support a broad range of physical and creative activities for children. Unlike conventional materials used in stepping games or building exercises, these stones are intended to go beyond basic balancing. They can be thrown, kicked, stacked or arranged into interactive play environments inviting varied and dynamic use.

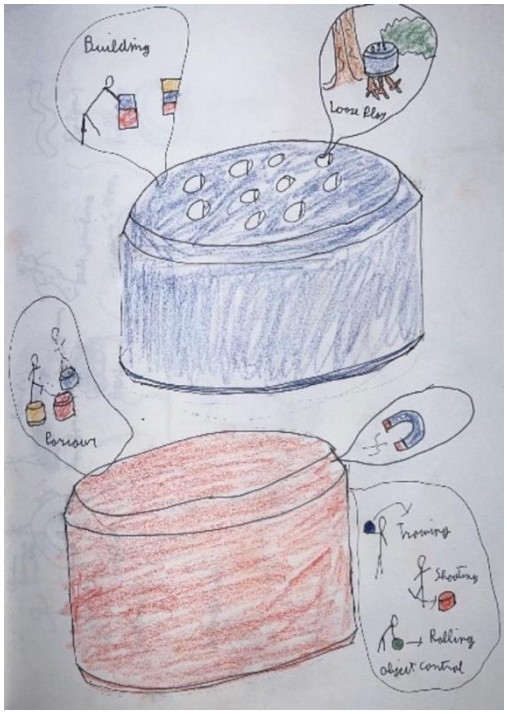


Figure 35: Stepping Stones sketch

The design focuses on a selection of basic geometric forms, each chosen for its ability to stimulate a different type of movement or motor skill. A half-sphere encourages children to practice balancing and weight shifting, while a flat circular shape invites rolling and ball-like interaction. Square and rectangular stones are more construction-oriented, offering children the chance to build, stack or create platforms and structures. This diversity ensures the product supports both gross motor development and imaginative play.

Although the shapes may appear simple at first glance, the intention behind this concept is to test whether abstract and open-ended forms can still lead to creative thinking and physically varied play. The goal is to explore whether these minimalistic objects stimulate spontaneous movement.

A possible direction for the final product is a design in which each stone is built around a foam core, chosen for its compressibility, softness and resilience. These qualities support dynamic activities such as jumping and throwing. The outer layer could be made from rubber or synthetic leather, which provides resistance to UV light, tearing and abrasion. It also is resistant to water and dirt, is non-toxic and offers a non-slip surface, ensuring safety and durability in a variety of play environments.

The dimensions are adapted to the average foot size of young children. Each stone has a thickness of 5 centimeter (cm). Circular versions are 20 cm in diameter, square ones measure 20 × 20 cm, rectangular stones 20 × 25 cm, and the half-sphere is 25 cm in diameter and 8 cm high to offer a balance challenge.

Foam prototypes have been created to test the shapes, comfort, and visual appeal (Figure 36: Prototyping Stepping Stones).

Figure 36: Prototyping Stepping Stones

In addition, a single render was developed to provide a clearer visual representation of the concept, showcasing the variety of forms, colors, and intended play interactions (Figure 37: Render of Stepping Stones).

Figure 37: Render of Stepping Stones

Bright colors were used to enhance engagement and visibility. These models provide a strong base for observing how children interact with the stones in future user testing and evaluating their effectiveness in promoting active play.

Figure 38: Coloring prototypes

These prototypes provide a foundation for assessing how varied shapes and textures influence spontaneous motor activity and exploratory behavior during the next phase of user testing.

Concept 2 – The Throwing Game

Figure 39: Sketch of The Throwing Game

The Throwing Game was developed through rapid prototyping and explores how a simple cone shape can become a versatile and multifunctional play object. Inspired by the principles of loose parts play, the concept allows for spontaneous, self-directed use while subtly guiding children toward specific types of physical activity.

The design intentionally aligns with several categories from the *morphological chart*, including throwing activities, locomotion, balancing, music integration and movement variation. The cone's curved base causes it to roll in unpredictable directions, encouraging children to run, change direction and bend to retrieve it. These movements support dynamic balance, coordination, and trunk rotation.

The open core allows for stacking, though with some difficulty. Because of the cone shape, children must find alternative ways to build higher structures. For example, they may turn the cones upside down and place them on top of each other instead of sliding them inside one another. This motivates strategic thinking and motor control while aiming and aligning, which directly supports hand-eye coordination.

The ribbed surface produces sound when tapped or dragged, creating auditory feedback that introduces a sensory element to the play experience. This aligns with the idea of music integration from the morphological analysis. The shape and size resemble a drumstick or horn, which can invite rhythmic or symbolic play depending on the context.

Although the design invites open-ended exploration, the interaction opportunities were carefully selected to promote specific motor skills. Each physical feature serves to activate movements that contribute to a child's gross motor development, spatial awareness and sensory engagement. By combining imaginative freedom with structured physical challenges, *The Throwing Game* offers a balanced and developmentally meaningful play experience.

While I am aware that the cone is not a new or unique form, the goal of this concept was to explore how far my own ideas about movement stimulation, variation and material interaction could be expressed through a seemingly simple object. The intention was to test whether these embedded qualities would emerge during user interaction, and to identify how the concept could be further developed and refined based on those observations.

A possible material choice for the final product is hard plastic, selected for its potential to offer UV resistance, abrasion and tear durability, resistance to water and dirt and non-toxicity. These characteristics would make it suitable for both indoor and outdoor use.

During prototyping, existing cones in various bright colors were used to observe form, size and engagement potential (Figure 40: Prototype throwing game). These cones measured 25 cm in height, with a 7 cm base diameter and a 4 cm top opening. The proportions proved ideal for grip, throwing and stacking, making them intuitive and effective for small children.

Figure 40: Prototype throwing game

To visually communicate the concept and its playful possibilities, a render was created showing how the cones can be thrown, stacked and combined with other shapes, emphasizing their open-ended use in dynamic, child-led play scenarios (Figure 41: Render throwing game).

Figure 41: Render throwing game

While The Throwing Game is simple in form, the prototype allows for observing how material characteristics and unpredictable movement patterns can contribute to motor skill engagement in open play settings.

Concept 3 – Modular Movement Kit

The **Modular Movement Kit** enables children to design and build their own play environments, combining construction and physical interaction in a single concept. The set includes hollow tubes, connectors, anti-slip strips, and a soft foam ball. Each component is designed to stimulate creative thinking, motor skill development and social cooperation.

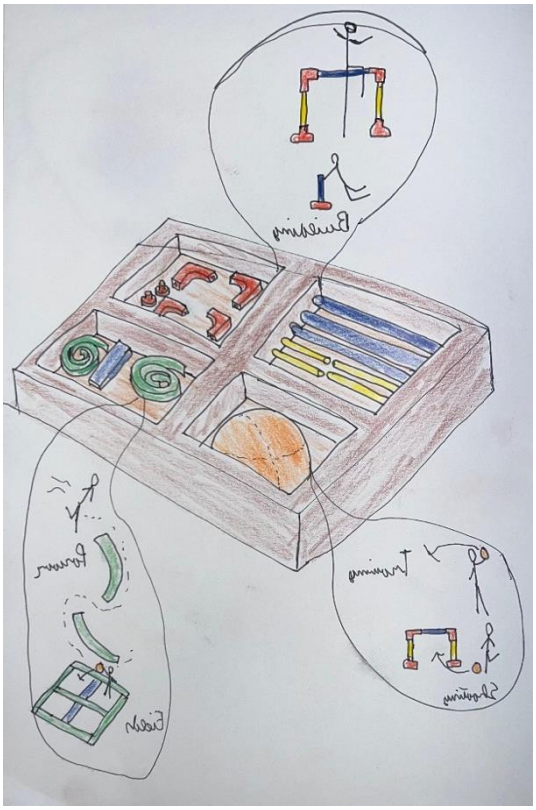


Figure 42: Sketch from the Building Play Kit

Children can construct a wide range of structures, such as goals, hurdles or tunnels, and then actively engage with them. These self-made elements create opportunities for specific movement challenges. Throwing or shooting the ball promotes hand-eye coordination and ball control. Crawling under or climbing over low tunnels supports dynamic balance, strength and spatial awareness. Jumping over obstacles or stepping between zones trains coordination and postural stability. Children can also create their own parcours or play fields, which encourage movement variety, rhythm and route planning.

By merging building with active play, the kit invites both fine and gross motor skills while fostering problem solving and imaginative experimentation. It supports core goals from the morphological chart, including balancing, throwing activities, locomotion and movement variation, while also strengthening collaborative interaction through shared construction and play.

This concept may initially resemble a standard construction set, but its purpose is in the dynamic transition from building to movement. The goal is to investigate whether children understand the potential of the kit and whether constructing their own parcours naturally leads to exploratory, self-motivated motor skill activity. The open-endedness is deliberate, inviting interpretation, decision-making and variation in play.

The tubes come in lengths of 15, 25, and 35 cm, with a diameter of 3.5 cm. The open ends are intentionally left accessible to stimulate creative thinking and loose parts play, allowing natural materials such as sticks or rope to be inserted for grip, customization or other types of play.

The connector pieces include T-junctions, L-corners, X-joints, vertical elbows and angled links, enabling construction in multiple directions. A possible material direction for the final product is a design using lightweight yet durable plastics for the tubes and connectors. Anti-slip strips (30 × 4 cm) help define boundaries or create zones, while the foam ball (10 cm in diameter) adds a dynamic, interactive element.

3D-printed prototypes of the tubes and connectors were developed and tested for their fit, handling, and build flexibility (Figure 43: Prototype Building Play Kit). Children were observed building and adjusting their setups independently, showing that the system supports intuitive, movement-based play.

Figure 43: Prototype Building Play Kit

To help communicate the concept visually, a render was created that showcases the Modular Movement Kit's modular components, its physical layout possibilities, and how children can engage with the structures in active, imaginative ways (Figure 44: 3D Sketch the Building play Kit).

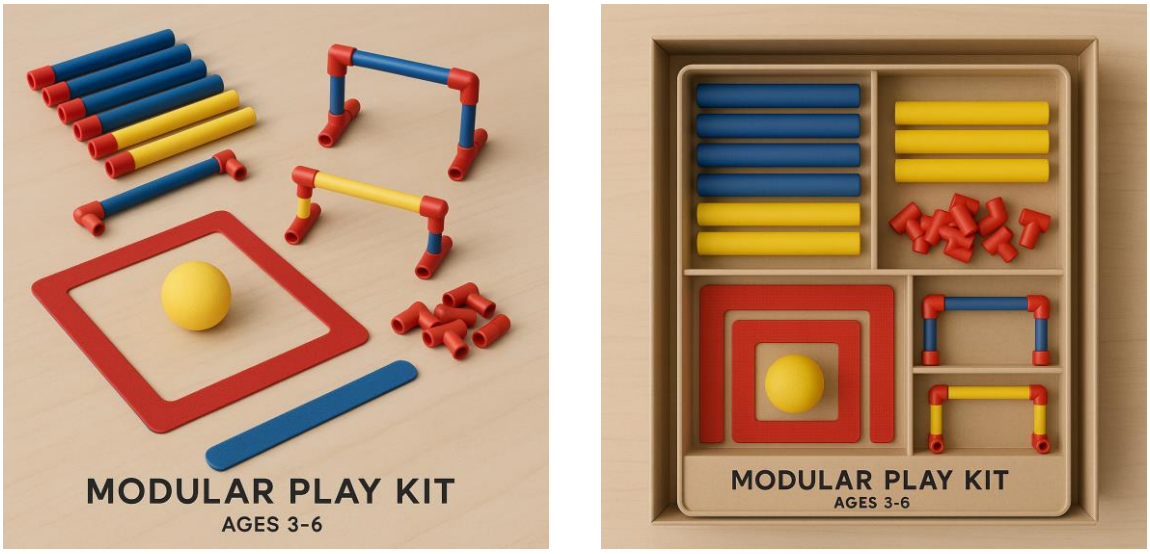


Figure 44: Ai render of sketch Modular Play Kit

The kit will be further explored in user testing to evaluate whether the transition from building to active use effectively supports motor skill variety and self-directed group play.

Concept 4 – Play Mat

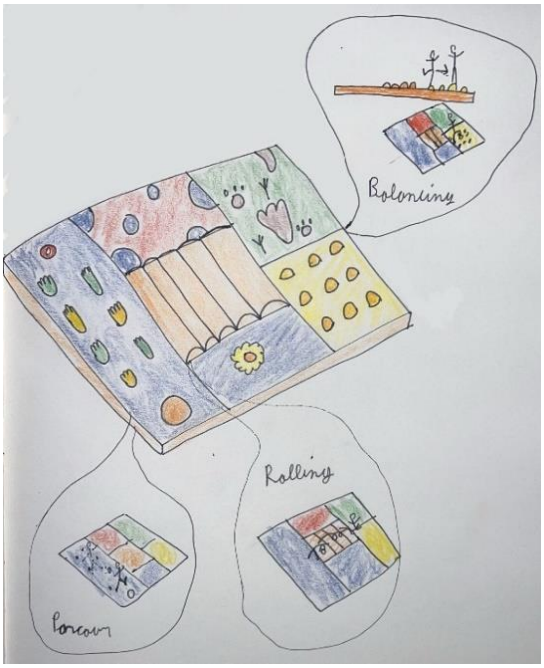


Figure 45: Sketch of Play Mat

The Play Mat is designed as a safe, soft and sensory-rich environment where children can move freely, explore different types of movement and engage with visual and tactile prompts that encourage motor skill development. Its cushioned surface lowers the risk of injury, which invites children to try new movements such as balancing on one leg, jumping or rolling, supporting the development of balance, coordination and movement confidence.

The mat measures 120 x 120 centimeters and is divided into six distinct zones, each designed to stimulate specific types of motor activity, sensory input or imaginative play.

One zone, sized 120 x 40 centimeters, invites dynamic locomotion through a combination of jumping, stepping and twister-like rotations. This layout encourages movement variety, rhythm and body control.

Three zones of 40 x 40 centimeters offer focused interaction:

- the raised tubes challenge balance and require precise foot placement;
- the dots act as aiming targets for ball control and coordination;
- the flower symbol with textured surfaces provides tactile input and suggests creative uses such as landing, turning or touch-based tasks.

Two additional zones, each 60 x 40 centimeters, focus on imaginative movement and spatial awareness. One features animal footprints that encourage role play and themed locomotion, based on observations where children mimicked animal movements or initiated chasing games. The other includes yellow protruding domes, designed to stimulate dynamic balance, stepping precision and movement planning by inviting children to step on or around the elements.

In its entirety, the mat can also function as a small open play field. When used with a ball, this setup encourages children to anticipate irregular motion, adjust their body position and practice ball control, supporting the development of coordination, balance, and reaction timing in an intuitive and engaging way.

Elements such as hands, feet, flowers, arrows and targets are arranged to guide movement in playful ways. While the mat may seem like a familiar play surface, the embedded visual and tactile prompts are designed with specific motor goals in mind (such as balance, ball control and coordination). The goal of this concept is to observe whether motivating symbols, textures and color zones can successfully encourage diverse forms of movement. It explores how subtle environmental cues influence behavior without the need for direct instruction.

A possible direction for the final product is a design that the mat is constructed from soft foam with a durable outer layer that is UV-resistant, water- and dirt-repellent and non-toxic. The surface is comfortable and safe, offering both protection and inspiration for a variety of motor skills.

For the prototype, a yoga mat and soft bathroom mats were combined (Figure 46: Prototype Play Mat). Adhesive shapes in bright colors were added to simulate the final visuals and encourage interaction. The aim was to evaluate the layout, texture variation, and visual clarity of the design.

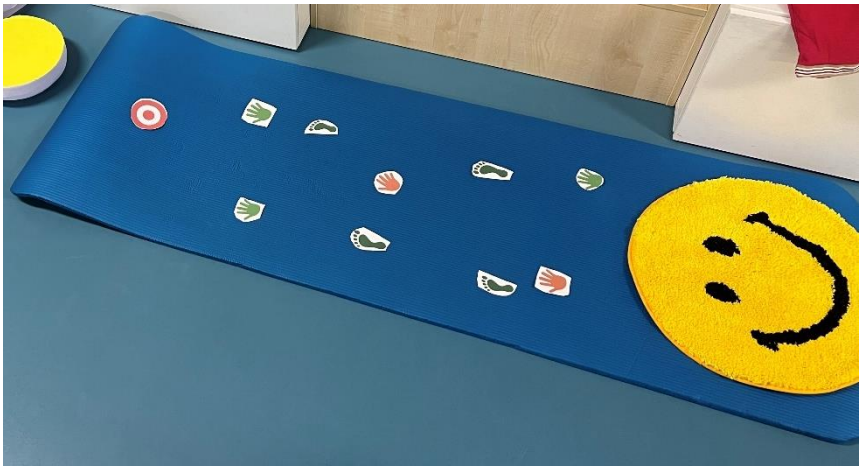


Figure 46: Prototype Play Mat

To complement this, a render was created to visually communicate the spatial layout and material appearance of the Play Mat, illustrating how the zones and tactile prompts can support dynamic and exploratory movement (Figure 47: Render Play Mat).

Figure 47: Render Play Mat

The prototype will serve to examine how visual and tactile cues can shape children's movement choices and support a range of motor skill activities in a safe environment.

From Concept to Evaluation

After developing and prototyping the four concepts: Stepping Stones, The Throwing Game, Building Play Kit and Play Mat, the next phase in the design process involves conducting a user test. Each concept offers a unique approach to encouraging movement, varying in form, material, play style and openness of use. This variety allows for exploration of which types of interaction most effectively invite children to engage in active play.

The goal of the user test is to gain insight into how children respond to each concept in practice. Key aspects to observe include enjoyment, level of physical activity, intuitiveness and spontaneity of use. The findings from this test will guide the selection of the most promising concept to be further developed into a final design direction.

Figure 48: Transformation from concepts to evaluation

7.6. Validating Design Concepts Through User Interaction

As part of the concept development phase, a user test was conducted to evaluate four early design directions in terms of their physical engagement, inclusivity, play value, adaptability, Multi-Use Functionality and versatility. The main objective was to explore how young children interact with the concepts in both indoor and outdoor contexts, and to assess whether the elements encouraged varied movement relevant to different motor skill domains. Additionally, the test sought to understand whether certain features or forms held more appeal, and whether both boys and girls responded positively to the materials.

Test Setup

To evaluate the effectiveness of four early design concepts, user tests were conducted in a kindergarten setting during unstructured playtime. The tests took place both indoors and outdoors, in small, intentionally varied groups (e.g. all-girls, all-boys, mixed-gender and one mixed-age group). Each session lasted approximately 15–25 minutes and was carried out in collaboration with the class teacher.

Children were presented with four prototypes and allowed to explore them freely, without any instructions. This open-ended approach aimed to reveal spontaneous behaviors, motor skill engagement, social dynamics and creative use. Observations focused on movement type, engagement level, group interaction and physical activity. Additional input was collected through informal conversations and teacher reflections.
A more detailed description of the test method, materials and observation focus can be found in Appendix Q (User testing Egelantier school).

Data Collection

Data was collected through informal conversations with the children, brief field notes written down on a phone during and after the sessions and a reflective brain dump immediately following each test moment. These unstructured insights were later organized and thematically analyzed to identify patterns in behavior, preferences and interaction style. Observations focused on the type of physical activity (e.g., jumping, balancing, building), use of individual elements or combinations, signs of social interaction (such as imitation, turn-taking or shared construction) and creative or imaginative uses (e.g., transforming a shape into an imaginary object). Informal follow-up questions helped clarify the child's preferences and perceived possibilities or limitations of the materials. The findings from these sessions formed a key basis for selecting which concepts to further develop.

Figure 49: Testing Setup

Result Analysis

The user tests yielded rich qualitative data on how young children interacted with the four proposed play concepts: Stepping Stones, Cones, a Construction Kit and a Play Mat. Through spontaneous, unstructured play sessions in both indoor and outdoor settings, key patterns in **physical engagement**, **motor variety**, **creative play** and **social interaction** emerged. These patterns reflect the central evaluation criteria established in the test setup, such as **versatility**, **multi-use potential** and **inclusive appeal** across genders and age levels. Taken together, the observations offer grounded insights into which concepts best supported active, varied and imaginative play, and how each concept aligned with the broader Program of Requirements for this design project.

To aid comparison and provide an overview of the most prominent behaviors, the following table summarizes typical uses per concept, observed motor domains and levels of social engagement:

Concept	Common Uses	Motor Domains Engaged	Social Interaction
Stepping Stones	Balancing, jumping, stepping, building, rolling, sound play, role play, shooting and throwing	Balance, coordination, object control, fine motor skill, movement variety	High collaborative building, shared games
Cones	Stacking, obstacle courses, balancing, running, throwing, rolling sound play	Balance, coordination, object control, fine motor skill, movement variety	High collaborative building, shared games
Construction Kit	Building objects (e.g. tools, houses and weapons), fantasy play and throwing	Object control, fine motor skill, symbolic play	Medium mostly alone or together with another child
Play Mat	Used as base for other objects or ignored	Minimal motor engagement	Low

Table 1: Results of use concepts

Stepping Stones and Cones

Among all prototypes, the **Stepping Stones** and **Cones** clearly stood out in terms of engagement and frequency of use. Children were naturally drawn to these elements and engaged in a wide range of play behaviors, including balancing, jumping, building and imaginative scenarios. Across all sessions, both boys and girls interacted with these elements in physically active and diverse ways, suggesting broad appeal and inclusivity.

The **Stepping Stones**, in particular, proved to be a **multi-functional object**. Children used them not only to create balance courses, but also repurposed them as beds, drums, and even rocket ships. The semi-spherical stones introduced an additional **challenge** that was appreciated and repeatedly explored, despite being difficult for some children to balance on. Outdoor sessions further highlighted their potential, as the stones were rolled, thrown, and kicked, demonstrating their suitability for dynamic movement and physical experimentation. This resulted in consistently varied and sustained physical engagement across different users.

Similarly, the **cones** were used with great enthusiasm. Children stacked them, used them as megaphones, created obstacle paths and explored their tactile qualities. The ribbed surface and form, in particular, inspired children to use them as **musical instruments**, generating rhythmic sounds by tapping or scraping on the other cone or use it as a drumstick. When used in combination with the Stepping Stones, the cones added complexity and variety to physical play, suggesting a strong potential for hybrid functionality.

Both products also sparked **collaborative play**, with children building together or competing in friendly challenges. Their simple yet versatile forms allowed children to assign their own meanings and rules, thereby stimulating creativity, motor skills and social interaction. Both prototypes supported a broad range of developmental subskills, including balance, coordination, ball control, fine motor precision and movement variation, making them well aligned with the targeted motor skill development goals of this project.

Figure 50: Use of the Stepping Stones and Cones

Key Insights

- The Stepping Stones offer a **multi-purpose platform** for movement, creativity and collaboration.
- They stimulate a range of motor domains: balance, locomotion, throwing/kicking and construction.
- The semi-sphere adds functional variation and dimensionality.
- Circular discs are essential to promote **rolling and throwing games**.
- Sound-based or musical elements could be further explored.
- Texture and form can trigger unexpected functions (e.g., sound, exploration and measurement).
- The cones supported physical, cognitive and creative forms of play.
- Merging cone-like features into the stepping concept could increase multifunctionality, making it suitable for movement, construction and even **educational or quiz-like games**.

Construction Kit

The **construction kit** was also well received, particularly for imaginative play. Children created a range of objects such as pistols, houses, hammers and snakes and took pride in their creations. However, the nature of the kit encouraged more **static, solitary play**, with limited gross motor activity. Conflicts occasionally arose over who could use which pieces, indicating that the design was less effective in promoting collaborative use.

While the kit successfully supported fine motor skill development and fantasy play, it did not align as well with the project's goal of encouraging active, physical movement. However, the creative and role-playing potential could represent a valuable addition to the ongoing concept development, as it may support the integration of elements such as insertable parts and connectors that facilitate fine motor skills and symbolic play (Figure 51: Use of the Building Play Kit).

Figure 51: Use of the Building Play Kit

Key Insights

- Promotes fine motor skills and symbolic thinking, but **understimulates active movement**.
- More fitting for **individual and seated play**, not aligned with the project's goals.
- Valuable as inspiration for connector-based design features, but not as a primary concept.

Play Mat

The **play mat** intended to inspire movement through visual cues (like Twister), saw the least engagement. Children recognized its purpose but largely ignored it, except when using it as a **supportive surface** for Stepping Stone constructions or imaginative setups (e.g., pretending it was a bed or launchpad). The mat lacked the physical interactivity that captured the children's attention with other prototypes. This suggests that visual instructions alone are insufficient to spark active play in this age group, who prefer objects they can **hold, manipulate and transform** (Figure 52: Use of the Play Mat).

Figure 52: Use of the Play Mat

Key Insights

- Children in this age group prefer objects they can hold, move and manipulate over static visual prompts.
- The mat functioned best as a complementary surface, not as a central play tool.
- Visual-only prompts (e.g., prints or symbols) need to be paired with physical interaction possibilities.

Emerging Themes and Design Implications

Across all sessions, several key themes became evident:

- **physical interaction and variation** are essential to sustained engagement;
- children are highly responsive to **open-ended materials** that support both movement and imagination;
- **multisensory feedback** (e.g., balance, sound, shape, color) enriches the play experience;
- **social dynamics matter**: as the research provided by the user test showed materials that support shared, collaborative play are more positively received.

These findings confirm that the concepts which performed best were those that offered **freedom, variety and tangible physicality**. Both the Stepping Stones and Cones fulfilled these criteria effectively, while the Construction Kit and the Play Mat were either too limited in movement or too passive in use. Minimal differences were observed in how the materials were used across different age groups and between boys and girls. This suggests a high level of inclusivity, indicating that the most successful concepts appeal broadly and support varied play styles regardless of gender or developmental stage.

Conclusion & Next Steps

Based on behavioral observations, verbal feedback and teacher input, the Stepping Stones and Cones emerged as the most promising concepts (Figure 53: Combination Cones and Stepping Stones). Their versatility, high level of engagement and adaptability to both indoor and outdoor play environments make them ideal candidates for further development. The Stepping Stones, in particular, demonstrated a unique capacity to blend physical, creative and social dimensions of play, and are selected as the primary direction for refinement in the next phase of the design process.

Although only one concept was chosen to continue, qualities from other tested concepts were consciously integrated into the design evolution. The Cones, for instance, inspired movement-based interaction through stacking, balancing, throwing and rhythm-based play. From the Construction Kit, the use of insertable and modular elements informed the integration of fine motor skill actions within active play scenarios. Lastly, the limited engagement with the Play Mat reinforced the importance of three-dimensional, moveable elements to effectively stimulate physical activity.

In addition to user feedback, the selected direction was critically assessed against the full Program of Requirements (PoR) to ensure it meets all functional, developmental, and contextual goals. The current design fulfils key priorities such as motor skill stimulation, screen-free use, age-appropriate dimensions and multi-use functionality. It also supports both individual and collaborative play, is gender neutral and is adaptable across various environments. Attention points such as durability, outdoor resistance and ease of cleaning will be addressed in the upcoming material testing and refinement stages.

In the next phase, these insights will be translated into functional features that expand the core concept's potential, while ensuring alignment with the Program of Requirements and key themes emerging from user testing.

Figure 53: Combination cones and Stepping Stones

7.7. Iteration

Refining the Stepping Stones Concept

Following the first user test, which yielded highly positive results, the **Stepping Stones** concept emerged as the most promising direction. Children interacted with the product in spontaneous and diverse ways: balancing, jumping, throwing, stacking and even transforming the stones into musical instruments or elements of imaginative scenarios. Based on these observations, the next iteration focuses on a **core set consisting of two shapes: the circle and the square**. These forms proved to be the most versatile and engaging, and therefore form the foundation of a **starter kit** intended for general use (Figure 54: Starter kit).

Figure 54: Starter kit

Other forms such as the **rectangle**, **semi-sphere** and **cone** were initially considered for integration but have been temporarily removed from the design. The rectangle was excluded because it did not provide additional value compared to the square. The semi-sphere and cone did support interesting play patterns, including added balance challenges and throwing activities, but their core functions were already sufficiently addressed by the circular and square Stepping Stones. To simplify the current iteration and assess whether these shapes are truly necessary, they have been set aside for now.

If upcoming user tests reveal a lack of balance variation or a demand for greater complexity, these forms may be added to the starter kit or introduced later as part of a **modular expansion pack**. Variation in form was still actively explored through a brief ideation session, which generated possibilities for reintroducing shape diversity in future phases without increasing the complexity of the current design (Figure 53: Ideation on new forms).

Additionally, observations from the first user test indicated that children did not attempt to sit on the stones or build step-like platforms that required structural connections. Most constructions relied purely on surface contact. This confirmed that **friction between the elements was sufficient**, and no additional connection system was required at this stage.

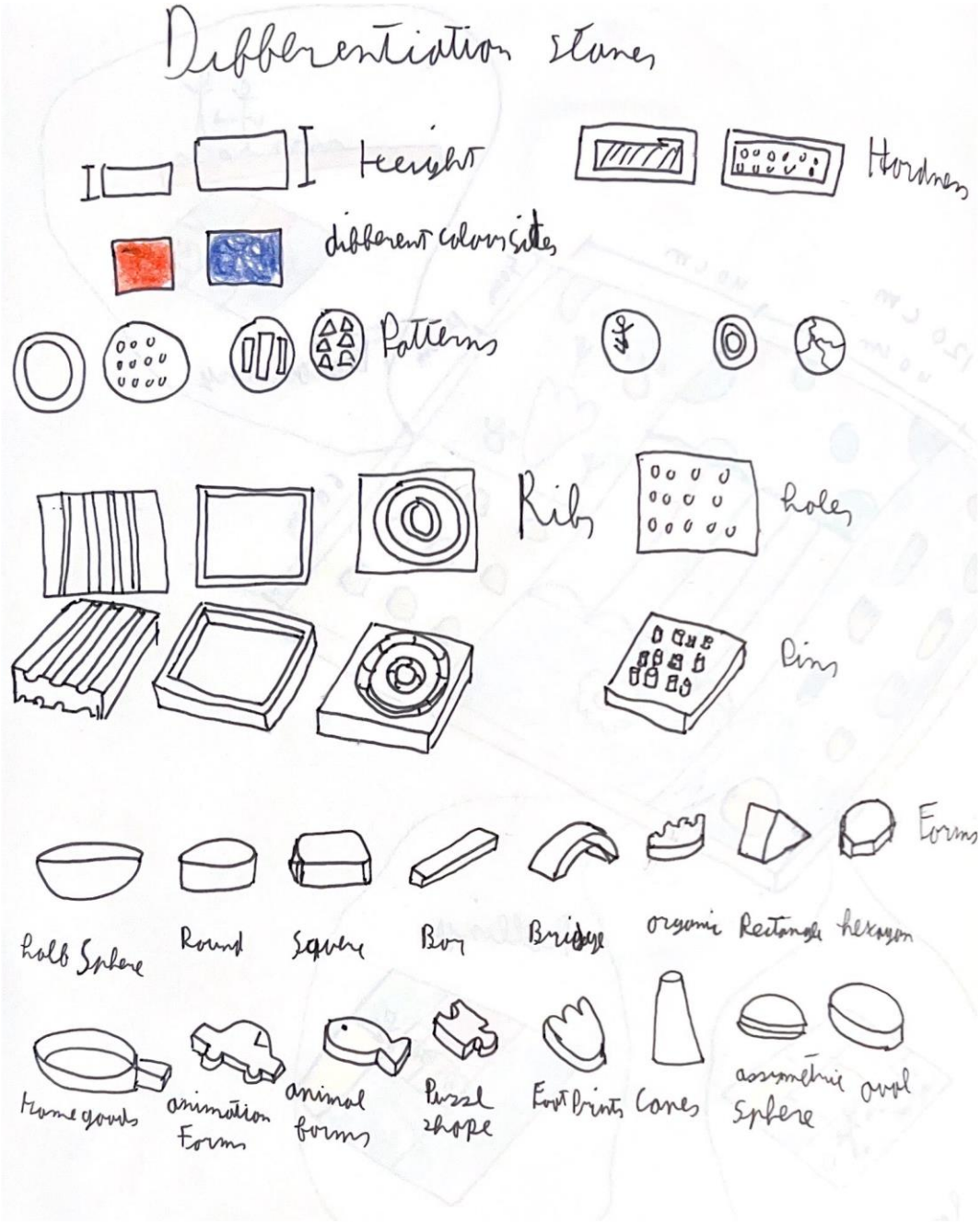


Figure 55: Ideation on new forms

Material Iteration and User Test

The primary focus of the new prototype phase is to evaluate **foam firmness**. This is a key factor influencing both comfort and usability. To this end, three materials were selected: polyurethane (PU) foam, known for its soft and lightweight feel; polyethylene (PE) foam, which offers a firmer, more stable surface; and a rubber-based foam, such as EVA or EPDM, which provides maximum firmness, durability and shock absorption (Figure 56: Foam materials). Each material has been integrated into Stepping Stones that are identical in shape, enabling a direct comparison of tactile and functional differences during play.

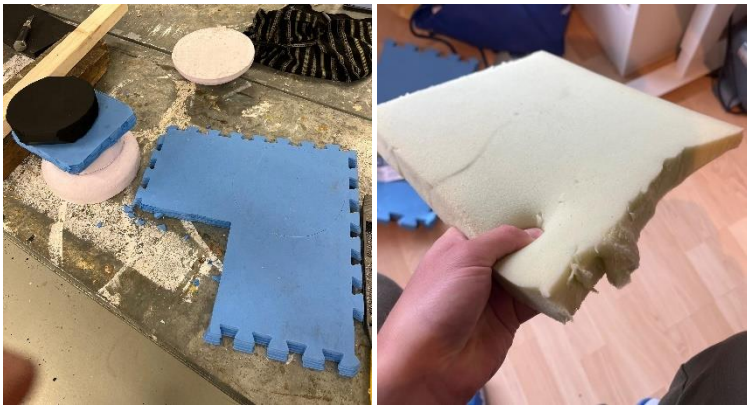


Figure 56: Foam materials

To simulate the final look and feel of the product, the test prototypes are covered in a smooth, paper-like material that gives a representative surface finish (Figure 57: Cover prototypes). However, the main objective of this iteration is to determine whether a minimal, material-focused approach without added shapes or visual cues can still deliver meaningful and engaging play.

Figure 57: Cover prototypes

The user test will provide insight into children's preferences regarding material firmness, as well as confirm whether the basic set of shapes is sufficient to stimulate varied physical play. This evaluation will form the foundation for making final decisions about material selection, product composition and whether (or not) to reintroduce more complex forms in future iterations.

7.8. User Test – Material Evaluation & Open-Ended Play

As part of the iterative design process, a user test was conducted to explore how kindergarten-aged children interact with different material types and simple shapes within a modular play concept. The goal was to identify the most suitable material for long-term, dynamic use, while also understanding whether additional forms (such as cones) or functional features (like holes) were necessary to enhance play.

This test also aimed to capture the **imaginative potential** of simple objects by observing what children would naturally invent with minimal guidance.

Test Setup

Three material variants of the same play object, a circle and a square, were created, each made from a different material. One circle included holes designed to test if children would engage in activities like building or inserting sticks to create new forms, such as a table.

The setup closely followed the structure of the first user test (see Appendix U (Dimensions products)), with only minor adjustments in group size. This change aimed to gather more in-depth feedback and explore whether the material also worked well in smaller group dynamics.

The sessions were conducted in collaboration with a kindergarten teacher, in a safe and supervised school environment. As in the previous test, children were invited to participate voluntarily in pairs. During 15–25 minutes sessions, they were given free access to the play materials with no explanation or instruction. This allowed their spontaneous interaction and creativity to emerge.

Testing was carried out both indoors and outdoors to evaluate environmental influence.

Data Collection

Like the concepts user test, data was collected through informal conversations with the children, brief field notes written down on a phone during and after the sessions and a reflective brain dump immediately following each test moment. These unstructured insights were later organized and thematically analyzed to identify patterns in behavior, preferences and interaction style. Observations focused on whether any material was clearly preferred or underperformed in terms of the types of activities it enabled. After each session, children were asked which material they preferred, whether they enjoyed playing with it and why.

The findings from these sessions formed the foundation for further development of the concept.

Figure 58: Test setup

Result

The results revealed an incredible range of **imaginative games and active use** of the discs. Children continuously transformed the simple shapes into props for entirely different activities, including:

- **Obstacle courses** (*"The floor is lava*"): With jumping, path-building and tree stump integration. "*I'm a lava monster! Now I'm safe again!"*
- **Sports-inspired games**:
  - **Football** (discs as balls and squares goalposts) "*Shall we play soccer?"*
  - **Hockey** (square discs as sticks, round ones as pucks)
  - **Tennis** (using sticks and woodchips to hit items across water) *''Look how far I can hit!''*
  - **Bowling** (using cones as pins and discs as bowling balls)
  - **Frisbee** (throwing and catching discs as far as possible or between players.)
  - **Dodgeball-style play** (throwing discs at each other to avoid being hit)
  - **Boxing**: (using the square as box pillow ta punch against)
- **Squid Game**: Trying to flip square discs by throwing round ones at them.
- **Construction**:
  - Towers (to knock over)
  - Goals
  - Motorbikes
  - Houses

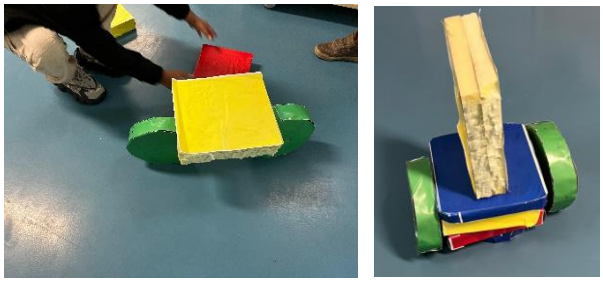


Figure 59: Building stuff

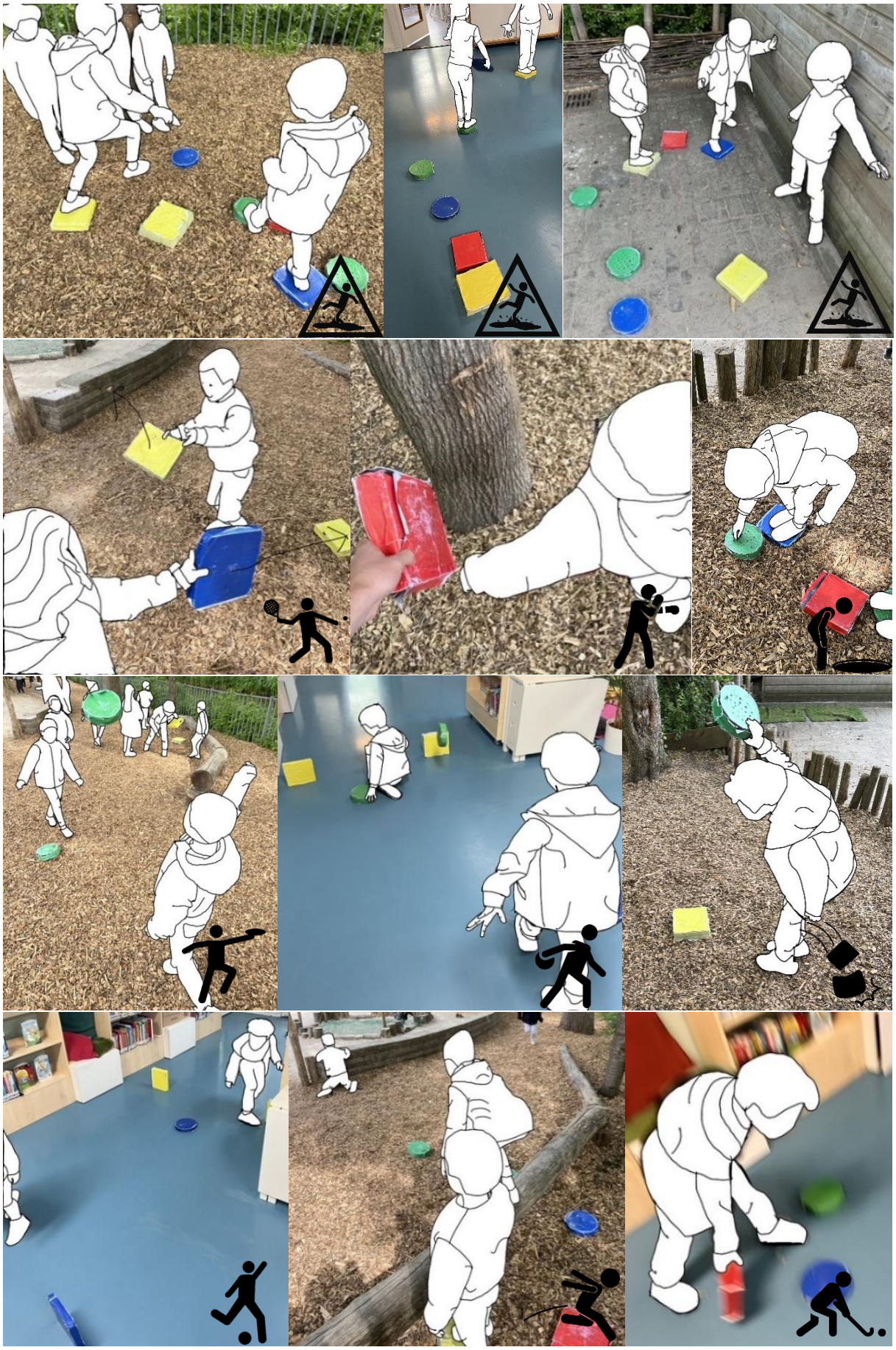
- **Physical movement**: Jumping between discs and from a tree stump onto a disc, testing balance and coordination.

Functionality of Additional Features

One of the discs included **holes**, intended for children to insert natural objects like sticks. However, this feature did not resonate well:

- Many children assumed the disc was broken *''Look, this one is broken".*
- Once told what the holes were for, interest faded quickly.
- Only one child attempted something creative using a stick between his toes to jump from disc to disc, but it was a one-time experiment.

The test therefore indicated that this feature did not provide the added value that had been anticipated. Since this was a low-fidelity prototype, its appearance may have influenced how children perceived and engaged with it. Nevertheless, the holes did not negatively impact the overall use of the disc's shape, though they were largely ignored.



Material Preference

Across nearly all sessions, children consistently preferred the softer, slightly compressible material (Figure 60: Preferred hardness foam). They described it as more fun and comfortable to use. Importantly, this material provided **natural feedback** when standing or jumping on it. Each step became a **balance** and **core stability exercise**.

Figure 60: Preferred hardness foam

Despite its functional advantages, a critical issue emerged: the material lacked anti-slip coating. As a result, it occasionally slipped out from under the children's feet, presenting a safety concern that might discourage parents from adopting the product. Addressing this friction issue will be essential.

Engagement and Motor Skill Development

Throughout the testing, children showed high levels of engagement:

- Many who weren't selected to participate still tried to join in.
- Participants often didn't want the session to end, showing signs of emotional attachment. When leaving some children went crying and quoted*: 'I want to play with it"*.
- Verbal feedback was positive, with many saying they thought the activity was "*really fun*".

From a developmental perspective, the play activities clearly stimulated a broad range of **motor skills**. Using the framework introduced in **section 5.3**, the observed actions could be categorized into the following four primary motor domains:

- **locomotive skills** – including running over the stones or after a thrown stone, jumping from stone to stone or from a tree to a stone and stepping between surfaces such as stones, edges and trees;
- **manipulative skills** – such as throwing, catching, striking with sticks, and stacking discs and squares to build a tower that can be knocked over;
- **balance and stabilizing skills** – demonstrated through balancing on unstable surfaces, shifting weight and maintaining core control during dynamic movement;
- **fine motor skills** – visible in handling small sticks, precisely arranging and stacking the Stepping Stones and inserting objects, although this activity occurred only occasionally.

These findings suggest that the product not only inspired creativity and active exploration, but also provided meaningful support for physical development across all key motor domains. The open-ended, unstructured nature of the product encouraged repeated practice, diverse movement patterns, and self-directed challenge, which are all critical elements for fostering foundational motor skill competence in early childhood.

Conclusion

This user test demonstrated that simplicity drives creativity. The children thrived when given minimalistic and open-ended materials. Even without complex shapes or added features, the play was rich, dynamic and joyful. The product successfully encouraged movement, social interaction, imaginative storytelling and the development of a wide range of motor skills (Figure 61: Mult- use of the product).

The tests also clearly showed that a set of just six to seven elements provided sufficient variety and challenge, confirming that this quantity is appropriate for a starter kit. Across both user tests, children continuously found new ways to interact with the forms, demonstrating that even a limited number of elements can support extensive motor development and creative exploration.

These findings support the decision to move forward with a simple, soft and safe disc design, refining only material properties such as adding anti-slip features, while keeping the form intentionally uncomplicated. In this case, less truly is more.

Although balance was successfully trained, the ability to adjust difficulty and the unpredictability that the half sphere provided were noticeably missing. As a result, the half sphere will be reintroduced in the next iteration to restore this essential element of challenge and dynamic engagement.

Figure 61: Multi-use of the product

8. Final Concept

8.1. Introducing Movemates – A Playful System for Movement and Development

The name ***"Movemates"*** was created during a dedicated brainstorming session focused on finding a name that captures both the function and spirit of the product. The word ***"move"*** refers directly to the goal of encouraging physical activity and motor skill development in young children. The word ***"mates"*** refers to playing together, whether that means interacting with other children, with caregivers or even playing alone with the Stepping Stones themselves, which can take on a friendly, imaginative role in the eyes of a child.

By combining these two elements, the name *Movemates* expresses the essence of the product. It stimulates movement through playful and social interaction. The name is accessible, friendly, and meaningful, and fits seamlessly with the open-ended, modular nature of the final concept.

Figure 62: Presentation of the final model.

8.2. Design Rationale

The concept of Movemates was developed from a combination of insights, observations and inspirations drawn from both children's behavior and existing play materials. A key starting point was the **versatility** and **unpredictability of balls**. Their rolling motion, tactile feedback and the universal enjoyment of ball games. especially dodgeball, demonstrated that children across genders are highly engaged by objects that invite throwing, chasing and aiming. Importantly, this type of play is only enjoyable when the object is soft enough to prevent pain or fear of injury (Figure 63: Dodge ball (Mini Trefbal Mega Set 50st., z.d.)). Despite their popularity, ball-based designs come with a limitation: the market is already saturated with variations that primarily focus on object control, particularly the subskill of ball handling. This narrow focus limits opportunities to stimulate a broader range of motor skill domains or to encourage more diverse, full-body engagement.

Figure 63: Dodge ball (Mini Trefbal Mega Set 50st., z.d.)

In parallel, **traditional gymnastics mats** provided a second point of inspiration (Figure 64: Gymnastics mat (Vinex shop, z.d.)). Children were observed actively jumping and tumbling on soft surfaces, enjoying the physical feedback and the sense of safety it offered. The sensory experience of landing on something cushioned added a layer of excitement and freedom to their movements. Yet, these mats present practical drawbacks. Their bulk makes them difficult to transport or reconfigure, and while they do encourage certain types of movement, their contribution to overall motor development remains relatively limited due to their static nature.

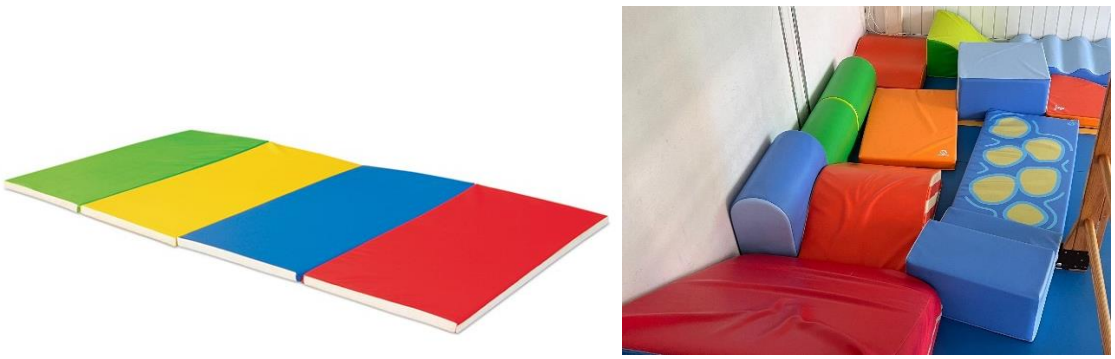


Figure 64: Gymnastics mat (Vinex shop, z.d.) & mats observation Egelantier school

Finally, **existing stepping stone products** highlighted the appeal of open-ended, modular elements that children can arrange and reimagine in countless ways (Figure 65: Stepping stones (GmbH, 2024; kinderspel, 2025)). Whether used to build an obstacle course, practice balance, or simply stack, their shape offered both physical challenge and creative opportunity. What stood out most was how children intuitively assigned their own function to the form, turning a balance path into a launchpad or flipping a dome into a seat.

Although this modularity promotes imagination, the strongly defined form of these commercial products tends to guide play in predictable directions. Most existing stepping stone designs are specifically intended for balancing alone, with limited affordances for other types of interaction. For instance, the GmbH version mainly supports two-dimensional configurations, and the rigid material somewhat limits how it can be handled or repurposed. As a result, the creative freedom of the child is subtly constrained by the object's predetermined function and form. In contrast, the goal of my design is to offer children full flexibility in how they choose to interact with the product, whether through building, throwing or constructing imaginative courses, without the form imposing a predefined use.

Figure 65: Stepping stones (GmbH, 2024; kinderspel, 2025)

By combining these three worlds **the active engagement of soft balls**, **the safe energy of gym mats** and **the creative freedom of modular stepping forms**, the concept of the Stepping Stones was developed. These objects are designed to invite throwing, building, balancing and movement, all while remaining safe, soft and open to interpretation. The resulting design is not a single-function toy, but a dynamic play tool rooted in freedom, motor skill development and sensory joy.

8.3. Concept description

Movemates is a multifunctional and modular play system designed to support the development of motor skills, creativity and self-directed physical activity in children aged 3 to 6. The final concept comprises six soft geometric elements and a complementary set of play instruction cards (see Figure 66: 3D Concept):

- Two circles (one with and one without a hole)
- Two squares (one with and one without a hole)
- One half-sphere
- One ring

These lightweight and durable components together form a versatile and intuitive play environment. The design approach is based on the principle of "less is more," whereby a limited number of elements with varied functional features aim to create broad motor skill engagement. This strategy is based on the principles of the Athletic Skills Model (ASM), which highlights the importance of movement diversity and adaptable tools for early motor skill development (Appendix S (Key Insights Athletic skills model workshop Best)). Each element was developed to contribute a distinct interaction modality while remaining part of a coherent visual and functional system.

To support both autonomous and facilitated play, the concept includes a set of instruction cards. These cards provide movement suggestions that correspond to the different elements, offering users, whether children, educators or caregivers, entry points for engaging with the system. The content remains intentionally open-ended to accommodate a variety of play styles and developmental levels, as required in the Program of Requirements (PoR) related to inclusivity, repeated use and intrinsic motivation.

The structural core of each element is constructed from PU foam, selected for its lightweight and deformable qualities. These characteristics allow the elements to be lifted, squeezed, stepped on and thrown safely, enabling both fine and gross motor interaction. The TPU outer layer provides non-slip functionality and resistance to abrasion, tearing, UV exposure, and water, thereby meeting safety and durability requirements for both indoor and outdoor use.

From a functional perspective, each element is designed to support a specific subset of motor skill domains including balance, object control, fine motor coordination and movement variety as identified in the analysis of motor skill delays (Chapter 5.5) and in Figure 13: Movement Goals. For instance, holes in selected elements enable the insertion of sticks or ropes, thereby expanding the range of use and encouraging actions like connecting, building or lifting. These features are intended to stimulate both tactile engagement and imaginative movement planning.

The concept was iteratively tested in two user sessions involving children within the target age group. These sessions were used to evaluate how children engaged with the elements and to determine whether the design prompted diverse motor skill activities. Observations showed that even a limited set of six components provided a broad basis for spontaneous and varied movement. Children interacted with the elements in different ways, including climbing, jumping, rolling and constructing. Several forms were repurposed into imaginary tools or props, such as

goals, ramps or platforms, indicating that the system supports flexible interpretation and motor skill-rich play scenarios.

This set of findings provides a foundation for the subsequent development of the individual elements, which will be discussed in the following section on form development.

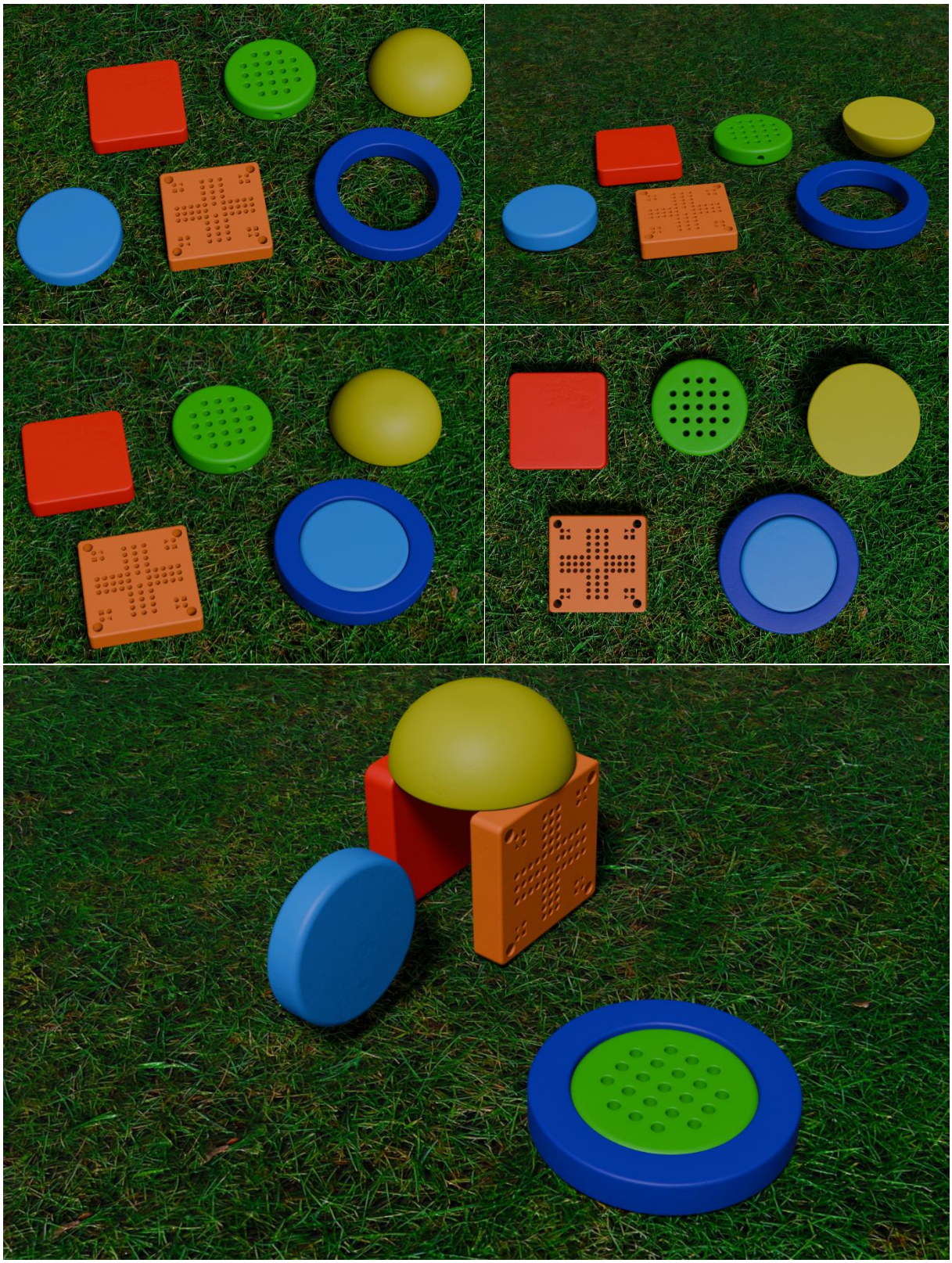


Figure 66: 3D Concept

8.4. Functional Form Descriptions

Each form is selected for its motoric value, symbolic meaning and role as a modular stepping surface. Together, the set creates endless combinations that encourage children to build, jump, balance, aim and explore. The simplicity of each form ensures that children are not led by instruction, but by curiosity, allowing spontaneous and self-directed play.

● **Circle**

The circular form supports ball-related play such as rolling, throwing and kicking. Its rounded shape stimulates gross motor coordination, especially in targeting and tracking moving objects. The circle also functions as a stepping target, inviting children to land or balance precisely, which promotes spatial control and dynamic balance. In building, circles are intuitively associated with wheels, seeds and rotating parts, sparking creative constructions.

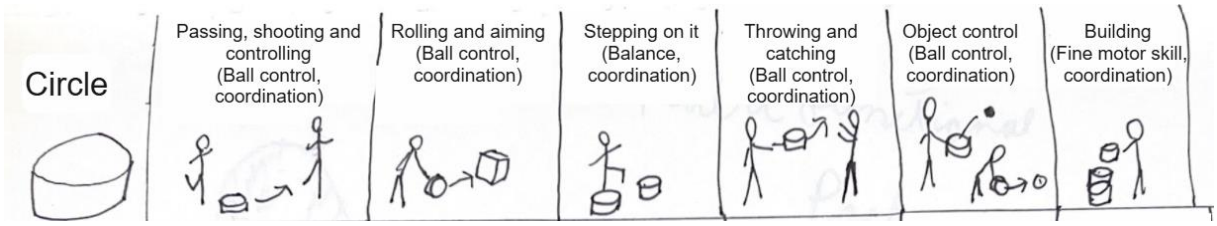


Figure 67: Circle activities

■ Square

The square offers a stable and familiar platform for stepping, standing and jumping, making it ideal as a Stepping Stone in parcours-style play. Its flat and predictable surface supports confidence-building in children who are still learning to control their body in space. Squares are also used as targets to throw at, or as obstacles to step over or around, training object control and spatial planning. In construction, they symbolize walls, foundations or platforms, providing structure in creative builds.

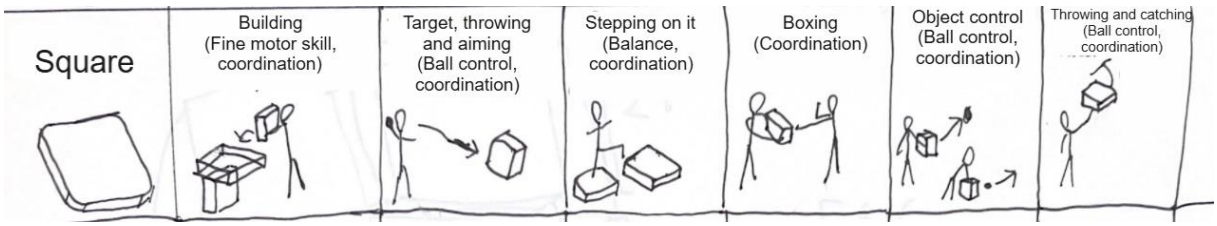


Figure 68: Square activities

◐ Half Sphere

The half-sphere shape is primarily designed for balance training. Its rounded base creates an unstable surface, encouraging children to stabilize themselves while standing, stepping or shifting weight. This improves core activation and balance reflexes. The half-sphere can also be turned upside down to create a raised stepping point, adding a new challenge to movement paths. When thrown, its irregular bounce patterns promote reaction speed and hand-eye coordination. As part of construction play, it introduces a dynamic element, mimicking a rocking base or a moving seat.

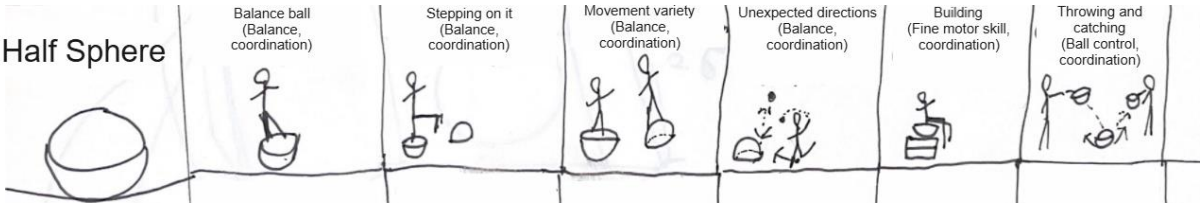


Figure 69: Half sphere activities

◯ Ring

The ring, with its open circular shape, offers multiple motoric possibilities. It functions as a target for throwing games, a stepping point with limited surface area and a rolling object that requires control and timing. As a Stepping Stone, it challenges precision and balance, since the child must aim for a narrow surface and stabilize quickly. The ring invites both goal-oriented and creative use, supporting coordination, dynamic stepping and imaginative interaction. When tilted or stood upright, the ring introduces new movement dynamics and additional balance or aiming challenges.

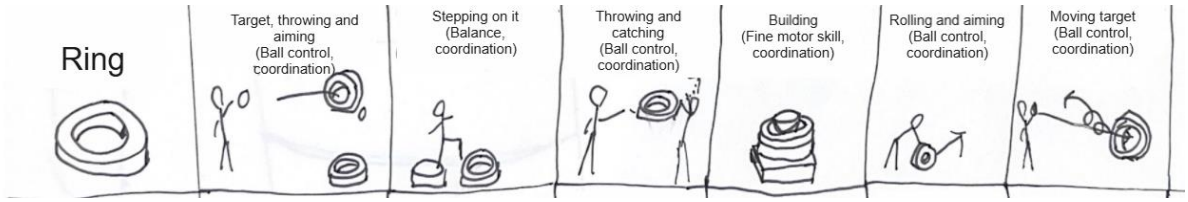


Figure 70: Ring activities

● Patterns

Integrated holes in the shapes allow for additional play extensions, such as threading ropes, attaching sticks or hanging elements from higher structures. This enhances fine motor skill activity and enables the construction of swings, climbing setups or vertical targets. In building play, the holes invite children to connect pieces using natural or found objects, supporting creative engineering and collaborative exploration.

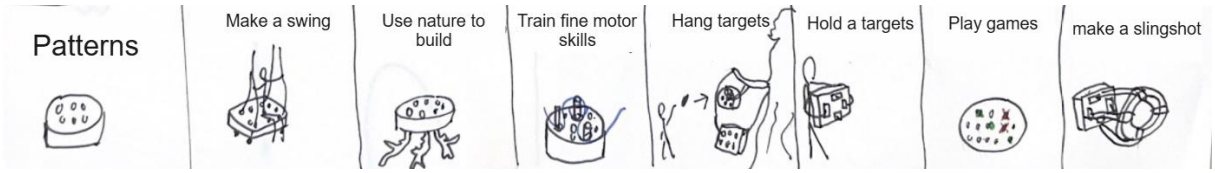


Figure 71: Patterns activities

Surface Pattern Selection

To maintain the simplicity of the product, only features that offer clear added value were included. The half-sphere already allows for diverse interaction, and to avoid compromising its core characteristics, no additional holes or patterns were added. The same applies to the ring, as excessive modifications may compromise the foam's effectiveness. Moreover, to preserve space for imagination, overly specific surface detailing was intentionally avoided.

To still introduce variety and stimulate loose parts play such as incorporating environmental objects surface patterns were only applied to the circle and the square.

Circle

For the circle, a brainstorming session was conducted to explore a variety of options regarding shape size, patterns and quantity. These ideas were developed both as sketches and as SolidWorks models. The proposed variations were evaluated based on functional added value, visual simplicity (whether they looked orderly and easy to understand) and whether they would compromise the foam's properties.

Key functional additions included the ability to hang the product and insert external objects. This supports fine motor skill development and encourages loose parts play, for example by inserting sticks or branches. One important goal for the circle was to support various levels of object control. Therefore, the idea of adding holes to the side was explored to enable the insertion of sticks, branches or broom handles, making it possible to create items like a racket or a play stick.

After the iteration phase, the decision was made to include four holes spaced 90 degrees apart (Figure 72: Ideation on holes on the side of the circle). This offers sufficient anchor points without excessively affecting the foam's structure. These side holes connect to a hole on the top surface, allowing a rope to be threaded through, enabling children to create features like rackets or hang the object as a target.

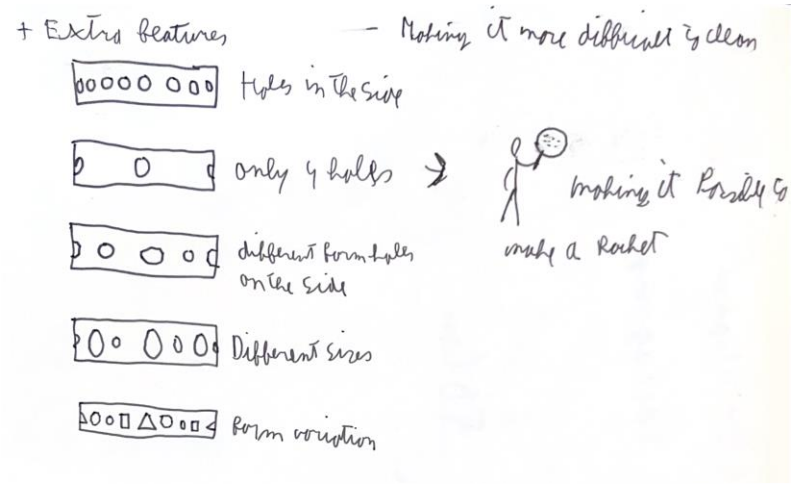


Figure 72: Ideation on holes on the side of the circle

Two of the holes have a diameter of 25 mm to allow the insertion of a standard broom handle. Common garden and household broomsticks typically range from 22 to 28 mm (De Greef, n.d.). The other two holes have a diameter of 20 mm, making them suitable for threading rope or inserting slightly thinner sticks. The tested handles were 22 and 23 mm in diameter (Figure 73: Measurement diameter broom 22 & 23 mm). Thanks to the flexibility of the foam and the stretch of the outer cover, these fit snugly and remain firmly in place. Swing rope typically ranges from 10 to 18 mm in thickness, with 10 mm used for standard swings and 16 mm for larger models (Touwbestellen.nl, 2022).

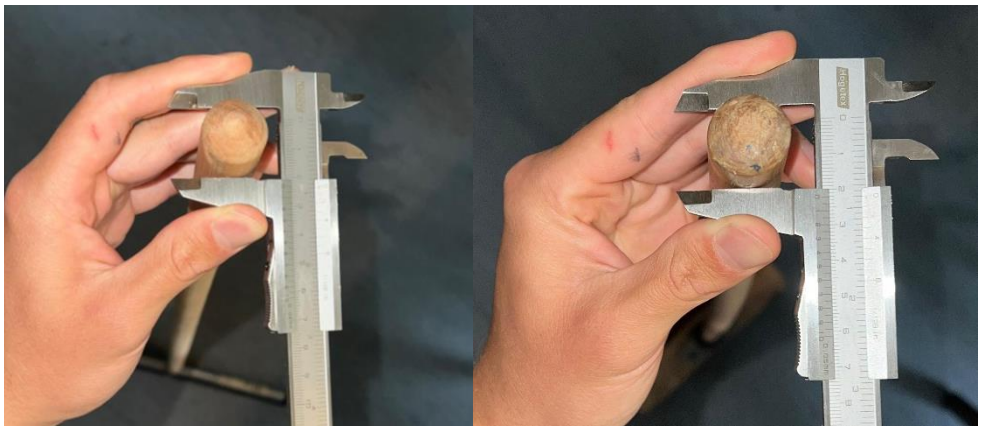


Figure 73: Measurement diameter broom 22 & 23 mm

For the top surface pattern, a structured paddle-like layout was chosen out of the brainstorm session to stimulate tapping interaction while maintaining a clean appearance (Figure 74: Pattern ideation circle sketches and SolidWorks models). The holes in this pattern are 15 mm in diameter. This size was selected to support marbles, which most commonly measure 16 mm in diameter (De Knikkerprins, n.d.). The slightly smaller holes allow the marbles to rest stably, partially recessed into the indentation. These holes also allow rope to be threaded through, broadening the potential for creative interaction.

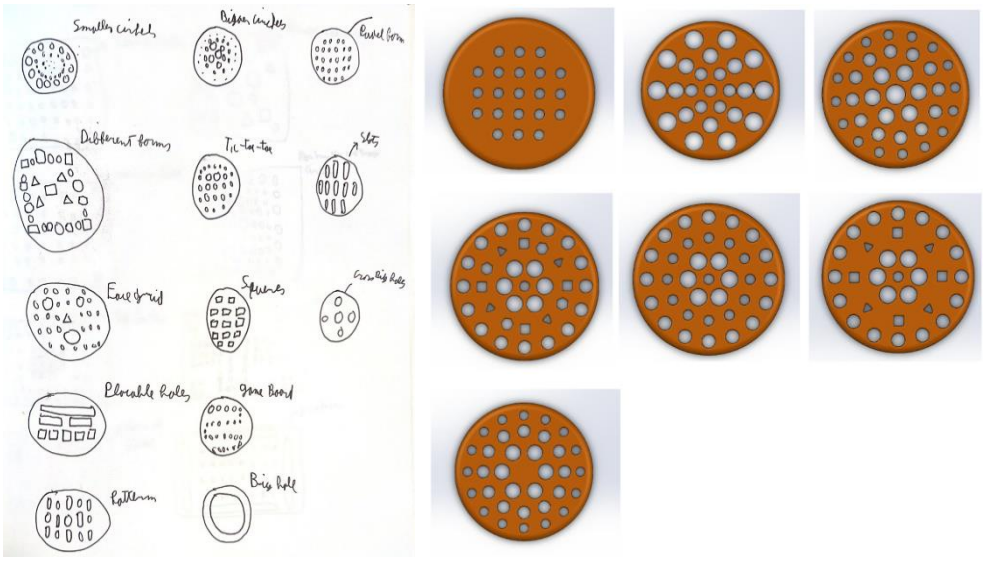


Figure 74: Pattern ideation circle sketches and SolidWorks models

Square

For the square, the design objective was to create added functional value by enabling the construction of a simple swing. Additionally, the surface features pattern elements in different sizes and shapes to encourage shape recognition and matching, thus promoting fine motor development.

As with the circle, a brainstorming session was conducted to explore different pattern layouts, forms, and configurations for the square (Figure 75: Ideation pattern squares). This surface was evaluated using the same criteria as the circle. After several iterations, a cross-shaped pattern was selected. This functions both as a visual focal point and a simplified game board for Ludo, a

game popular in family environments that also encourages parent-child interaction. The area around the cross was intentionally left open and not fully filled in, in order to preserve visual clarity and simplicity and to avoid compromising the foam's flexibility and usable surface area.

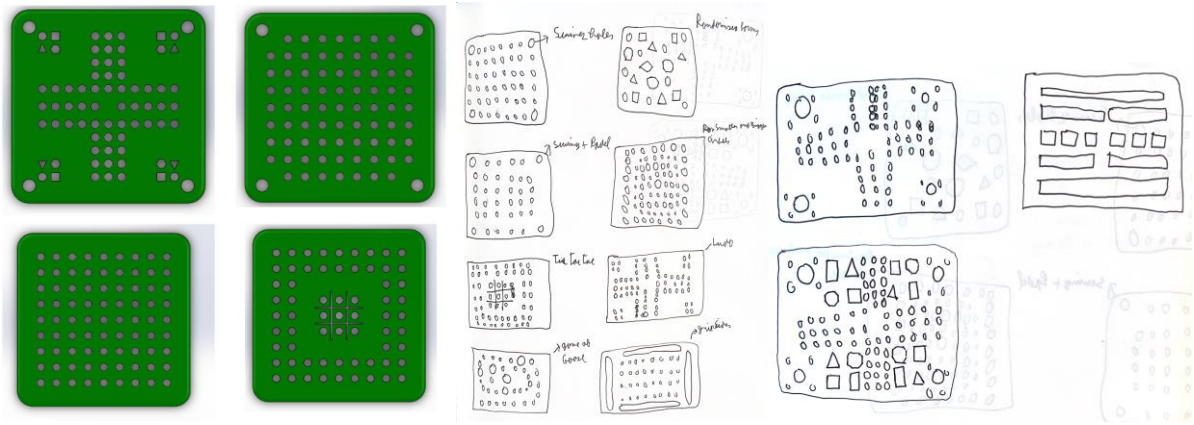


Figure 75: Ideation pattern squares

In the starting fields of the Ludo layout, additional shapes were included to encourage children to match and place forms, thereby initiating gameplay and supporting fine motor skill development.

Each corner of the square contains a hole with a diameter of 20 mm, allowing easy attachment of swing rope. All pattern holes have a diameter of 15 mm, for the same reasons as in the circle: to support threading, placing marbles and enabling various playful interactions. The chosen shapes also allow for a wide variety of external objects to be inserted, expanding the possibilities for imaginative and active play.

Conclusion

While the visual language of *Movemates* is intentionally minimalistic, each shape reflects deliberate design decisions based on the intended motor skill development outcomes and observations from user testing (Figure 64: Form and function). Rather than offering a single-use function, the elements serve as flexible tools that support a wide range of physical activity, imagination and open-ended interaction. This allows the product to address multiple motor domains, including locomotion, object control, balance and fine motor skill coordination.

The design reflects multiple criteria outlined in the Program of Requirements. It facilitates movement-rich motor skill development by offering varied physical engagement opportunities. The open and modular structure allows for both individual and collaborative forms of play, contributing to repeated and sustained interaction over time. In addition, the use of simple geometric shapes combined with features, such as integrated holes for potential extension supports, multi-use application and adaptability across diverse environments. The form factor and interaction modes are aligned with the developmental needs and physical abilities of children aged 3 to 6.

By combining accessibility with purposeful variation, *Movemates* forms a platform that invites children to explore, construct, balance, throw and imagine. Its versatility ensures that core requirements such as safety, durability and physical engagement are addressed, while maintaining space for child-led discovery and developmental progression.

8.5. Added Value – play instruction card set

To enhance engagement and encourage meaningful movement experiences, **Movemates** includes a complementary **instruction card set**. This set is designed for children aged 3–6 and can be used by children alone, with peers, or in **collaboration with caregivers**. Each card contains:

- a simple, playful activity;
- a clearly linked movement goal (such as balance, coordination, or creativity);
- a tip for adult-child interaction to strengthen social and emotional connection;
- an indication of which Stepping Stone shapes (based on the physical set) can be used for the challenge;
- a theme with a color code.

These cards are intended to serve as accessible guidance tools for caregivers, particularly for those who may feel unsure about how to support their child's motor development an issue identified during the research. By providing clear instructions and structured yet playful suggestions, the cards lower the threshold for caregiver involvement and help create supportive movement experiences during critical developmental periods.

In addition, the themed scenarios are designed not only to stimulate imagination and narrative play, but also to enrich children's general knowledge. Each theme introduces new contextual elements that may lie outside the child's direct experience. This approach fosters cognitive engagement and thematic learning, encouraging children to explore unfamiliar domains while engaging physically. Blank cards in the same visual style are included to allow children to invent their own games. These allow children to invent their own games, encouraging personal expression and ownership (Figure 76: Format play card and Figure 77: Example play cards).

This approach bridges **open-ended play** with **guided movement tasks**, empowering children to explore while also gaining structure when needed. The design of the cards ensures usability across settings, from homes to schools and therapy spaces.

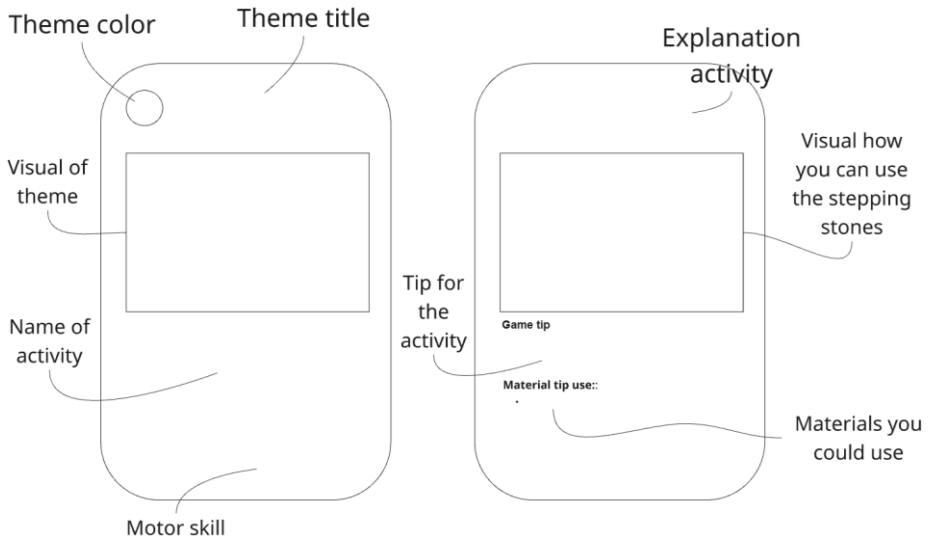


Figure 76: Format play card

Figure 77: Example play cards

8.6. Design and Play Value

The selected set of six Stepping Stones allows children to create a wide variety of movement patterns, whether playing individually or in groups. This number provides an ideal balance between play versatility and manageable scale, making the system suitable for use in homes, classrooms and outdoor environments.

All forms are designed with rounded edges and corners to prevent sharp edges from potentially causing injury, such as contact with the eyes. The rounded design also gives the elements a more elegant appearance and prevents them from looking bulky. The following figure illustrates the key dimensions and anthropometric rationale behind the sizing of the elements, which are further elaborated on in the paragraphs below. An overview of the specific product dimensions is included in Appendix U (Dimensions products).

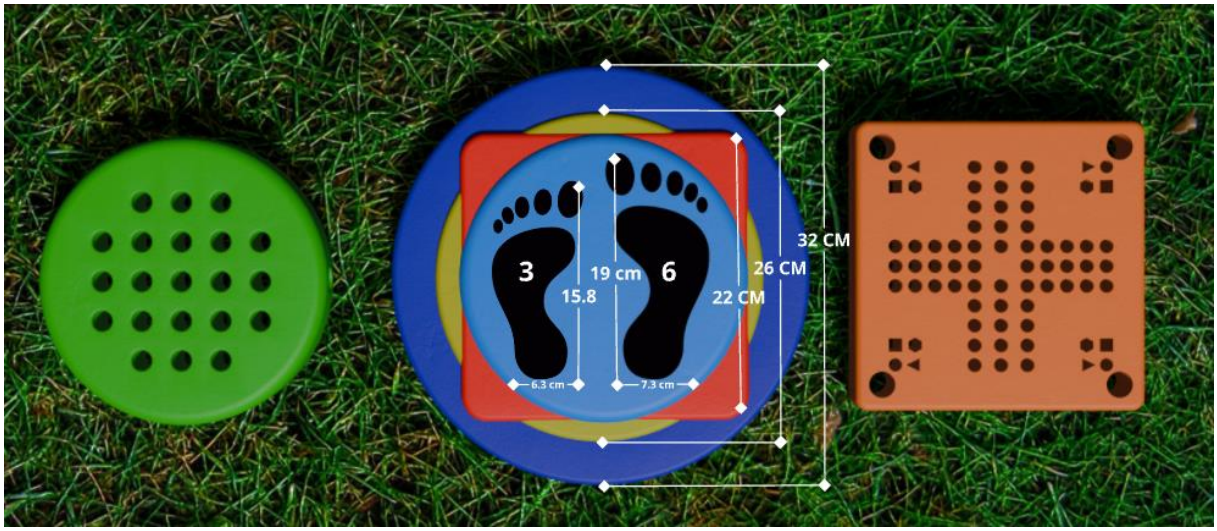


Figure 78: Measurements and visual communication of mean from 3 and 6 year old child according to DINED

The circle and square elements each measure 22 cm in diameter or side length. This size was chosen based on validated anthropometric data for children aged 3 to 6. According to the DINED Dutch child anthropometry database, the average foot length of a 6-year-old is approximately 19 cm, with 99% of children falling below 21 cm. To ensure sufficient surface area for stable stepping and landing and to promote confident movement, a margin of 1 to 1.5 cm around the average foot length was applied. This choice is informed by general recommendations for children's footwear, which advise 1 to 1.5 cm of space to allow for natural movement and growth (Walenkamp, 2025). In the context of Movemates, this margin is particularly important because the product is designed for both indoor and outdoor use, where children may wear shoes. The added space helps maintain a safe and accommodating landing surface across a variety of use scenarios. This sizing ensures nearly universal usability within the target age group and complies with ergonomic standards for child-centered, load-bearing platforms as outlined in ISO 15537:2004 and EN 71-1:2014.

The ring is designed with an inner diameter of 22 cm and an outer diameter of 32 cm, enabling the circular forms to nest inside. This creates opportunities for layered interaction and larger landing zones for dynamic activities such as jumping. All three of these flat forms share a

standard thickness of 5 cm, which supports stability, stackability and a coherent visual language across the set.

The half-sphere is intentionally designed with a diameter of 26 cm and a height of 10 cm. This sizing is also grounded from the DINED database, which states that the average hip width of a 6-year-old is approximately 217 mm, with 99% of children below 245 mm. The chosen diameter provides a stable and spacious surface beneath the hips, which are essential for maintaining balance during upright or dynamic activities. Research confirms the importance of hip stability in supporting balance and coordination in early childhood (Jacobs et al., 2024). The 10 cm height of the half-sphere raises the center of gravity, introducing a greater balance challenge, coordination training and motor skill development, while still offering a safe and spacious standing surface. This combination of increased height and appropriately sized diameter makes the half-sphere both safe and effective for stimulating postural control and coordinative play in early childhood.

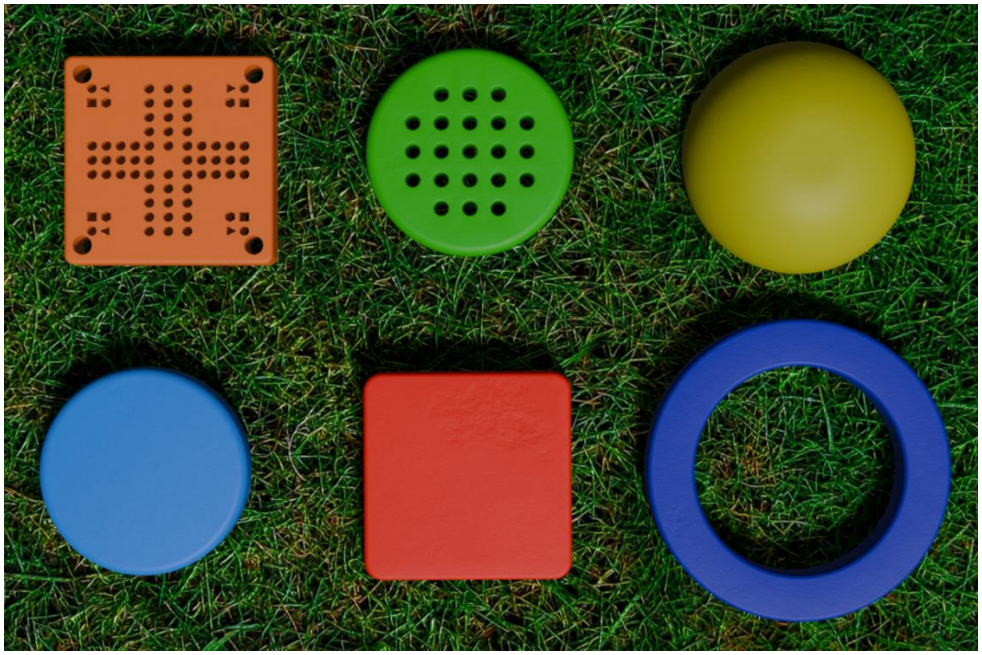


Figure 79: Colored stepping Movemates

Finally, all elements are produced in bright, saturated colors (Figure 80: Saturated colors (Primary- and Secondary colors)) that were carefully selected to optimize visibility, engagement, and play motivation. Studies show that vivid hues naturally capture children's attention and support sustained interaction, making them ideal for stimulating energetic and imaginative play. The chosen palette is deliberately gender-neutral, ensuring that the product appeals equally to all children regardless of gender, and avoids reinforcing stereotypical color associations.

Figure 80: Saturated colors (Primary- and Secondary colors)

Material Choices

Material selection was made in close consultation with a **materials expert** (L. Rossing, meeting March 2025), to ensure the final product would meet the demands of **durability**, **child safety** and **comfort**. The product consists of two primary layers:

- **Outer Shell: Thermoplastic Polyurethane (TPU)**
  Chosen for its high-performance characteristics, TPU is UV-resistant, abrasion- and tear-resistant, water- and dirt-repellent and non-toxic. Its anti-slip texture and soft-touch provide both safety and sensory appeal.
- **Core: Flexible PU Foam**
  This foam is lightweight, compressible, and resilient, ensuring safety during active play. It also offers sound-dampening properties and remains comfortable to the touch even in warm or cold conditions.

The foam hardness will be refined in the next phase based on children's physical responses during testing. Finding the optimal balance between stability and softness is essential to ensure both comfort and safe motor skill engagement.

Manufacturing and Costing

The Movemates are designed for production using a combination of **Thermoforming** for the **TPU outer shell** and **foam casting** for the **PU foam core**. This method is ideal for medium- to large-scale manufacturing, offering a seamless, durable and child-safe product.
By foam casting the PU core into the thermoformed TPU shell, the product functions as a cohesive unit. It is built to last and is resistant to rough use (bully-proof)**.** Although this approach does not favor recyclability, further research should be conducted to determine the best way to balance durability with sustainable end-of-life solutions.

Since TPU is an airtight material, an integrated *venting solution* is required within the protective cover to allow trapped air and gases to escape during foam expansion. Without such a vent, negative pressure or internal deformation may occur during curing or regular use. Creating a controlled venting mechanism helps ensure dimensional stability, supports even foam distribution and prevents structural stress on the outer layer.

Cost Estimation

Based on an anticipated production volume of over 1,000 units, a comprehensive cost estimation has been conducted for one complete Movemates set, consisting of six play elements and an accompanying instruction card set. The total estimated manufacturing cost per set is approximately € 18.40, excluding tooling investment. When amortizing mold costs over a production run of 1,000 units, the total cost per unit increases to approximately € 22.50, which will decrease when producing more.

Breakdown of Unit Cost

Cost Component	Estimated Cost per Set	Details
TPU outer shell (Thermoforming)	€ 2.75	Based on a 0.3 kg material requirement per set and a bulk price of € 9.00/kg from Vreeberg (2025)
PU foam core (Casting)	€ 11.15	Based on 796 g per set and a bulk rate of € 14.00/kg from Silicones & More (n.d.)
Assembly and quality control	€ 1.25	Based on 12 min/set. NL wage € 14.40/h (Ministerie van Algemene Zaken, 2025), LT € 6.35/h (De Jong, 2024). Lowest rate used: € 1.25/set.
Basic packaging	€ 1.00	Corrugated box with inner wrap
Instruction card set	€ 0.50	Full-color printed, A6-sized cards
CE certification (allocation)	€ 0.30	Proportional cost for compliance with EN 71 standards
Contingency (5%)	€ 0.90	Margin for unforeseen material or process deviations
Subtotal	€ 18.40	

Table 2: Cost price estimation per set

These figures are based on current market rates and standard practices for medium-scale manufacturing. The relatively low unit cost is made possible by several factors: the use of common materials (TPU and PU foam) with low material costs, simple geometric forms that reduce mold complexity and tooling cost, and efficient production methods like thermoforming and foam casting which require minimal labor and post-processing. Furthermore, scaling the production beyond 1,000 sets ensures economies of scale, spreading fixed setup costs over a larger number of units.

Investment cost

To manufacture the six distinct foam elements, a total of six molds are required: four of standard complexity and two featuring internal cutouts. The latter require more intricate mold design and higher tooling costs. The breakdown is as follows:

Mold Type	Cost per Mold	Quantity	Subtotal
Standard PU/TPU molds	€ 600	4	€ 2,400
Complex molds (with holes)	€ 850	2	€ 1,700
Total Tooling Investment			**€ 4,100**

Table 3: Cost estimation per mold

These prices are based on quote estimator of Protolabs. Amortizing this tooling cost across a run of 1,000 units results in an additional € 4.10 per set, bringing the total estimated cost per set to € 22.50.

The total cost per set of € 22.50, including amortized tooling, reflects medium-scale production at a volume of 1,000 units. This cost is expected to decrease at higher production volumes as fixed costs are distributed across a larger quantity. Production and assembly are planned within Europe, which aligns with goals of maintaining process control, supporting traceable supply chains and reducing transport-related environmental impact.

This cost structure positions Movemates within an accessible price range for both educational and consumer markets, while supporting material durability and safety requirements defined by relevant standards (EN 71-1:2014; ISO 15537:2004).

Certification and Compliance

The product will be CE certified, adhering to EN 71 safety standards for mechanical integrity (EN 71-1), flammability (EN 71-2), and chemical composition (EN 71-3 and EN 71-15). Materials and production processes are selected to meet these requirements, ensuring child safety across all contexts.

Certification under EN 71 standards and the selection of durable, child-safe materials ensure that the product meets the requirements defined in the Program of Requirements regarding safety, material quality and applicability across both educational and consumer contexts.

8.7. Conclusion

The final concept of *Movemates* consists of six modular elements developed to support diverse motor skill development in children aged 3 to 6. Design choices regarding form, dimensions and material were based on anthropometric data, functional requirements and outcomes from multiple user tests. Each element was intentionally kept simple to allow for open-ended use, while still offering variation in movement, grip and play scenarios.

The selected material combination PU foam core with a TPU outer shell meets durability, safety, and comfort criteria relevant to both indoor and outdoor contexts. The chosen shapes enable a wide range of movement types and interaction modalities, covering balance, object control, fine motor activity and locomotion.

Instruction cards were developed to support varied application settings and promote repeated use. The concept aligns with the requirements defined in the design brief, including inclusivity, safe use, modularity and compatibility with motor skill development frameworks.

This chapter establishes the design direction, usability and intended function of the concept. The next phase focuses on validating technical feasibility, material processing and production considerations.

Figure 81: Scale prototype of the end product

9 Evaluation and Validation

9.1 Initial Material Feasibility Assessment

Prior to the prototyping and testing phase, several material specialists from Silicone & More, Vreeberg, and the technical teams at Rossing and Kooijman were consulted to assess the technical feasibility of the proposed concept. These consultations, complemented by extensive desk research, provided insights into material behavior and production techniques.

The research confirmed that combining thermoforming and foam casting within a single mold was a potentially viable production method. During this process, it was found that *PU foam* reacts rapidly after mixing and releases toxic gases, necessitating use in a **well-ventilated** environment. Additionally, PU foam adheres strongly to surrounding surfaces, making the use of non-stick agents or anti-adhesive liners essential to avoid unintentional bonding. With this knowledge in mind, the tests were conducted in a well-ventilated environment and under safe conditions, including the use of protective clothing (Figure 82: Implementation of Safety Measures During Material Testing).

Figure 82: Implementation of Safety Measures During Material Testing

9.2 First Iteration – Prototype Development

Physical prototypes were created to validate the concept and assess material behavior during the foam casting process. Two PU foam types: Altrofoam SF 50 (50 kg/m^3) and AltroFoamFlex SF 280 (280 kg/m^3) were tested to determine the optimal softness , based on findings from earlier user testing.

TPU printed shell

The intended approach involved casting the foam directly into a TPU shell formed through thermoforming. Due to limited availability of suitable TPU film, initial trials utilized **3D-printed TPU covers**. These attempts were unsuccessful, as the resulting material proved too rigid and lacked the expected flexibility. Subsequent consultations revealed significant variation in TPU formulations and processing methods, which greatly influence final material characteristics. This highlights the critical role of material selection in ensuring compatibility with thermoforming and foam casting processes, while maintaining functional integrity and user comfort.

Figure 83: TPU printed cover

9.3 Material Sourcing and Adaptation

Sourcing appropriate TPU film proved more challenging than initially anticipated. Eventually, sample sheets from Vreeberg were obtained, offering a realistic representation of the required material characteristics in terms of flexibility, UV resistance, abrasion and tear resistance, and non-toxicity. Given the limited number of suitable suppliers in the Netherlands, the focus shifted toward testing the foam casting process itself.

Waterproof adhesive aslan folie in various colors were used to mimic the final appearance of the TPU cover. To reduce material costs, **baking paper** was used as a substitute for professional anti-stick sprays. Although this may have affected surface results slightly, it was sufficient to evaluate the core principles of PU foam casting within a mold. To explore different surface qualities and simulate the intended outer layer, materials such as Aslan foil and baking paper were employed during prototyping. In addition, samples of TPU, foamed TPU, and TPE were collected to evaluate tactile, visual and structural properties relevant to the design intent (Figure 84: Mold with Aslan foil, baking paper for prototyping & TPU, Foamed TPU and TPE samples).

Figure 84: Mold with Aslan foil, baking paper for prototyping & TPU, Foamed TPU and TPE samples.

9.4 PU Foam Density Testing

A preliminary test was conducted to evaluate how different PU foam densities behaved during mold casting, with the specific aim of identifying a formulation that closely matched the softness preferences identified in previous user testing. Two variants were assessed: *Altrofoam SF 50* (50 kg/m^3) and *AltroFoamFlex SF 280* (280 kg/m^3).

Based on tactile assessment and the materials' behavior during expansion and curing, Altrofoam SF 50 was identified as the most suitable option. Its softness and flexibility corresponded well with the comfort and safety requirements indicated during prior validation sessions. A side-by-side comparison of both foam types is shown in Figure 85. As a result, Altrofoam SF 50 was selected for continued prototyping and further functional evaluation.

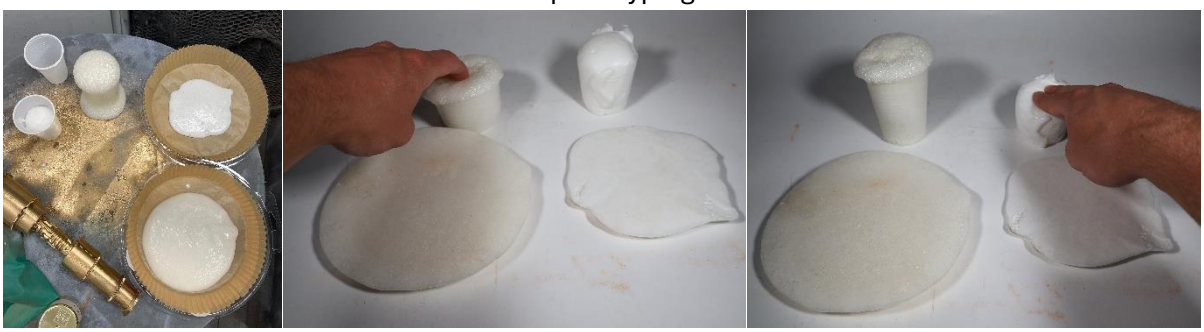


Figure 85: Density testing PU left Altrofoam SF 50 right AltroFoamFlex SF 280

9.5 Mold Design

The mold design process focused on incorporating gas venting and overflow channels to manage excess foam during the casting process. An additional priority was to ensure precise alignment between the two mold halves, in order to guarantee a consistent and accurate final shape. To evaluate this, an initial scaled prototype was created using protruding alignment pins designed to fit exactly into corresponding holes.

Following the 3D print, it became clear that achieving a perfect fit was challenging. As a result, fillets and chambers were added to the pin geometry to improve alignment and ensure a tight seal during casting. This adjustment significantly enhanced the mold's performance, although separating the parts after casting still required considerable force.

To evaluate whether the tight fit was necessary, a final iteration was produced using only alignment holes and pins, without additional locking features. This approach allowed for easier

demolding while still maintaining sufficient guidance and stability. In practice, this simplified version proved even more effective, demonstrating improved usability without compromising the overall casting quality.

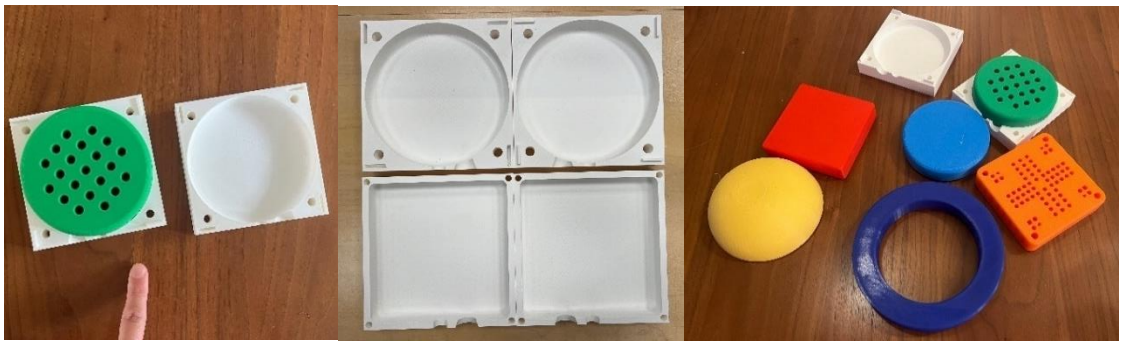


Figure 86: Iteration molds

9.6 Iterative Testing

The first casting attempt failed due to insufficient PU volume and the presence of **wrinkled, non-thermoformed film**, which allowed foam to leak behind the intended lining.

In a second test, **raised mold edges** and an **increased PU volume** were used. While this allowed for more effective overflow management, the raised edges negatively impacted the final shape. In a third and final test, a **flat TPU film** was applied, precisely matching the top surface without folds or rounding. This configuration produced a significantly improved result: foam spread evenly, and both **thickness and distribution** were consistent. Minor surface irregularities were observed, likely due to the use of baking paper in place of professional anti-adhesive solutions. These outcomes underline the importance of using a mold that is suitable for both thermoforming and foam casting, in order to prevent deformation and ensure a consistent final shape.

Figure 87: Foam casting iteration

9.7 Test of foam hardness

A test was conducted to evaluate whether the foam provided sufficient resistance to prevent children from sinking too deeply during use, while still offering the intended balance challenge observed in earlier user testing. The disc was also thrown and kicked during the test to assess whether the material conveyed the desired soft and safe interaction.

As illustrated in Figure 88, the foam compressed by approximately 20% under body weight, indicating that it is likely suitable for the target age group in terms of both support and comfort. Kicking the disc reactivated the previously observed football-like interaction, supporting the material's versatility in active play scenarios.

However, during stepping and jumping, some elements occasionally slid on smooth surfaces. This observation underlines the importance of incorporating **anti-slip properties** into the TPU outer layer to ensure safety during dynamic movement.

Importantly, when the discs were thrown or used in light impact play, they did not cause discomfort or pain, suggesting that the foam hardness provides an adequate level of cushioning for safe physical interaction.

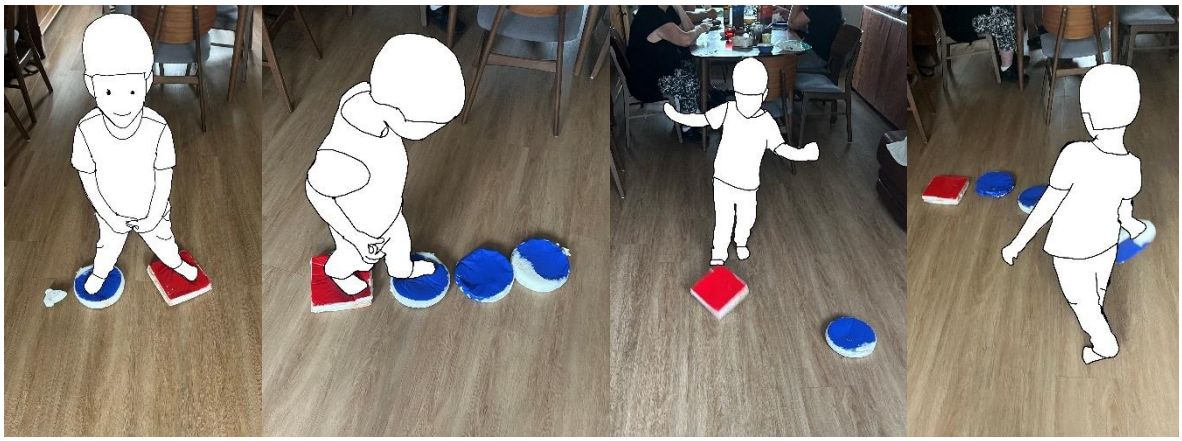


Figure 88: Foam hardness test where the kid directly started to play with the concept

9.8 Key Insights and Considerations

The iterative testing process revealed several critical considerations relevant to the feasibility, safety and reproducibility of the manufacturing method.

- **Mold alignment and shell integrity**: a precisely formed outer shell (e.g., TPU or simulation foil) is essential to ensure correct positioning within the mold and to avoid deformation or uneven casting results.
- **Foam volume control**: accurate dosing of PU foam is necessary to guarantee full mold filling without excessive overflow, which can compromise surface finish and increase material waste.
- **Ventilation strategy**: integrating a small but effective venting channel enables controlled gas release during the exothermic curing process. This prevents internal pressure build up and contributes to consistent foam expansion.

- **Release facilitation**: the application of a reliable anti-adhesive solution (beyond temporary substitutes like baking paper) is crucial to ensure clean demolding, preserve surface quality, and improve process efficiency.
- **Anti-slip requirement**: observations during physical testing emphasize the importance of including anti-slip properties in the outer shell material to ensure user safety during dynamic movement, especially on smooth indoor surfaces.

These insights provide essential input for the refinement of the production setup and material specification, and form the basis for the recommendations outlined in the following chapter.

Figure 89: Iteration of foam casting

9.9 Conclusion

The evaluation and validation phase confirmed the technical feasibility of combining thermoforming and foam casting into a single manufacturing process, aligning with safety and usability requirements defined in the Program of Requirements. Material selection and prototyping efforts identified Altrofoam SF 50 as the most appropriate foam due to its favorable balance between softness and structural integrity for the target age group.

The mold design was optimized through iterative testing, resulting in a configuration that ensures reliable alignment and consistent casting quality. The inclusion of gas venting channels proved essential for avoiding pressure build-up during curing and preventing surface deformation.

Functional testing of foam hardness showed that the material compresses approximately 20% under load, offering sufficient stability for stepping and landing activities while maintaining comfort and safety during impact play. However, the tendency of the discs to slide on smooth surfaces during active use emphasized the critical importance of integrating anti-slip properties into the TPU shell.

Together, these findings validate the material and structural choices of the concept, while highlighting final adjustments such as validation grip and optimized demolding that will be addressed in the recommendation. These refinements ensure the product continues to meet user needs and safety standards while supporting the intended motor skill development goals.

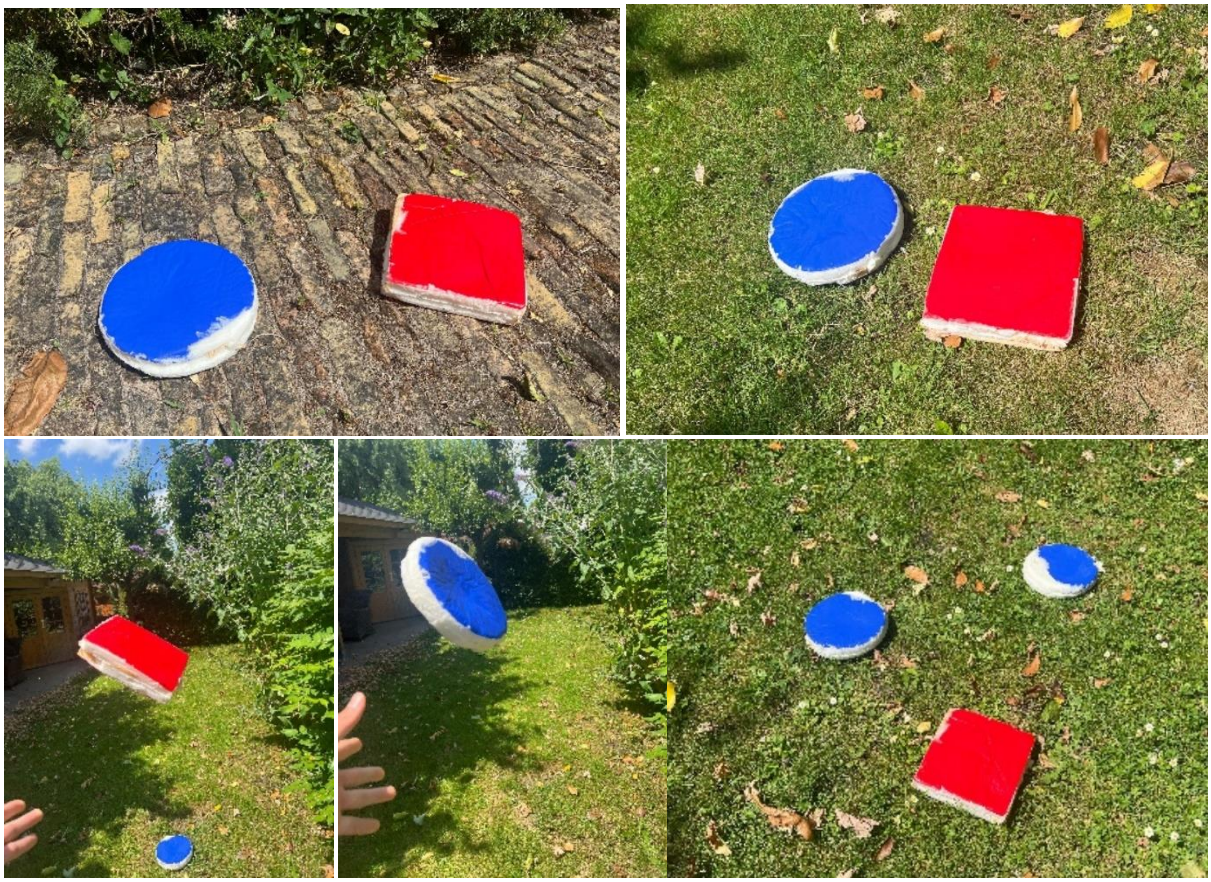


Figure 90: Final prototypes PU-Foam

10 Overall conclusion

This graduation project explored the development of a modular play system designed to stimulate motor skill development in children aged 3 to 6 through open-ended, intrinsically motivating play. Grounded in literature on early childhood motor skill learning, the design was guided by open-ended play, the Athletic Skills Model and supported by movement goals across four motor skill domains: locomotor, manipulative, balance and stabilizing, and fine motor skills. These formed the foundation for both the Program of Requirements and the functional design strategy.

The final concept, *Movemates*, consists of a compact set of geometric play elements, each intended to provoke varied physical interaction while remaining simple and intuitive. The use of soft, deformable PU foam and a protective TPU shell provided a safe and appealing tactile experience, while integrated design features such as varied forms and functional holes encouraged construction-based and imaginative play.

Two cycles of user testing confirmed the concept's validity. Children spontaneously engaged with the play objects across all targeted motor skill domains, showing high levels of physical activity, social interaction and imaginative use. The findings highlighted the product's capacity to support both structured and unstructured play, offering variation in motor skill challenge while remaining adaptable to individual needs and preferences. Particularly notable was the sustained engagement observed even with a limited set of six elements, suggesting that the core design offers sufficient diversity for repeated use without diminishing play value.

The design explicitly addresses the five subdomains in which motor skill developmental delays most frequently occur among children aged 3 to 6: balance, coordination, ball skills, fine motor skill control and movement variety. Each play element was developed to support at least one of these subdomains through its specific form and interaction modality. This alignment ensures that the concept is consistent with the movement goals for targeted motor skill development.

In parallel, extensive prototyping and material testing demonstrated that the proposed manufacturing method combining thermoforming and foam casting is technically feasible. Key insights included the importance of mold alignment, foam volume control and the integration of gas venting to ensure consistent casting quality. The final PU foam formulation provided the desired balance of softness and structural support, while also allowing for impact-based interactions without risk of injury. Observations during testing further emphasized the necessity to test anti-slip properties of the TPU shell to ensure safe use, particularly on smooth indoor surfaces.

Overall, This project shows that applying a research-based, child-centered design approach can lead to a concept that supports motor skill development in early childhood. Movemates brings together movement goals, material considerations, and user insights in a way that reflects the developmental, educational, and safety criteria outlined in the Program of Requirements.

The results indicate that a modular and open-ended play concept, when combined with appropriate materials and feasible production techniques, can contribute to addressing current shortcomings in motor development tools for young children. Recommendations for further development, personalization and design refinement are presented in the following chapter.

11 Recommendations

Based on the insights gained through material testing, iterative prototyping, user observations, and alignment with the Program of Requirements, the following recommendations are proposed to guide the further development and implementation of the Movemates product:

10.1 Design and User Interaction Enhancements

- **Expandability through modular add-ons**
  To enhance long-term play value and motor skill development opportunities, future product lines could introduce additional shapes (e.g., domes, ramps, cones) that expand the physical and cognitive challenge. Each added form can be linked to new activity cards with targeted movement goals, ensuring pedagogical consistency while increasing replayability.

- **Interactive and sensory elements**
  Consider integrating **color-changing features** that respond to heat or water exposure. These sensory stimuli add surprise and engagement, aligning with the product's goal of supporting multi-sensory exploration.

- **Personalization options**
  Offer children the ability to personalize individual elements using reusable and recyclable sticker sets. This not only strengthens the emotional connection with the product but also promotes ownership and creativity, especially in group or therapeutic settings.

- **Functional plugin accessories**
  Design thematic plug-in accessories that fit into the pre-existing holes. These inserts can serve both aesthetic and functional roles such as creating mini playfields, fine motor skill challenges or thematic constructions without compromising modular integrity.

- **Full Instruction card set**
  Develop a complete activity card set that supports both child-led and adult-guided interaction, includes visual prompts and movement goals, and introduces thematic play to stimulate creativity and cross-domain learning.

10.2 Material and Production Optimization

- **PU foam dosing and hardness**
  Further testing is recommended to determine the optimal PU foam volume and density. This ensures sufficient softness for impact play while maintaining enough firmness to support body weight and provide a balance challenge. Observations suggest a compression range of ~20% is appropriate for the target group.

- **Outer shell anti-slip properties**
  Incorporate or enhance the anti-slip surface texture of the outer TPU layer. During dynamic play, especially indoors, slippage was observed, highlighting the need for friction-enhancing features to improve safety and user confidence.

- **Ventilation solution for outer shell**
  Because TPU is airtight, the outer cover must include a discreet yet effective **venting**

solution to prevent pressure build up and underpressure during foam expansion. This is necessary to avoid deformation and ensure clean casting.

- **Mold alignment refinement**
  Future mold designs should continue to prioritize precise alignment features (e.g., guiding pins, fillets, or chamfers) to ensure consistent results. Simpler alignment solutions with reduced locking strength have proven effective and should be further refined for ease of demolding.

- **Foam casting efficiency**
  Ensure the **accurate measurement of PU foam volume** per mold. Overfilling leads to overflow and surface defects, while underfilling results in incomplete parts. Standardizing volume per shape will improve production efficiency and consistency.

- **Anti-adhesive application**
  The use of a **professional-grade release agent** is recommended for future iterations. Substitutes such as baking paper proved inconsistent and can negatively affect surface texture and demolding quality.

10.3 Packaging and Product Ecosystem

- **Multifunctional packaging design**
  Develop packaging that serves a dual purpose: both as a transport/storage unit and as an additional play element (e.g., stackable crate, goal target or ramp). This adds value to the unboxing experience and aligns with sustainability and play-extension goals (Figure 78: Sketch packaging)

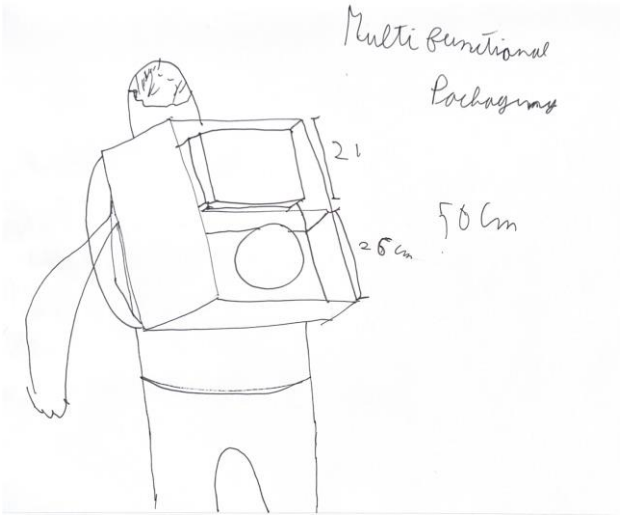


Figure 91: Sketch packaging

- **Construction-focused expansion kit**
  Introduce a “build-your-own-ball” or modular construction kit that allows children to create larger, combinable structures using the same system logic. This would expand the product offering toward constructive and collaborative play.

These recommendations serve as a foundation for future refinement, upscaling and diversification of the Movemates product line. They address both practical manufacturing needs and user-centered enhancements, supporting a robust, safe and developmentally meaningful play experience.

12 Reflection

Personal Development Goals

At the outset of this project, I formulated personal development goals alongside the design objectives. My ambition to work in the field of sports and motor skill development shaped the following focal areas:

- gaining practical experience with co-design methods involving young children;
- improving my ability to visualize concepts through professional-quality renderings;
- becoming more confident in conducting interviews with stakeholders and experts;
- deepening my understanding of motor skill development and effective training strategies.

Co-Design with Children

Through interviews with professionals and by applying co-design elements during user testing, I developed a better understanding of how to meaningfully engage young children in a design process. In parallel with this graduation project, I facilitated co-design sessions as part of my part-time job, which enhanced my confidence and ability in this domain. I now feel equipped to conduct participatory design processes with young children in future projects.

Visualization Skills

Initially, I relied on AI-generated imagery to present design ideas, but as the project progressed, I actively worked to improve my own rendering capabilities. This investment led to visual outcomes I am proud of and which contributed to the overall quality of the project presentation. While there is still room for growth, I now possess a stronger foundation for communicating design intent visually in professional contexts.

Interviewing and Networking

Prior to this project, conducting interviews felt daunting. One of my personal goals was to overcome this hesitation. During the project, I approached and interviewed numerous professionals including well-known names in motor skill development such as Hoeboer, Scherder and Koolwijk. These conversations were not only informative but also empowering. I have since lost my reluctance to reach out to experts and have gained the confidence to build interdisciplinary connections in future roles.

Knowledge of Motor skill Development

My understanding of early childhood motor skill development has grown considerably. I learned to recognize common subdomain delays including *balance, coordination, ball skills, fine motor* skill *control* and *movement variety*, and to design for them with intention. This knowledge base now serves as a foundation for future work in which I aim to contribute to child health and physical development through play-based interventions.

Research Translation and AI Use

One of the core challenges I encountered was translating research insights into actionable design decisions. Over time, I learned to extract key findings and incorporate them coherently into the design narrative. The use of AI-supported tools proved beneficial for refining grammar and structure, but also highlighted the need for careful human oversight: automated tools sometimes removed contextually important information, requiring manual correction. This experience reinforced the importance of critical authorship and editing.

Planning and Time Management

During the early research phase, I underestimated the required time and lacked a clear schedule. After the midterm, I began working with structured planning and realistic intermediate deadlines. This change resulted in a more efficient and less stressful workflow. Going forward, I intend to adopt backward planning methods and integrate peer feedback moments as part of my design process.

Prioritization and Interview Processing

In the early stages, I delayed transcribing and analyzing interviews, which created unnecessary time pressure later on. I now recognize the importance of promptly processing qualitative data and will allocate focused time for this in future projects. Immediate reflection improves data quality and sharpens insight generation.

Target Group Considerations

I learned the importance of considering the calendar of the target audience, particularly when working with schools. Planning around holidays or using them strategically, can enhance access to the target group and streamline research. Understanding daily routines and seasonal factors helped me gain richer insight into children's play behaviors.

Field Engagement and Societal Awareness

By interacting with educators, parents and therapists, I gained a multifaceted view of the challenges facing young children today, particularly in relation to reduced physical activity and increasing screen exposure. These insights have not only influenced my design but also strengthened my commitment to addressing societal issues through meaningful design work.

Design Iteration and Open-Mindedness

A final but important lesson was to avoid discarding design features prematurely. For example, holes in the play elements initially seemed to lack clear value, but might be more effective with minor instruction or framing. I now recognize the importance of iterating thoughtfully and evaluating ideas across multiple contexts before drawing conclusions.

Learning About Materials and Manufacturing

Something I had not expected at the start of the project was how much I would learn about different materials and manufacturing processes. The evaluation phase, in particular, provided deep insights into the behavior of polyurethane foam, the challenges of foam casting and the importance of precise mold design. Through hands-on experimentation, I gained a better understanding of gas venting, foam expansion, material adhesion, and mold alignment. These technical explorations not only improved the prototype's quality, but also broadened my perspective on material selection and production feasibility. Adding a valuable layer of knowledge to my designer's toolkit for future projects involving soft, interactive materials or small-scale manufacturing.

Conclusion

All in all, this graduation project has been an intensive but highly rewarding experience. I have achieved the personal development goals I set at the start, and in doing so, I have grown both professionally and personally as a designer. The process has further confirmed my ambition to work in the field of physical activity and motor skill development, whether through product design or spatial interventions by creating meaningful solutions that stimulate movement and support early developmental needs. I am proud of the final result, which not only reflects a thoughtful and research-driven design process but also marks a clear and confident step toward the kind of designer I aspire to be.

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15 Appendix

Appendix A (Literature review)

Optimizing Motor Skill

Interventions, Impacts, and the Role of Environment

Bart M. W. Gerlag

Abstract

This literature review explores the importance of motor skill development in early childhood (ages 3-6) and examines the most effective interventions, their timing, and key influencing factors. The review brings together research on the roles of genes, environment, and parental support. It emphasizes how important early interventions are for a child's physical, mental, and social development.

Motor skill development in early childhood has lasting effects, laying the foundation for future well-being. Methods such as play-based learning, the Athletic Skills Model, and gamification are identified as effective strategies for enhancing motor skills, physical fitness, and emotional health. Early interventions support the development of coordination, balance, and fine motor skills, improving social-emotional development and cognitive processing. The review also addresses barriers such as socioeconomic inequality, cultural norms, and limited access to resources, which can hinder motor skill development in children.

By identifying optimal intervention strategies and promoting inclusive, engaging methods, the review provides insights for educators, researchers, and policymakers. Promoting motor skill development in early childhood not only benefits individual health, but also reduces long-term public health costs, offering long-lasting societal benefits.

Keywords

Motor Skills, Early Childhood, Physical Activity, Interventions, Influences

Introduction

For decades, the motor skills of Dutch children have been declining (Hoofwijk et al., 2020). In 2022, 43.2% of children aged 4 to 12 did not meet the physical activity guidelines set by the Ministry of Health, Welfare, and Sport (Nederlands Jeugdinstituut, 2023). Modern home environments contribute to this decline, as children increasingly engage in screen-based activities—such as gaming, watching TV, or browsing social media—rather than outdoor play and physical exercise (Iyer et al., 2021).

This decrease in physical activity lead to long-term health consequences. Childhood inactivity is linked to lower participation in sports and exercise in adulthood and poses broader public health risks. Insufficient physical activity is associated with a 20% to 30% higher mortality rate compared to adequate activity levels (World Health Organization, 2024). Encouraging physical activity from an early age not only benefits individual health but also helps alleviate pressure on healthcare systems.

Strong motor skills in early childhood contribute to a healthy BMI, increased physical activity, enhanced social-emotional development, and improved cognitive processing speed and fitness levels (Hoeboer, 2022). Additionally, a solid motor foundation reduces the risk of injury, fosters a sense of accomplishment, and supports neurological development, facilitating learning new sports skills later in life (De Vries & Post, 2021).

This literature review explores effective strategies for improving motor skills and identifies the age at which interventions yield the greatest societal impact. To make sure the analysis was complete, relevant studies were chosen using keyword searches and ideas from news sources and TED Talks were added. All research that was cited was checked for scientific validity. Recent publications were prioritized to maintain accuracy.

Focusing on the optimal timing, methods, and influencing factors in motor skill development among children, this review aims to highlight the most effective interventions. By identifying the most effective interventions and their timing, this review aims to provide insights that maximize both individual and societal benefits.

This review first examines why early childhood is a critical period for motor skill development and explores methods for measuring these skills. It then addresses the role of genetics and various environmental factors in shaping motor development. The review continues with an analysis of interventions, as well as the challenges and barriers to improving motor skills. Finally, the report concludes with a summary of key findings and a personal reflection.

Optimizing Motor Skill Development in Early Childhood: A Critical Period for Intervention

During infancy (0–2 years), children develop foundational gross motor skills such as crawling and walking; however, effective interventions at this stage remain limited (Newell, 2020). Early childhood (ages 3–6) marks the *symmetrical phase*, a critical period in motor development when movements become more coordinated and balanced between both sides of the body. The brain is especially receptive to learning new motor patterns during this time, making it an optimal window for intervention (Lloyd et al., 2014).

In early childhood, varied physical movement plays a key role in shaping motor skill development, which in turn influences long-term physical activity levels (Stodden et al., 2014). Low levels of physical activity increase the risk of poor motor competence (Koolwijk et al., 2024). Early interventions at this stage not only enhance motor skills but also support broader physical, cognitive, and social development. Skill acquisition during this phase has a profound and lasting impact on a child's overall growth, helping to prevent developmental challenges later in life (Newell, 2020; Piek et al., 2012).

From a psychosocial perspective, it is suggested that the main emphasis of any program at this stage of development should be on promoting fun and social interaction to help young children enjoy the learning of new skills and to encourage the interaction process with their peers. (Lloyd et al., 2014)

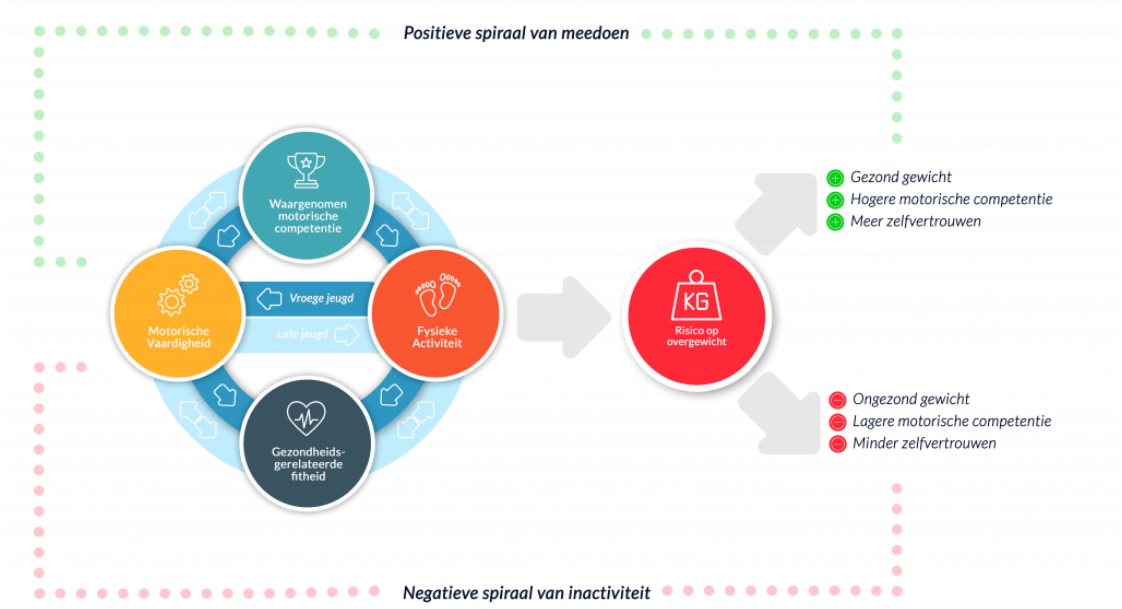


Figure 92 motor skill in relation to physical activity (kennis centrum sport & beweging, 2023)

Methodological Approaches in Studying Gross Motor Skills

In the study of gross motor skills, various methodological approaches have been employed to assess and track motor development. These methods have been extensively reviewed and compared in order to understand their strengths, weaknesses, and overall effectiveness. For further research, attention has been focused on identifying the techniques used, evaluating their reliability, and examining their practical application in the field. The "state of the art" of these methods is determined by assessing how well they are supported by credible and reliable sources, as well as their practical effectiveness in real-world settings.

A table included in the appendix A provides a comprehensive comparison of these methods, highlighting key characteristics such as ease of implementation, scientific validation, and their appropriateness for different contexts. This comparison is crucial for identifying the most suitable methods for assessing gross motor skills, particularly in the context of product development.

For my own research, I have decided not to use the methods outlined in the table, as they fall outside the scope of my product development. Additionally, measuring results over extended periods is not feasible within the framework of my current study. However, based on the literature review, the MQ Scan stands out as the most promising tool for assessing motor progression. This is because it focuses on age-specific tests and the coupling ability within broad motor development, allowing for the accurate measurement of developmental variations. It is scientifically validated, easy to implement, and widely used in the Netherlands. Therefore, the MQ Scan could play a crucial role in either validating my product or evaluating its impact on motor development.

Method	Strengths	Weaknesses	Context use	State of the Art	Suitability for Research	References
Körperkoordinationstest für Kinder (KTK)	- Detailed assessment of motor skills. - Widely used and validated.	- Requires time and training. - Difficult to scale for large groups.	Suitable for **clinical evaluation** and **pre- and post-intervention measurements**, but not ideal for school interventions without additional resources.	Yes	**Less suitable** for large-scale school interventions. Best for clinical evaluations.	(Kiphard & Schilling,2007; Li et al., 2023)
Peabody Developmental Motor Scales (PDMS-2)	- Reliable and standardized. - Measures motor skills at different levels.	- Requires a lot of time and training. - Less suitable for group assessment.	Good for **individual evaluation**, but time-consuming and difficult for large-scale school use.	Yes	**Less suitable** for large-scale school application, better for individual clinical evaluations.	(Folio & Fewell, 2000; Zhu et al., 2024)
Fus Test	- Easy to administer. - Suitable for larger groups.	- Limited in measuring detailed motor skills.	**Excellent for school interventions** and large-scale programs. Useful for measuring general progress in motor skills.	No	**Suitable** for school interventions and larger groups.	(Makaruk et al., 2023)
Bloc-test (Balance, Locomotor, Object Control)	- Simple to administer, suitable for larger groups. - Assesses motor coordination.	- Limited in depth, less detailed.	**Handy for large-scale screening** of motor skills in schools but lacks detailed information.	No	**Suitable** for quick use in schools but lacks depth.	(Visscher & De Kroon, 2011;
VolMij test	- Simple, reliable motor evaluation. - Suitable for multiple children.	- Limited in measuring fine motor skills.	**Good for screening** in schools and large groups but lacks detailed information for interventions.	No	**Suitable** for screening motor skills in large groups but limited in details.	(Vrieswijk et al., 2021)
4's test	- Simple to administer, suitable for smaller groups.	- Limited in measuring motor coordination.	**Suitable for monitoring** motor skills in **small group interventions**.	No	**Suitable** for small group interventions and monitoring, but not for detailed assessments.	(Van Gelder & Stroes, 2010: Van Kernebeek et al., 2018)
Mq scan	-Offers a detailed analysis of various motor skills	- Requires specific equipment and	**Suitable for monitoring motor skills in small group interventions,**	yes	**Suitable** for research due to its reliability and	(Hoeboer et al., 2017; Hoeboer et al., 2016)

	-Designed for ease of use by physical education teachers -Facilitates tracking of motor development over time - age group adjustable - Mostly used in the netherlands	trained personnel for accurate assessment. -Conducting and inputting assessments can be labor-intensive, especially with large groups.	**particularly in educational settings for tracking children's development.**		validity in measuring motor competence in children	

The Roles of Genetics, Environment, and Parental Support on motor development

Genetic Contributions

Genetics significantly influence early motor skill milestones, with heritability accounting for 52% of milestone timing (Zi et al., 2023). Gender-specific patterns show that boys' motor skills are more influenced by genetic factors, while girls are initially more affected by environmental factors, which shift as they age. Though genetics set the foundation, interventions can still enhance motor skills and physical activity levels in early childhood (Zi et al., 2024).

Environmental Factors

The home and family environment contribute 39% to motor skill variation (Zi et al., 2023). Children who engage in goal-oriented play and have active social environments, including positive parental interactions, develop stronger motor skills (Sutapa et al., 2021). Providing safe spaces for physical activity is also crucial for motor development (Vrieswijk et al., 2021).

Parental Influence

Parental support is key in motor skill development. In children with developmental delays, parental encouragement accounts for 30% of physical activity variance, directly impacting motor skills (Ku et al., 2020). Highly educated parents, especially mothers, have a greater influence on girls' motor development, with higher heritability in motor skills (Zi et al., 2023). Parental involvement in physical activity is particularly important for children with developmental delays (Ku et al., 2020).

Educational Impact

Educational settings that prioritize physical activity can improve motor skills and academic achievement (Aadland et al., 2017). Structured programs in schools can help counter the effects of reduced physical activity, as seen during the COVID-19 pandemic (Vrieswijk et al., 2021). In addition Schools contributed to approximately half of daily moderate-to-vigorous physical activity during weekdays (Remmers et al., 2024).

Interventions for Improving Motor Skills

The following paragraphs discuss various interventions for improving motor skills, including the role of play-based learning, the Athletic Skills Model, and the use of gamification to enhance motivation and physical well-being.

The Role of Play-Based Learning in Reducing Mental Health Interventions

Over recent decades, there has been a decline in play-based engagement in elementary schools, which has negatively impacted children's physical and mental well-being. Increasing opportunities for age-appropriate playful learning can help reduce the need for mental health interventions by promoting social-emotional skills and physical health (Allee-Herndon et al., 2019).

The Athletic Skills Model: A Holistic Approach

The Athletic Skills Model (ASM) promotes a broad-based movement education, focusing on "physical intelligence" such as agility, flexibility, and stability. This model encourages varied training programs, fostering skilled athletes while prioritizing health and well-being (Wormhoudt et al., 2017). It suggests that a diverse motor skill base not only prevents injury, but also strengthens neurological development, making it easier for children to learn new sports in the future.

Gamification and Motivation

Incorporating gamification into physical education or rehabilitation programs has proven effective in enhancing motivation, adherence, and overall physical fitness (Alfieri et al., 2022). This approach not only improves physical health. It also supports mental well-being by increasing engagement and enjoyment in physical activities.

This table (Table 1: Intervention summary) highlights both the shared goals of these interventions and how their methods and outcomes differ.

Category	Similarities	Differences
Focus	All aim to improve motor skills and promote physical health.	Play-Based Learning focuses on social-emotional development, ASM focuses on physical intelligence and injury prevention, and Gamification focuses on motivation and engagement.
Key Strategy	All strategies involve engaging children in activities that promote motor skill development.	Play-Based Learning emphasizes playful learning, ASM emphasizes a broad-based movement education, and Gamification integrates game mechanics into physical activities.
Impact on Mental Health	All have a positive influence on mental well-being.	Play-Based Learning directly aims to reduce mental health interventions, while ASM and Gamification focus more on supporting mental well-being through physical activities.
Additional Benefits	All approaches enhance physical health and motor skills through active engagement.	Play-Based Learning emphasizes social skills, ASM focuses on neurological development, and Gamification boosts motivation and enjoyment.

Table 4: Intervention summary

Challenges and Barriers in Motor Skill Improvement for Children (Ages 3-6)

The following paragraphs highlight key challenges and barriers to improving motor skills in children aged 3-6, including access to resources, cultural norms, engagement, and gaps in research.

Access to Resources:
Unequal access to physical education and therapy services is a key barrier. Children from low-income backgrounds often lack structured physical activity opportunities, which impacts motor development (Hock et al., 2024). Addressing these gaps is crucial for equitable skill development.

Cultural and Social Norms:
Cultural norms influence participation in motor activities, with some cultures prioritizing academics over physical play (Gurleyik et al., 2022). Gender roles also impact motor skill opportunities, especially for girls in certain contexts (Zi et al., 2024). Changing these norms is essential for inclusive motor development.

Engagement and Motivation:
Keeping children and caregivers motivated in motor skill interventions is challenging. Children in this age group often struggle with sustained focus (Stevenson et al., 2022). However, play-based learning and gamification can increase engagement (Allee-Herndon et al., 2019), but continuous support of physical play is needed for long-term success.

Gaps in studies
While many studies highlight the benefits of early interventions, there are still challenges. Most studies are short-term and don't show long-term effects. Additionally, different measurement methods make it hard to compare results. Future research should focus on long-term studies and cross-cultural comparisons to better understand motor skill development.

Conclusion

In conclusion, early childhood (ages 3–6) is a key period for motor skill development, which affects physical, cognitive, and social growth. Early interventions are important for preventing future challenges and encouraging a lifelong active lifestyle. While many studies show the benefits of early interventions, there are still challenges. Most studies are short-term and don't show long-term effects, and different measurement methods make comparisons difficult. Future research should focus on long-term studies and cross-cultural comparisons.

Tools like the MQ Scan can help effectively monitor motor development, while parental involvement remains a key factor in supporting healthy growth. Promoting play and movement in schools can contribute to better mental health outcomes and overall development.

Finally, addressing barriers like socioeconomic inequality, cultural norms, and limited access to resources is essential to gain a better understanding of motor skill development over the years. By ensuring equal opportunities and using engaging methods like gamification, play-based learning, and the Athletic Skills Model, motor development and well-being in children aged 3–6 can be improved.

Appendix B (Benchmark analyses)

Product	Description	Motor Skills	Setting	Individual / Group	Strengths	Weaknesses
Tumble Trax (Lakeshore) 	Magnetic marble run for wall-based construction	Fine (building), Gross (reaching)	Home, School	Both	Creative, open-ended play	Requires magnetic surface
GoNoodle Games 	Movement-based digital games	Gross (jumping, dancing)	Home, School	Both	High energy, guided activity	Screen time required
Bilibo 	Shell-shaped toy for rocking and spinning	Gross (balance, core strength)	Anywhere	Both	Versatile, imagination-driven	Limited skill targeting
Montessori Climbing Set 	Wooden climbing structure	Gross (climbing, coordination)	Home, Therapy	Mostly Individual	Durable, encourages physical activity	Needs supervision and space
LEGO DUPLO 	Large interlocking blocks	Fine (grasping, assembly)	Anywhere	Both	Well-known, encourages creativity	Minimal gross motor development
Yoto Mini + Activity Cards 	Audio player with guided movement cards	Gross (guided movement)	Home, Therapy	Both	Screen-free interaction	Limited interactivity

Kibbo Balance Board Kit 	Balance board with guided play cards	Gross (balance), Fine (assembly)	Home, Therapy	Both	Easy to store, promotes skill building	Limited appeal in group contexts
Melissa & Doug Lacing Beads 	Wooden beads for threading	Fine (dexterity, hand-eye coordination)	Home, School	Both	Enhances pincer grasp	Not ideal for group settings
Crocodile Hop Floor Game 	Movement/color-based game	Gross (balance, hopping)	Home, School	Both	Interactive, promotes social skills	Requires space
Fat Brain Toys Squigz 	Suction-based building toys	Fine (grip, coordination)	Home, Therapy	Both	Tactile, creative	Suction can wear out
PlaSmart PlasmaCar 	Ride-on toy propelled by steering	Gross (core strength)	Home, Outdoors	Individual	Promotes movement	Not suitable for carpeted floors
Kinetic Sand 	Moldable sensory sand	Fine (tactile, hand strength)	Home, Therapy	Both	Highly engaging	Messy, needs supervision

Step-a-Trail 	Obstacle course with trail pieces	Gross (balance, coordination)	Home, School	Both	Modular, customizable	Bulky to store
Magnetics 	Magnetic building tiles	Fine (spatial reasoning)	Home, School	Both	Encourages problem-solving	Potential safety hazard if damaged
Toniebox 	Audio player triggered by toy figurines	Fine (interaction with device)	Home, Therapy	Individual	Screen-free audio storytelling	Limited interactivity
Nugget Play Couch 	Foam couch for climbing, jumping, lounging	Gross (jumping, climbing)	Home, School	Both	Imaginative, versatile	Large object, expensive
Trailblaze Ninja Slackline 	Outdoor hanging obstacle course	Gross (upper body strength)	Outdoors	Group	Promotes teamwork and outdoor play	Needs special setup (trees/posts)

Appendix C (Trend and development analyses)

Trends and Developments:

Introduction

In the context of increasing attention toward early childhood development, particularly for children aged 3–6, motor skill development is now recognized as foundational for long-term physical, cognitive, and social growth. This section analyzes current trends within the domain of motor skill development and organizes them by thematic domains. These insights are crucial for designing inclusive and effective play-based tools that can be used across various settings—such as at home, in physical therapy, in school, and outdoors.

Domain 1: Environment & Accessibility

Trend: Expansion of Motor Opportunities in Educational and Urban Spaces

Modern educational institutions and urban developers are playing an increasingly active role in providing opportunities for physical play. Schools are extending their motor-skill-related responsibilities by organizing after-school sports programs, enriching school days with movement activities, and reconfiguring schoolyards for multifunctional use—including public accessibility outside of school hours (Delft voor Elkaar, 2025).

Example: Schoolyards in the Netherlands are being redesigned as community play spaces making more demand for outdoor gyms outdoor gyms (Nijha, 2024), and even rooftops (e.g., the IKEA rooftop sports field in Utrecht) are being converted into movement-friendly environments.


Trend: Decrease in Available Urban Play Space

Contrastingly, urban densification has led to a decline in informal play areas. Residential developments often reduce green space, pushing play opportunities into more structured environments like schools and clubs (NOC NSF, 2025).

Trend: Parental Restrictions and Overprotection

Parents increasingly restrict children's outdoor play due to safety concerns, limiting opportunities for self-directed motor exploration (Son & Kim, 2024; Oliver et al., 2022; Kalish et al., 2010).

Domain 2: Learning Design & Play Approaches

Trend: Structured Multisport and Movement Education
Models like the **Athletic Skills Model (ASM)** promote versatile, non-specialized movement experiences to develop fundamental motor skills in a structured yet varied way. This approach is widely implemented in Dutch youth sports programs and increasingly in physical education (Wormhoudt et al., 2017).

Trend: Unstructured, Risk-Inclusive Play
Simultaneously, there is a resurgence of interest in **loose parts play** and **risky outdoor play** (e.g., climbing, jumping from heights) as essential for children's motor, cognitive, and emotional development (Visser et al., 2024).

Trend: Interactive Learning Spaces
Tools like **interactive learning walls** are emerging in educational contexts, combining motor movement with learning tasks (e.g., language or math games involving physical response), effectively integrating physical and cognitive engagement (*Lü Interactieve Gymzaal | Idema*, z.d.)

Domain 3: Technological and Developmental Support

Trend: Motion-Based Video Games and Exergames
Digital games that require body movement **motion-based video games or exergames** are gaining traction in homes and schools. These tools can enhance balance, coordination, and engagement through immediate feedback and gamified rewards (Sween et al., 2014).

Trend: Gamification and Motivation
Incorporating game mechanics such as levels, challenges, and rewards is shown to increase motivation for physical activity, particularly for repetitive or therapeutic exercises(Alfieri et al., 2022).

Trend: Increased screen time
Niet alleen de schermtijd onder oudere neemt toe maar ook onder kinderen. Digitaal mediagebruik vaak samengaat met stilzitten en dat dit toeneemt als kinderen ouder worden

Trend: Monitoring, Benchmarking, and Research-Driven Design
There is an increased focus on **evidence-based product development**, with benchmarking of current tools and growing research on what types of play and movement activities produce measurable developmental gains.

Appendix D (Doing co-sessions & research with children)

How can research and testing with children aged 3-6 be best conducted during co-design sessions and product validation?

To understand how children interact with and respond to a product, it's essential to involve them directly in the design and validation process. Insights from experts, designers, and educators informed a set of best practices for conducting co-design sessions and research with children aged 3–6. These guidelines focus on creating playful, safe environments and using child-friendly methods to gather meaningful feedback and observations.

For observations:

- **Start with an introduction day** – Allow children to familiarize themselves with the environment and the people involved. This helps them feel more comfortable and open during the sessions.
- **Create an activity checklist** – This ensures that all the key activities are covered and can be observed systematically, allowing for consistent data collection.
- **Conduct observations at different locations** – Testing in various settings gives a broader view of how children interact with the product in diverse environments, helping to identify location-specific behaviors.
- **Use informal interviews during play** – Asking open-ended questions while children are engaged in play can lead to deeper insights into their thoughts and preferences. Casual conversations often reveal more than structured interviews.
- **Pay attention to non-verbal cues** – Children aged 3-6 may have difficulty articulating their thoughts. Focus on their body language, facial expressions, and behavior.
    - **Observe how they play** – Their actions can often reveal more than verbal responses. Watch for their interactions with the product, how they engage with it, and what excites or frustrates them.
    - **Look for emotional cues** – Expressions such as excitement, shyness, or distraction can provide important insights into their feelings towards the product or activity.
- **Create a playful setting** – A relaxed, enjoyable atmosphere encourages children to act naturally and engage with the product freely. The more comfortable they feel, the more authentic their reactions will be.

Key insight:

- Make use of an orientation day
- Keep one focus point when observing and make use of a checklist
- Observe at different locations to spot differences

Research

- **Clarify Your Goal** – Ensure your research goal is clear in your mind and keep it focused throughout the process. This helps maintain direction and ensures relevant data is gathered.
- **Combine Methods** – Use both qualitative (interviews, observations) and quantitative (statistics, surveys) methods for deeper insights. This blend allows you to capture both detailed, personal experiences and measurable data.
- **Keep the Research Short, Flexible, and Playful** – Children are unpredictable, so keep sessions brief (10-15 minutes) to match their attention spans.
    - Use creative activities such as **drawing or crafting** – Ask children to draw or make something that represents their thoughts or feelings.
    - **Games and role-playing** – Encourage children to act out scenarios to express their ideas and emotions.
    - **Loose play** – Provide random objects for the children to explore and see what they pick up. This can reveal their natural interests and preferences.
- **Keep Groups Small** – Limit the group size to 2-5 children to ensure that each child has a chance to participate and express themselves comfortably.
- **Involve Parents and Caregivers** – Ask parents or caregivers for observations from daily life. Their insights can provide valuable context and help interpret the children's reactions.
- **Ask Open and Simple Questions** – Avoid direct or leading questions like "Why do you like this?" Instead, ask open-ended questions such as "Can you tell me what you liked the most?" to give children the space to interpret and express their own thoughts.
    - Use **'What if...?' questions** – These encourage imagination and help children explore different possibilities.
    - Let children make their own choices by offering options, like choosing from cards with different answers.
- **Use Creative Research Methods** – Incorporate activities that let children express themselves in non-verbal ways, such as through art or play. These methods give deeper insight into their preferences and thoughts.
- **Create a Safe and Familiar Environment** – Make sure children feel comfortable by conducting the research in a space they know and trust, such as a schoolyard or classroom. Allow time for children to relax and adjust before starting.

Key insight:

- Keep the sessions short and playfull with children from the age group
- Keep the sessions flexible
- Use small groups

Appendix E (Expert Interview Insights: Motor Skill Development (Krajenbrink, 2025))

Key notes:

- **Movement precedes motor skill**: Until age 7, movement stimulates motor development; from age 7 onward, motor skills become the foundation for continued movement.
- **Avoid performance pressure**: Especially for children with DCD, performance pressure can lead to insecurity and withdrawal from physical activity.
- **Progress drives motivation**: Visible progress is essential to keep children engaged and motivated.
- **Parental influence is key**: Parents serve as behavioral role models; inactive parents often lead to inactive children.
- **Schools and pediatric physiotherapists play a crucial role**: Physical education is central to both development and early identification of motor delays.
- **DCD is genetic but manageable**: While DCD does not disappear, early and targeted intervention can reduce its impact. Children can learn compensatory strategies thanks to the plasticity of the developing brain.
- **Movement variety is essential**: It is not only the amount of physical activity that matters, but also the variety of movements performed.

1. Importance of Early Motor Development
Motor development starts in infancy, with key milestones such as rolling, crawling, and creeping. The first years of life (ages 0–12) are critical: before the age of 8, physical activity contributes significantly to the development of motor skills. After that, the relationship reverses: the more motor-skilled a child is, the more likely they are to remain physically active.

2. Factors Influencing Motor Skills
Internal factors: Genetic predisposition, physical health, presence of motor disorders such as DCD (Developmental Coordination Disorder).
External factors: Parenting, access to sports facilities, parental role models, socio-economic status.
Movement variety and practice are essential, not just how much a child moves, but how varied the movement is.

3. Role of School and Early Detection
School, particularly physical education, plays the central role in development and identifying issues.
Some schools use a color-coded model:

- Green: good
- Orange: slight delay → additional physical activity moments
- Red: significant delay → referral to pediatric physical therapy

4. Approach to Motor Disorders (e.g., DCD)
The CO-OP method (Cognitive Orientation to daily Occupational Performance) is effective:

- Think about the task
- Perform it

- Evaluate

The Sportbouwer app is a tool based on this method, teaching motor skills in steps.

5. Designing Products for Motor Development
Effective toys or products should:

- Encourage movement
- Be challenging without causing frustration
- Show progression (the child sees improvement)
- Adapt to different levels but also allow for collaboration
- Offer variety (balancing, throwing, jumping, swinging, etc. — similar to the ASM model)

6. Design Pitfalls
Ensure enough successful experiences to prevent frustration and failure.
Avoid overly performance-focused designs; instead, emphasize fun, development, and self-confidence.

7. Social-Emotional Impact of Motor Delays
DCD does not disappear over time. Children often develop coping mechanisms but may continue to struggle lifelong with tasks like driving or cooking.
DCD can also lead to social challenges, especially when children feel excluded from physical activities.

Appendix F (Expert Interview Insights: Motor Skill Development (Koolwijk,2025))

Key notes:

- Up to age 7, movement is the foundation for motor development. From age 7 onward, motor skills become the foundation for movement.
- The ideal age to develop motor skills is 3–6. At that age, children barely compare themselves to others.
- Progression is taught in stages from easy to hard (e.g., juggling).
- Three types of motor skills:
    - **Balance:** equal between boys and girls
    - **Throwing/kicking:** better developed in boys
    - **Locomotion (hopping, walking, running):** better developed in girls
- Children in this age group are focused on what they can do, not on who is better.
- The environment is crucial. Children from low socio-economic status (SES) often have delays, due to lack of knowledge or safe play opportunities (e.g., drugs, highways nearby).
- Pediatric physiotherapy doesn't function optimally. Group work increases motivation and fun, and saves therapist time.

Phase: Ages 3–6 (Fundamental Motor Skills)

- Children develop basic skills such as running, jumping, throwing, catching — crucial for organized sports.
- Focus areas: locomotor (movement), manipulative (object control), balance/stability.
- Gender differences: girls often better in locomotion, boys in object control.

Developmental Aspects

- Motor development progresses from gross to fine motor skills:
    - **Gross motor skills:** large muscles and movements (e.g., running)
    - **Fine motor skills:** smaller muscles, precision (e.g., writing)
- Brain development supports motor coordination from unilateral to bilateral movements.
- Practice and variety are essential — different experiences (ball sizes, speeds) help build skills.
- Performance pressure is not relevant for 3–6-year-olds; they begin comparing themselves only around 7–8 years old.

Social and Physical Environment

- **Physical environment:** Access to play spaces leads to better motor skill development.
- **Parental behavior:** Active parents who encourage movement foster motor development.

- **SES impact:** Lower SES can mean limited access to sports/play, leading to developmental delays.

Role of the Pediatric Physiotherapist

- Pediatric physiotherapists play a key role in supporting children with delays.
- **Motor screening** (e.g., MQ test) at schools helps identify those needing extra help.
- **Group therapy** is often more beneficial than individual sessions — promotes social skills and self-confidence.

Motor Skills and Other Developmental Areas

- **Social development:** Skilled children join more group activities, enhancing cooperation, communication, resilience, confidence.
- **Cognitive development:** Physical activity supports brain development, focus, memory. The relationship with academic performance is complex.

Frameworks for Motor Development

- **Movement variety:** Offering diverse forms (running, jumping, throwing) is key.
- **Age-appropriate materials:** Equipment should match the child's stage e.g., large soft balls before moving to smaller ones.
- **Progression:** Skills build step-by-step from simple to complex.

Social Influences

- **Social aspect:** Peer interaction can be a barrier or boost for starting sports. Early sports experience builds confidence.
- **New sports discomfort:** Insecurity about skills can reduce motivation to try new activities.

Tests and Measurements

- Tests like the **MQ-scan** and **AST-test** assess children's motor skills.
- These tests have high **ecological validity** — meaning they reflect how children perform in real settings (e.g., gyms).

Conclusion

Children's motor development is shaped heavily by their physical and social environment, and by the roles of parents and educators.
Diverse movement, age-appropriate materials, and a positive, playful approach are essential. Pediatric physiotherapists are vital in addressing motor delays, with group-focused strategies and school collaboration proving most effective.

Appendix G (Interview Insights: Child physiotherapist)

Influence of Growth on Motor Skills
Growth has a significant impact on a child's motor skills.
A product intended to support motor development should be usable throughout different stages of a child's physical growth.

Role of the Consultation Office
The child health consultation office (in the Netherlands: *consultatiebureau*) evaluates whether a child needs additional support or referrals to specialists, such as a pediatric physiotherapist.

Play-Based Treatment Approach

Children are treated through playful activities, typically for about 30 minutes.
Exercises are designed based on items commonly found at home, ensuring accessibility and relevance.
Toys are often used in therapy — fine motor issues are most common, but balance, coordination, and core stability are also frequently addressed.

Excessive Screen Time
Children spend too much time on their phones or tablets.
This is a major concern raised by parents, who play a crucial role in addressing this issue and encouraging physical activity.

Impact of Socio-Economic Status (SES)
Children from lower SES backgrounds often face greater motor skill delays.
Limited resources, unsafe neighborhoods, and a lack of knowledge about motor development can all contribute.

Home-Based Exercises
When a child is given exercises to do at home, therapists consider what materials or toys are already available in the household to make the activities feasible and effective.

Reduced Outdoor Play
Outdoor play has declined significantly compared to previous generations.
This leads to poorer posture and reduced physical resilience.
However, children can train themselves naturally through active play, sports, and simply spending less time sitting — specific exercises are not always necessary.

Gross Motor Skill Development Exercises
Examples of exercises include:

- Hopping on one leg
- Standing on one leg
- Skipping
- Core stability activities
  These are often incorporated into playful formats, such as:
- Obstacle courses with stepping platforms and wobble boards
- Exercises using large yoga balls to roll over

- Wheelbarrow walking

To practice aiming and catching, therapists use a wide range of objects:

- Start with a large ball to ensure success
- Then progress to smaller balls
- Then to different textures (harder or softer materials)

This variety fosters skill acquisition more effectively than repetition alone.

Age-Based Treatment Focus
At a younger age, therapy is primarily game-based.
As children grow older, sessions become more structured and exercise-focused, though still playful.

Inspirational Tools Used by Physiotherapists
There are many varied objects designed for specific single-purpose activities, but a multifunctional tool is needed (Figure 93: Stepping stones, balance trainers, target training, different types of balls and fine motor skill training objects).

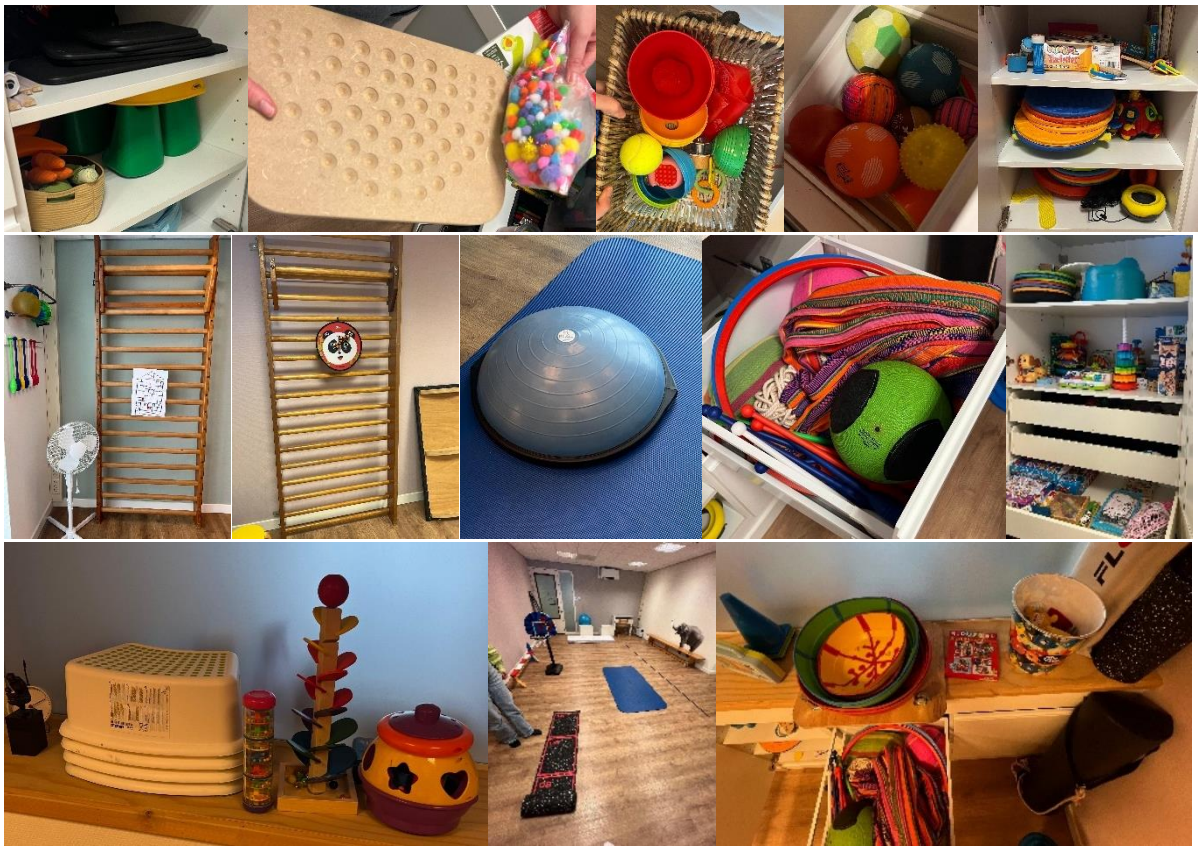


Figure 93: Stepping stones, balance trainers, target training, different types of balls and fine motor skill training objects

Appendix H (Interview Insights: Rehabilitation Physician from Rijndam Rehabilitation)

Key Insights

- **Personalization is essential** for engagement .
- **Biofeedback should be implemented** (think of the Fitbit): it enhances *intrinsic motivation*.
- **Movement information** (e.g. feedback on how you're moving) is an important factor for improvement.
- **Gaming** has pros and cons: it can encourage movement, but some games reduce physical activity.

Training Philosophy

- Children shouldn't train because they are "bad" at something (e.g. ball control), but should be encouraged to **practice sports** to develop naturally.
- **Unnatural or unfamiliar movements**, especially when done in heat, may cause injuries.
- **Warm environments** help loosen muscles and reduce injury risks.
- **Cold increases injury risk**, so warming up is important.

Motor Delays in Children

- Many children with **DCD (Developmental Coordination Disorder)** or other limitations undergo detailed diagnostics.
- DCD often occurs alongside **ADHD** and **concentration issues**.
- Other causes include **neurological disorders**, **muscle diseases**, and **genetic conditions**.

Treatment & Support

- **Child rehabilitation** focuses on improving function within the child's capabilities.
- The **ICF framework (International Classification of Functioning)** is used to assess strengths and limitations.
- Therapy adapts to age:
    - Young children learn through **play**.
    - Older children receive more **coaching** and guided exercises.

Environmental & Social Factors

- The **living environment** heavily influences activity. Urban areas typically offer fewer play opportunities than rural areas.
- **Parental and cultural habits** influence sports participation.
- **Parental involvement** boosts the likelihood of continued activity.

Technology & Innovation

- Assistive tools like **prosthetics, exoskeletons, and VR** can aid motor development.
- VR and games are sometimes used to stimulate activity but must be balanced with real-world movement.

Design Considerations for Motor Skill Products

1. Play-Based Learning

- Play is essential for learning, especially in **ages 3–6**.
- Exercises must be embedded in play and **not feel like training**.
- Physical games that include **running, jumping, rolling, grabbing** are effective.

2. Balance of Gross and Fine Motor Skills

- **Gross motor skills:** jumping, hopping, crawling, balancing, running.
- **Fine motor skills:** gripping, cutting, building, small object manipulation (e.g. magnetic toys or marble runs).
- A good product can combine both — e.g., something that encourages **building through movement**.

3. Flexibility and Adaptability

- Products should **grow with the child**, adjusting in difficulty.
- **Modular or expandable** systems (e.g. climbing structures or marble runs) are especially effective.

4. Involving Parents and Peers

- Involving parents enhances physical activity.
- Playing with peers boosts **motivation** and **engagement**.
- Cooperative and competitive game elements make moving more fun.

5. Movement Space and Accessibility

- Product should work **indoors, outdoors, at school, or at home**.
- Safety is essential: no sharp edges, sturdy structure.
- Must be **inclusive**, adaptable for children with physical limitations.

6. Encouraging Independent Movement

- Children should explore on their own, without constant adult input.
- Products that spark **creativity and variation** (like marble runs, spring tiles, or balance beams) promote this.

7. Pitfalls to Avoid

- Over-reliance on screens or digital content without physical challenge.
- Products that become boring after just a few uses.
- Forcing unnatural or uncomfortable movement patterns.
- Allowing or encouraging the **"W-sit"** (harmful for hip development).

Inspirational motor skill development products at Rijndam

Figure 94: Fine motor development toys & Physical activation marble run

Appendix I (Interview Insights: expert in play & workshop insights (Magnano, 2025))

General notes for observation

- Ask children what they *like*, not what they *don't like* . Positive framing leads to better responses.
- Start initial sessions with an informal "getting to know each other" round to build trust.
- Write down reflections and key takeaways shortly after each session or meeting.
- Group discussions work well asking children as a group what they enjoy often leads to richer input.
- Fewer girls are present outdoors compared to boys.
- Girls tend to prefer activities involving turns, rhythm, and coordination (e.g. dancing, swinging).
- Boys more often gravitate towards football and physical team games.
- Swinging is a commonly enjoyed activity across genders.
- Gender stereotypes are still present and can influence ambition, confidence, and participation — especially among girls.
- Meaningful play experiences typically activate at least five developmental domains: cognitive, physical, emotional, social, and creative.

Research & Methodology Insights

- **Good preparation matters** :A clear research question and structured setup lead to stronger and more relevant results.
- **Data-driven insights**: Combining qualitative (e.g. interviews, observations) and quantitative (e.g. surveys, statistics) methods provides deeper understanding.
- **Flexibility is essential**: Allow room for unexpected findings and adjust your methods when needed.
- **Diverse perspectives enrich outcomes**: Including variation in gender, background, and culture leads to more inclusive results.

Gender & Girls

- **Barriers for girls remain**: Stereotypes around strength, leadership, or public activity still limit participation.
- **Role models make a difference**: Girls are more likely to engage and develop confidence when they see women in visible, active roles.
- **Active inclusion takes work**: Structural support through education, policy, and awareness is needed to close the gender gap in play and development.

Outdoor Play & Child Development

- **Outdoor play is essential**:It fosters creativity, autonomy, social bonding, and physical health.
- **Outdoor play is declining**: Screen time, overstructured schedules (e.g. BSO), and parental safety concerns reduce natural playtime.
- **Cities must support play** : Child-friendly public space design encourages safe, accessible, and spontaneous play.
- **Unstructured play has high value**: Free play without fixed rules builds problem-solving skills, imagination, and resilience.

Researching with Children

- **Use playful methods**:Games, storytelling, drawing, and movement create safe and open interaction.
- **Keep questions open and simple**: This allows children to express themselves without pressure.
- **Observe, don't just ask**: Body language, energy shifts, and interaction often reveal deeper insights than words.
- **Adapt and stay flexible**: Methods should adjust to children's energy, focus, and comfort.

Five Key Domains of Meaningful Play (Magnano, 2023)

Research identifies five core domains that support and stimulate meaningful play. These domains help designers and educators understand *why* children play and *how* to create environments that keep them engaged across different situations and personalities:

1. **Freedom**
   Enables spontaneity and self-direction. It allows children to explore on their own terms and adapt play to suit their preferences.
2. **Socialization**
   Creates opportunities for children to meet, interact, and discover both others and themselves. Peer dynamics enhance motivation and imagination.
3. **Challenge**
   Adds excitement and a sense of accomplishment. Play becomes rewarding when it pushes boundaries in an achievable way.
4. **Variety**
   Keeps activities engaging over time. Repetition with variation allows for mastery without boredom and stimulates creativity.
5. **Safety**
   Ensures accessibility and inclusion. Physical and emotional safety makes children feel confident to take risks and participate fully.

These five domains form a valuable lens for interpreting both observational data and guiding future design decisions.

Personality and Play: The Big Five (OCEAN) Framework

Children experience and engage with play differently depending on their personality traits. The Big Five model (OCEAN) outlines five broad dimensions that shape how individuals approach social interaction, novelty, structure, and emotion. These are *not* good or bad — each trait lies on a spectrum and brings different strengths to play contexts.

Trait	High Expression	Low Expression
Openness	Imaginative, curious, creative, enjoys new experiences	Practical, routine-focused, prefers familiar activities
Conscientiousness	Structured, goal-oriented, reliable	Spontaneous, flexible, less structured
Extraversion	Talkative, energetic, seeks out social interaction	Quiet, reflective, prefers solo or small-group settings
Agreeableness	Cooperative, empathetic, kind	Independent, sometimes skeptical, assertive
Neuroticism	Emotionally sensitive, prone to anxiety or mood shifts	Emotionally stable, calm, resilient

Understanding these traits can help interpret behavior during play sessions (e.g., who prefers structured games vs. unstructured exploration) and supports more inclusive, personality-sensitive design strategies.

Conclusion

Lea Magnano emphasizes the importance of inclusive research, equal opportunities for girls, and creating environments that support children's natural development. By addressing gender biases, promoting outdoor play, and using child-friendly research methods, we can create better policies and spaces that benefit both children and society.

Figure 95: Visuals workshop

Appendix J (Insights observation Playground Utrecht and interview researcher playing together (Beekhuizen, 2025))

Parental Influence on Play Behavior

- **Parental risk perception** strongly shapes how and where children are allowed to play.
- Some parents supervise closely and warn frequently ("Be careful!"), while others give children space to **explore and orient themselves** an essential factor in child development.
- **Parental restrictions** due to perceived danger can limit children's motor development and exploration.

Gap Between Therapy and Home

- There is a **lack of tools or products** that can be effectively used both in **pediatric physiotherapy** and **at home**.
- A versatile product that bridges this gap could support **continuous development** across settings.

Social Play and Development

- **Playing together** supports not only **motor and social development**, but also improves **academic performance**.
- Children **challenge and stimulate each other**, which accelerates their development.
- Pediatric physiotherapists also observe that **group-based therapy** is more effective than individual sessions however, it's rarely implemented due to **uncertainty around funding models**.

Observation Methods

- Observation is most effective using an **observational checklist (tally sheet)** and should be conducted **across multiple sessions**, not just the first visit.
- This allows for a better understanding of a child's progress and behavior patterns over time.

Playground Design & Inclusive Play

- In this specific playground, there was a strong desire to **promote inclusivity** and **lower barriers to participation**, even into adolescence.
- **Loose parts play** (unstructured, open-ended play with movable materials) is **very important** in the development of children's creativity, coordination, and motor skills.
- All children played together regardless of age or background. The **football field was barely used** — the **sandbox and water play area** were the most popular.

Social Dynamics in Young Children

- Children aged **3 to 6** mostly engage in **parallel play** — playing *next to* one another rather than *with* one another.

- Even so, this proximity lays the groundwork for future cooperative play and social learning.

Popular Activities Among Children

- **Climbing and clambering** are very popular and highly motivating.
- **Obstacle courses** are especially well-received children respond enthusiastically to these kinds of physical challenges.

Literature Reference

- The article **"Barriers for Children to Play (Barron et al., 2016)"** outlines obstacles that hinder children's physical activity, such as:
    - Lack of access to play spaces
    - Safety concerns from caregivers
    - Urban planning that prioritizes cars over play
    - Socioeconomic factors limiting opportunities

Figure 96: Inclusive playground in Utrecht

Appendix K (interview insights researcher Jante Beton (Bouman,2025))

Target Group Insights (Ages 3–6)

- **Movement Needs:** Children in this age range have a natural urge to move. Movement through play is essential for their motor development.
- **Developmental Stage:** At this stage, children develop gross motor skills (running, climbing, jumping) and begin refining fine motor skills (gripping, balancing, coordination).

Key Design Criteria from Interviews

1. Free Play Over Structured Play

Products should encourage open-ended play without fixed rules, allowing children to **explore and experiment** independently.
This supports motor skills, **self-confidence**, and **creativity**.

2. Inviting and Challenging, but Not Too Difficult

A good product offers a balance: **enough challenge** to keep children engaged, but without causing frustration.
Provide **levels of difficulty** so the product can "grow" with the child.

3. Sensory and Physical Stimulation

Products that stimulate multiple senses help improve **coordination** and **body awareness**.
Examples:

- Tactile materials (soft, rough)
- Vibrations
- Balancing, rolling, pushing, pulling elements

4. Stimulate Both Group and Solo Play

Products should enable **cooperative play** but also function well individually — matching the social development needs of this age group.

5. Safe, But With Room for Risk

Children benefit from **calculated risks**: learning to judge, adjust, and balance.
The product must be safe, but allow for **mild physical challenges**.

Environmental Design Considerations

A. Integration into Daily Environment

Products should be suitable for **multiple settings**: schoolyards, neighborhood playgrounds, parks.
Modular and portable elements increase flexibility in placement and use.

B. Durability and Low Maintenance

Outdoor products must withstand weather and use.
Materials should be **weather-resistant** and **easy to clean** especially if the product is used in multiple locations (e.g., home and therapy).

What Children Indirectly Expressed

- They crave **adventure, variety, and discovery**.
- Activities like **climbing, balancing, sliding, rolling, spinning** are especially exciting.

- Children enjoy **controlling or changing** elements in their environment — e.g., moving parts, changing routes, or triggering effects.

Field Observations & Playground Insights

- Children often use the **surroundings** of a playground (trees, electrical boxes) more than the designated equipment.
- Small local playgrounds are disappearing in favor of larger, more **inclusive** ones to **reduce maintenance**.
- In some playgrounds, **everyone played together** across age groups.
    - The **football pitch was barely used**.
    - **Water and sand areas** were most popular.
- **Loose parts play** is key: encourages creativity and independent movement.
- **Obstacle courses** are well-received children respond very positively.

Involving Parents

- Organize sessions **with both children and parents** to get maximum engagement and insights.
- Parents play a vital role in:
    - Enabling outdoor play
    - Balancing safety vs. exploration
    - Shaping attitudes toward risk and freedom
- There's a clear difference in parental supervision styles:
    - Some are very protective.
    - Others allow for **self-orientation**, which benefits child development.

Brainstorming & Research Tips

- Let children **rank different activities** (not just products) to understand their preferences.
- **Observe in different school environments**, especially with varied ground types or layouts.

Summary: What Makes an Effective Product?

A well-designed product for children aged 3–6 should:

- Encourage movement through **playful activity**
- Support **open-ended, imaginative play**
- Be **safe**, yet allow for **light physical challenges**
- Enable **both solo and social play**
- Be **visually and tactilely engaging**
- Be **durable, modular**, and **easy to clean**
- Fit into multiple environments: **therapy, home, school, outdoors**

Appendix L (Observational Insights: Delft voor Elkaar Playground and Informal Interview with Community Sports Coach)

Key Insights from Playground Use and Events

Gender & Cultural Dynamics

- **Mainly boys** are observed at general playgrounds.
- **Muslim girls** prefer activities **exclusively for girls**, allowing them to **play without wearing a headscarf** (e.g. indoor or closed-group sports).
- Organizing **girls-only events**, such as football tournaments, generates **a lot of enthusiasm** — e.g., **80+ sign-ups** for a single event.

Community Sports Events

- **Neighborhood tournaments** (e.g., football) spark high engagement and **create strong local enthusiasm**.
- Children from **neighborhoods with less outdoor play** often show **lower motor skills** and tend to **lose these tournaments** more often.
- The type of **sports children play depends heavily on available infrastructure**:
    - At the **Tanthof playground** with basketball hoops → basketball is preferred.
    - At **Aan 't Verlaat** with only soccer goals → football is dominant.

Popular Playground Sports

According to observations, the most frequently played sports at playgrounds are:

- **Football**
- **Dodgeball**
- **Floor hockey (knots hockey)**

Additionally, **bounce house events (inflatable castles)** draw large crowds and can serve as community magnets for sport and play engagement.

Organized Sports During School & Vacation Time

TSO (Midday School Care):

Various sports and games are offered, including:

- **Softball tennis** (using soft balls and ribbon nets)
- **Kingen** (a four-square-like game where the ball must bounce twice in an opponent's square)
- **Football**

Vacation Programs:

- **Delft voor Elkaar** organizes large-scale events during holidays, attracting many children.

- **Rijk Delft Initiative**: runs **2-hour sessions** at **Vitesse Delft**, introducing kids to **a variety of sports**.

Playground Infrastructure & Material Access

- One playground includes a **locked material box** (with sports equipment). It is:
    - **More frequently used** by neighborhood children.
    - Access granted to **trusted residents**, allowing **independent play** even outside of organized programs.

Other Popular Free Play Activities

- **Climbing** and **wave boarding** are also appreciated by children, though these are usually based on personal initiative and not always part of structured programs.

Implications for Product or Program Design

- **Gender-sensitive programming** can greatly increase inclusivity, especially for cultural groups.
- **Providing equipment variety** shapes which sports children engage in — infrastructure guides interest.
- Events with **fun, non-competitive elements** (e.g. bounce houses) create access points for less motor-skilled children.
- **Equity in playground access** and equipment sharing (e.g. neighborhood keys to supply boxes) fosters greater independent play.

Appendix M (Observation insights Midday School Care (TSO) 1st time)

Behavioral Observations

- **Girls tend to stand around and talk** rather than engage in active play.
    - *Quote from a girl not used to playing outside:* "It's way too early to be outside."
- **Children become very competitive** once engaged in a game and **hate losing**, which increases motivation.
- One **girl with a torn tendon** couldn't participate in gym class, but **could still play outside**, showing how outdoor play is more accessible even for kids with limitations.
- When faced with challenges or failure, **children tend to give up quickly** unless the activity is intrinsically motivating or socially supported.

Activities Observed

Children engaged in a wide range of activities, showing **diverse movement patterns** and **social interaction**:

- **Scootering**
- **Rollerblading** (mostly girls)
- **Skateboarding**
- **Playing Kubb** (very popular — a child also played it often at home)
- **Picking up trash** with a grabber
- **Table tennis**
- **Sliding**
- **Running**
- **Tag games**
- **Role play**

Younger age groups appeared to show slightly more **mixed-gender interaction** during play.

Environmental and Social Influences

- **The surrounding environment** plays a crucial role in stimulating physical activity. A rich environment enables spontaneous movement and varied play.
- **Peer behavior strongly influences participation**: example behavior acts as a motivator, and kids are drawn to large group activities.
- Example: **Basketball started slow**, but as more kids joined, it quickly became **the most popular activity**.

Therapeutic and Support Structures

- **Cesar therapy** was mentioned as beneficial for kids with **motor delays**, especially for:
    - Cycling skills

- Balance issues
- Weak ankles and poor coordination

"Cesar therapy" is a form of movement therapy that focuses on **improving posture and functional movement**. It's used with children who have developmental motor delays.

Community Initiatives

- The local **community center organizes events** like scavenger hunts and sports, which are **widely appreciated and well-attended** by children.

Individual Preferences (Example)

One younger boy who liked basketball also enjoyed:

- **Swinging**
- **Seesaws**
- **Football**
- **Basketball**

These preferences highlight the value of offering **a variety of physical experiences**, from gross motor play (e.g. swinging) to team sports.

Key Insights & Implications

- **Inclusivity**: Outdoor environments allow for participation even when children are injured or excluded from structured activities like gym class.
- **Motivation spikes with social proof**: Children are more likely to engage when they see others joining in.
- **Play infrastructure should accommodate social scaling**: activities that work for 1–2 players and can grow into group play are highly valuable.
- **Popular games like Kubb** demonstrate the importance of offering **accessible and repeatable activities** that children may also want to replicate at home.

Appendix N (Observational insights Delft voor Elkaar TSO 2st time & Gym lesson)

Groups observed:

- Younger group (ages 4–6), ~40 children
- Older group, ~40 children
- Special education group (children with ADHD, autism, high giftedness)
- New participants

Figure 97: Average of play distribution

Popular Activities by Type
Physical Activities (*frequency reflects approximate participation*)

- **Football:** 6–7 boys, 1–2 girls (girls often sit in goal)
- **Basketball:** 3–4 boys + 1 girl
- **Running/tag games (tikkertje):** 2–3 children
- **Hide-and-seek (verstoppertje):** 8–12 children
- **Stepping (scooters):** 4–5 children
- **Waveboarding/Skateboarding:** 1–3 children
- **Inline skating (skating/skeelering):** a few, often self-directed
- **Table tennis:** 2–3 (more attractive when staff is nearby)
- **Cone games / Bowling (kegels omgooien):** 2–3
- **Swinging, sliding, climbing (jungle gyms):** 8–10 children, mostly girls

- **Obstacle variations (like throwing at blocks):** 5–7 children, mixed gender
- **Dance:** popular in both groups

Special Mentions

- **"Koningsbal"** (King's Ball) and **dodgeball variants** are highly popular — especially with children who are **gifted or autistic**.
- **Simple racing games** (first to reach a color or point wins) are effective and fun.
- **Nerf guns** are liked, but may cause frustration if children lose.
- **Gym-based games like "over the vault box"** are popular but still developing in skill.
- **Children with poor motor skills** tend to play:
    - In the **background**
    - Choose passive roles (e.g., in the back of the gym)

Social Dynamics

Parallel Play & Grouping

- Most play is **parallel**, not collaborative.
- **Children group by gender**: girls pick girls, boys pick boys.
- Peer correction is common children **correct each other's behavior or rules**.
- Children **become highly competitive**, especially when goal-oriented.
- Some children **struggle with losing** and become visibly upset.
- Those with poor motor skills often **withdraw or remain passive**.

Role Play & Creative Games

- Roleplay present: e.g., acting, using a **"safe sword"** that can only chop wood, not hurt people.
- **Tactical use** seen in games:
    - Shielding the ball as a form of defense
    - Switching targets when one option doesn't work

Behavior Highlights

- Girls enjoy **gymnastics-inspired activities** (turn elements).
- Boys sometimes tease girls, but also engage in shared games.
- Trust and falling games are played among small groups.
- Children enjoy **team variation** and like when teams are switched.

Outdoor Free Play

- Small children played with:
    - **Branches and sticks**

    - **Scraping or rubbing surfaces (possibly with stones or sticks)**
- Other activities:
    - Table tennis
    - Sitting on fences
    - Digging and playing in sand

Therapeutic & Developmental Observations

- **Cesar therapy** supports children with motor challenges like:
    - Poor balance
    - Weak ankles
- **"W-sit"** posture observed in a child with poor motor skills — known to negatively impact hip development.

Key Takeaways & Design Implications

1. Design for Parallel Play

- Many children don't yet play collaboratively — products should allow **side-by-side interaction** and grow toward cooperation.

2. Inclusion for Children with Motor Challenges

- Provide roles for **less motor-skilled children** that still feel meaningful (e.g., scorekeeping, setting up).
- Encourage **self-paced participation** and **low-threshold activities**.

3. Simple Rules = High Engagement

- Games with **clear, simple objectives** (like races or block hits) are effective.
- Variability and novelty matter even minor changes make activities feel new.

4. Gender-Sensitive Design

- Consider activities that appeal across gender lines (e.g., balance-based, throwing games, obstacle structures).
- Include opportunities for **creative play** like roleplay, crafting movement stories, or pretend games.

5. Emotional Regulation Support

- Some children need **support dealing with frustration or loss**. Integrating soft competition or team support mechanics helps.

6. Environmental Interaction

- Nature-based play (sticks, sand, climbing) remains powerful and **doesn't require expensive equipment**.
- Allow children to interact with, **modify**, or **rearrange their environment**.

Appendix O (Observation DVV Delft sports event)

Physical & Motor Play Activities

Activity	Participation	Notable Observations
Moving & locomotion	40	Running in inflatable balls, chaotic movement without structure
Jumping & landing	10 (2 girls, 8 boys)	Obstacle course had short-lived interest
Romping & wrestling	40	Very popular; football often turned into uncontrolled physical roughhousing
Rolling & tumbling	10	Kids ran inside inflatables and then began rolling in them
Balancing & falling	20	Mostly happened inside inflatables, not always intentionally
Throwing, catching, aiming	16	Informal beach volleyball
Kicking & shooting	20	Football and volleyball play observed
Climbing & scrambling	10	Part of obstacle course, short attention span
Music & rhythmic movement	3 (girls only)	Girls joined dancing when adults participated
Exploration (sensory) play	5	Clay crafting with mothers; tactile and social
Loose parts play (creative use)	3 (plus 40 inflatables)	Inflatable cushions used as bouncing games
Constructive play	–	No building materials were present
Swinging	–	Not available in the environment

Play Type	Estimated Participation	Notes
Competitive play	45	Football (with and without inflatables) and beach volleyball
Physical play	40	Bending each other over in balls; rough contact; mostly boys
Symbolic/dramatic play	Low	Minimal; some stick-as-sword imitation
Sensory/exploration play	5	Focused crafting with mothers
Ritual/rhythmic play	4	Girls responded well when adults joined
Role play	Low	Rarely observed
Digital play	14	Cooperative sessions with police and community coaches
Social play	5	Overlaps with co-play and exploration
Loose parts play	3 (plus 40 inflatables)	High engagement through self-invented games
Mastery play	Implied (unmeasured)	Children repeatedly tried to balance or aim during activities

Social & Parent-Child Dynamics

- **Children imitate adults**: Activities like boxing or boot camp initiated by parents led to immediate child participation (e.g., 3 kids joined boxing when an adult started).
- **Father-child dynamic**: Children visibly sought validation — one child **followed his father everywhere**, constantly checking if he was being watched.
- **Only-child parents** expressed frustration: fewer kids play outside today due to **structured schedules like after-school care (BSO)**. Their children often **return home when no peers are available**.
- **Parents want low-effort involvement**: Prefer **passive engagement (watching or light participation)** but dislike **being on their phones** during playtime.
- **Pride & encouragement**: Parents **felt proud** seeing their children participate; some actively **stimulated shared play**.

Individual Insights & Patterns

Activity	Alone/Group	Emotion	Seeks Adult Validation	Notes
Obstacle course	Together	Excited	Constantly follows father	Seems to seek approval
Boot camp	Together	Focused	Constantly follows father	Watched father constantly, tried to impress
Inflatable ball play	Together	Excited	Constantly follows father	Highly physical, chaotic but fun

Contextual & Environmental Insights

- **Poptahof**: Children played mostly with **water and sand**, **talked**, and **swung on equipment**.
- **Crafting** was most popular among **girls with their mothers** a social and tactile experience.
- Children often **wait until someone else joins** or an **adult initiates an activity** before participating.
- Locations with **no children present** were not explored until **an adult stepped in**.
- **BN'er (celebrity) presence** at events increased attendance, proving that **influencers or recognizable figures** attract attention and increase engagement.

Design & Programming Implications

1. Adult Modeling = Engagement Trigger

- Include parent-friendly activities where **adults can participate lightly**, even just to **demonstrate** or **observe**.
- Consider using **community role models** or **local heroes** to trigger group activity.

2. Products Should Be Low-Effort for Parents

- Design for **low parental workload** but **high child stimulation**.
- Avoid needing setup, instructions, or continuous involvement **encourage co-attendance over co-play**.

3. Short Attention Cycles

- Most children engaged in **short bursts of activity** favor **high-variation modules** over static obstacles.
- Use **modular challenges** that can be rearranged or "leveled up" to renew interest.

4. Visual Grouping & "Snowball" Dynamics

- Activities gain momentum when **a few children start** use **visual clustering or signaling** to attract early adopters.
- Leave **open-ended physical tools** (e.g., inflatables, loose parts) that invite creative reinterpretation.

5. Social Play is Underdeveloped but Promising

- Children often play in **parallel**, but peer visibility and **mimicry are strong motivators**.
- Include **opt-in team modes**, with light **cooperative mechanics** and optional team rotation to build social bridges.

6. Appeal to Imaginative & Crafting Play

- Especially with girls, **crafting** and **symbolic play** (e.g. dancing, storytelling through movement) are meaningful.
- Include **sensory materials** and **open-ended art or movement prompts**.

Conclusion

Children are highly responsive to social triggers and strongly influenced by the presence of adults. Engagement rises quickly when just one child joins an activity or when an adult takes the lead. Spaces without visible activity are often ignored until an adult steps in. This underscores the importance of designing play experiences that leverage social dynamics and parental modeling.

At the same time, many parents prefer to be present in a low-effort, observational role. The most successful moments during play were those that combined minimal adult involvement with open-ended exploration and peer-driven interaction. Children consistently seek validation, especially from close family members, and are drawn to activities that offer variation, creativity, and freedom of expression.

In today's structured and screen-dominated world, organic outdoor play opportunities have diminished. To remain relevant and impactful, play products must:

- **Enable low-barrier engagement for parents** — encourage presence without demanding effort;
- **Use social dynamics to generate momentum** — make it easy for one participant to attract others;
- **Encourage flexibility, creativity, and short attention cycles** — modular, varied play maintains interest;
- **Integrate cooperative and sensory elements** — support different types of play and learning styles

Figure 98: Dvv delft event

Appendix P (Ideation clusters)

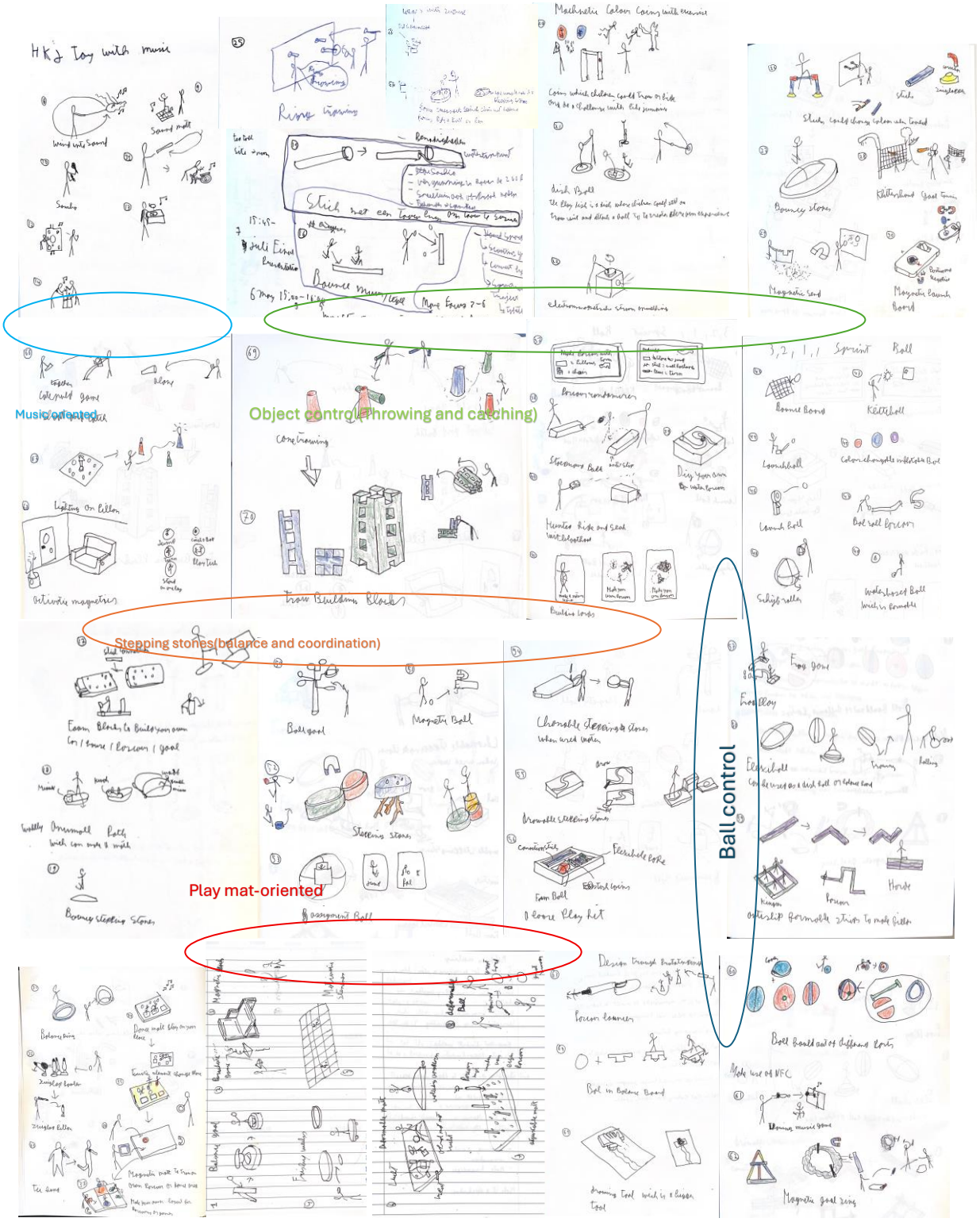


Figure 99: Cluster of ideation

Appendix Q (User testing Egelantier school)

4.1 Test Setup – Methodology for Play-Based Concept Evaluation

To assess the effectiveness of four design concepts developed for kindergarten-aged children, a **qualitative user test** was conducted. The prototypes were evaluated in a real-world school setting, where children could freely interact with the materials. The goal of the test was to understand which designs best encouraged movement, creativity, and engagement—without prompting or instruction.

Participants and Ethical Considerations

Participants were recruited from a kindergarten class at Egelantier School, in close collaboration with the class teacher. Participation was entirely voluntary. At designated times during the school day, **small groups of four children**(Session 2: Groups of 2 to be able to ask deeper questions) were invited to test the prototypes. These groups were intentionally varied: some all-girls, some all-boys, and some mixed-gender, in order to explore potential differences in interaction based on group composition. One group included a wider age range to assess the concepts' adaptability to different developmental stages.

Before participating, each child was individually asked if they wished to take part. For photo documentation purposes, verbal consent was also obtained in the moment. No images were taken without explicit agreement.

Environment and Conditions

Testing took place in a **controlled school environment**, both indoors and outdoors. Locations were chosen together with the teacher to ensure:

- **Good visibility** for observation
- **Minimal risk of injury**
- **Natural integration** into the children’s daily routine (e.g., free play periods)

By testing in both settings, allowing to evaluate whether **contextual factors** (such as floor surface, space, and lighting) influenced how the materials were used.

Procedure

Each test session followed a **child-led, exploratory format**, replicating natural play behavior with minimal adult interference. The typical **duration per session was 15 to 25 minutes**.

Steps:

1. The four concept prototypes were laid out in a shared space. Session 2 the concept prototypes
2. No explanation or instructions were given about the products.
3. Children were encouraged to explore and use the materials however they liked.
4. Observations were made regarding:
    - Product preference
    - Type of play (e.g., movement, construction, imaginative)
    - Duration and depth of engagement
5. After 15–25 minutes of play, the children were casually asked:
    - Which product they liked best
    - Why they liked it

Children often responded with "all of them," but when asked further, they were able to articulate clear preferences.

Observational Focus

Rather than scoring or testing for success criteria, this exploratory test prioritized **behavioral cues** and **qualitative insights**, including:

- Repeated interaction with a product
- Social dynamics (e.g., collaboration, conflict, imitation)
- Creative or unexpected uses of the materials
- Physical movement patterns (e.g., balancing, throwing, stacking)

Teachers were also consulted for their reflections on the children's behavior and engagement, providing a valuable secondary perspective.

Rationale Behind the Approach

This open-ended and **non-directive testing format** was chosen to:

- Avoid bias or shaping of play behavior
- Reflect real-world classroom conditions
- Allow genuine discovery of the material's affordances by the children

By creating an open-ended, low-pressure environment, the test yielded authentic insights into how the designs functioned in context and which aspects most successfully supported the project's goals of promoting **movement, creativity, and joy in play**.

Appendix R (Key Insights expert meeting: Motor Skill Development Koolwijk 2025 (Session 2))

Play Culture & Inspiration

In Sweden, there's a strong culture of open-ended play: children are allowed to leave toys scattered, and public spaces often include accessible play boxes. There are even small houses with microwaves for parents with young children to heat up food—illustrating a user-centered approach that supports both children and caregivers.

Current Limitations of Motor Play Materials

- **Parental concern over safety** is a major limitation. Many parents restrict physical exploration, which undermines spontaneous and valuable play experiences. According to Pim, it's essential that product design explicitly considers perceived safety in order to ensure both **adoption and sustained use**.
- Another major barrier is that many parents **don't know how to actively encourage movement**. Pim suggested that **movement cards with clear, accessible instructions** could help guide and inspire parents in facilitating physical activities.

Design Principle: Stimulating Natural Movement Through Play

Pim emphasized that movement should never feel like training for young children. Instead, the key is **"deliberate play"**—where every object is perceived as a toy, and naturally encourages activity. For example, a stick might become a tool to throw or to strike with. The role of the adult is to support variation: suggesting, *"you could also try this"*, to expand movement opportunities.

Feedback on Design Concepts

Concept 1 – Grippable, Textured Play Object

- Pim was **very enthusiastic** about this concept and saw potential in its tactile design.
- He recommended developing **multiple variations**: a flatter, more rounded version and the current, more compact shape.
- The soft, squeezable material invites **gripping and sensory exploration**. However, the use of **magnets** might be problematic:
    - They could break easily.
    - If they don't function reliably, children might get frustrated.
- Pim advised using **bright, high-contrast colors** to draw attention and to consider color-coded exercises or natural-toned versions for outdoor use.
- Offering **varied themed sets** could significantly increase market value.

Concept 2 – Throwing and Target-Based Play

- Pim liked the idea and noted it resembled **"Cubb"**, a popular outdoor game.
- He suggested designing the shape so that it could also serve **role-play functions**.
- However, he felt it closely resembled existing products and noted that **fewer motor skills were being activated**.
- The **magnet feature** may again cause frustration if children lack the strength to use it effectively.

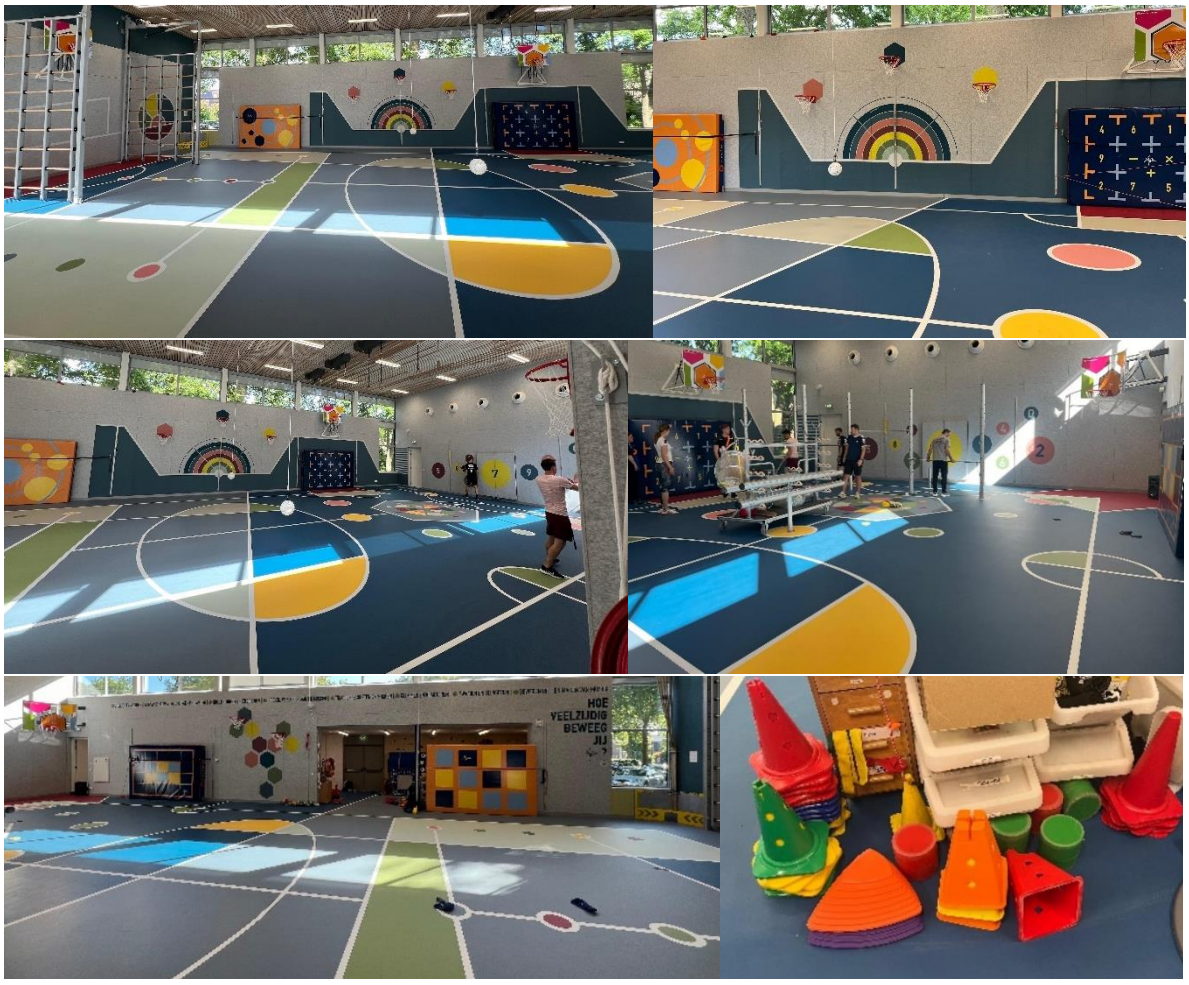
Concept 3 – Goal-Oriented Indoor Toy

- This was **the least convincing** of the three for Pim.
- He felt it was too limited for outdoor use, and that the **goal targets were too small**.
- He questioned whether young children would **understand the purpose** of the object or how to assemble it.
- Children at this age are **less focused on scoring goals**, and more interested in running, climbing, and experimenting with their body.

Concept – The Mat

- Pim was **very enthusiastic** about this concept.
- The use of **different shapes, colors, hand and foot prints** sparked strong positive feedback.
- He noted that children could use it to practice **rolling, crawling, or coordination**, making it suitable for **reimagined indoor play spaces** currently emerging.
- It could also **offer seating areas for parents**, supporting co-use.
- Pim asked whether the mat would be **modular (like Velcro) or magnetic**, enabling flexible setups.

Appendix S (Key Insights Athletic skills model workshop Best)



The use of different colors allows for the creation of various color-based games and prompts. These visual cues can guide children in choosing movement patterns, following instructions, or creating their own challenges.

The use of diverse shapes leads to different types of interaction and allows for varied movement possibilities. With just one product, children can engage in a wide range of physical activities that stimulate multiple motor skills.

By adjusting the height of a ball, different movement goals can be practiced. A lower position allows children to practice kicking and aiming. At medium height, they can train punching and coordination. When the ball is positioned higher, heading becomes the challenge. Since the ball keeps moving and must be followed visually, this also enhances focus and reaction time.

The play environment appears as a cohesive whole, yet almost every element is unique and serves its own specific function. This balance between unity and variation supports open-ended and skill-diverse play.

Encouraging variation in movement not only improves ability in the sport a child currently practices, but also builds transferable motor skills that benefit performance across other sports and physical activities.

Different types of stepping stones continue to appear in various locations, suggesting a strong and growing market demand for modular, movement-based play products.

Appendix T: (Field Visit Insights Sport Accommodations Fair)

General Observations

- **Girls play outside less** – This is a widely acknowledged issue and a trending topic at the fair.
- Often because they don't like being watched and prefer to talk more. They tend to sit more on the side or in corners.
- **There is a lack of collaboration** between different departments within municipalities.

ASM (Athletic Skills Model)

- Goals not facing each other create more variety in use.
- Different field setups invite more types of users to participate.
- **Color** adds motivation and helps children better understand prompts (e.g. "stand on the blue dot").

Gender-Based Differences

- **Boys** prefer individual, action-based play and just "go for it."
- **Girls** prefer playing together and benefit from seating areas and activities that encourage cooperation.
- **Slides are highly popular**, and children need the **freedom to interpret play on their own** to spark creativity.

Importance of Seating Areas

- Seating supports **onlooking children** in transitioning into play and also helps **parents supervise**.

Child Participation in Design

- **Children's input** has a major impact on how effectively playgrounds are used.
- Designs are tested and adjusted based on their feedback.

Variations in Goal Sizes

- Different goal sizes significantly influence play variety.
- At Heracles, the focus remains on football-based fields due to its everyday popularity.

Considering the Environment

- Development projects take existing surroundings into account—no need to duplicate what's already available.

Input Sessions

- Design sessions often involve **sport experts** and sometimes **local residents**, including parents and children.

Lighting Use

- **Lighting is still underused**, even though darker evenings are coming earlier each year.

Urban Dance Floor – Griekspoor

- Only **55% of boys** and **7% of girls** played outdoors.
- Girls missed spaces where they could **move freely**.
- Product uses **kinetic energy** to amplify sound.
- Girls wanted:
    - A **movement bench**
    - **Colored tiles** with goals
    - A **place to dance**
    - A **DJ booth**

Playground Equipment Companies

- Growing demand for **outdoor play structures**.
- Increasing interest in **multi-sport combinations**.

NOC*NSF (Representative Present)

- Emphasizes the **recreational sport model**.
- Sports have significant **social and societal impact**.
- **Motor skills are declining** among children.

KVLO (Physical Education Union)

- Contacted to think critically about **gaps in current education** and **what's missing** in PE environments.

NBSS

- Contacted to understand which **motor skills are lagging most** and to identify **key developmental issues**.

Lu llamp – Interactive Sports Products

- In the Netherlands, play happens mostly at **schools**, while in Belgium it's more at **sport clubs** (due to subsidy differences).
- High demand for **movement-based learning**.
- Created **non-competitive solutions** for autistic children and those with motor delays.
- Durable, **vandal-proof setups** in fixed formats.

Nijha

- Uses **community input** to co-create new equipment—children's ideas are included in designs.
- Equipment aligns with the **12 PE learning goals**.
- **Outdoor gym rooms** are an emerging trend, used for both sport and recreational movement.
- **Engineers** choose materials with over **100 years of experience**.
- Trial and error is essential: one example was a black cover on an inflatable that became too hot and had to be replaced.

Bosan

Movement is best developed through play, not instruction.
Children should intuitively understand how to use an object. The design must **encourage spontaneous and self-initiated movement** without explanation or guidance.

Durability is essential.
Equipment used in gym environments faces **heavy and often unintended use**. The product must be robust, safe, and **resistant to misuse**, especially in group settings.

Allow for creative misuse.
Children often use objects in **unexpected ways**. This is not a problem but a feature — your design should **embrace open-ended interaction**.

Fun is critical for motivation.
Without enjoyment, there is no lasting engagement. Educational goals should be **embedded in playful, enjoyable experiences**.

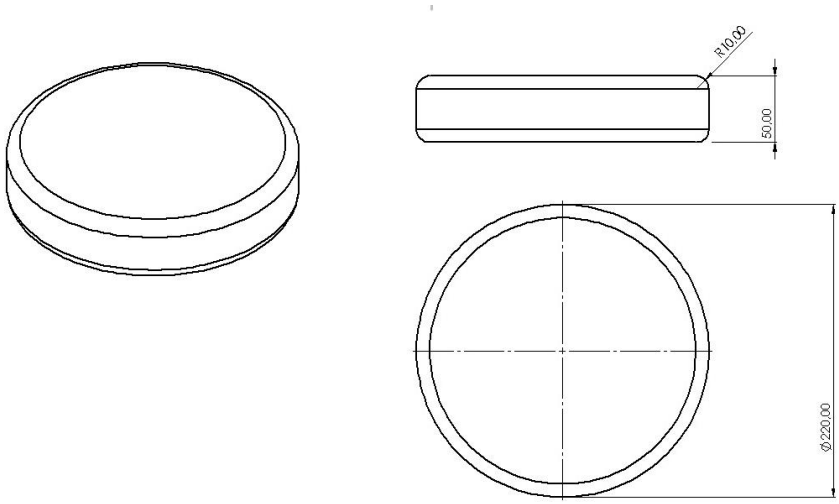
Interaction and variation keep children engaged.
Kids are drawn to elements with **light, sound, and responsive features**. Interactive, modular play elements help sustain attention and stimulate motor learning.

Teachers, not parents, are the key decision-makers.
The product must be aligned with the needs of **physical education teachers**, as they determine how it is used and perceived in practice.

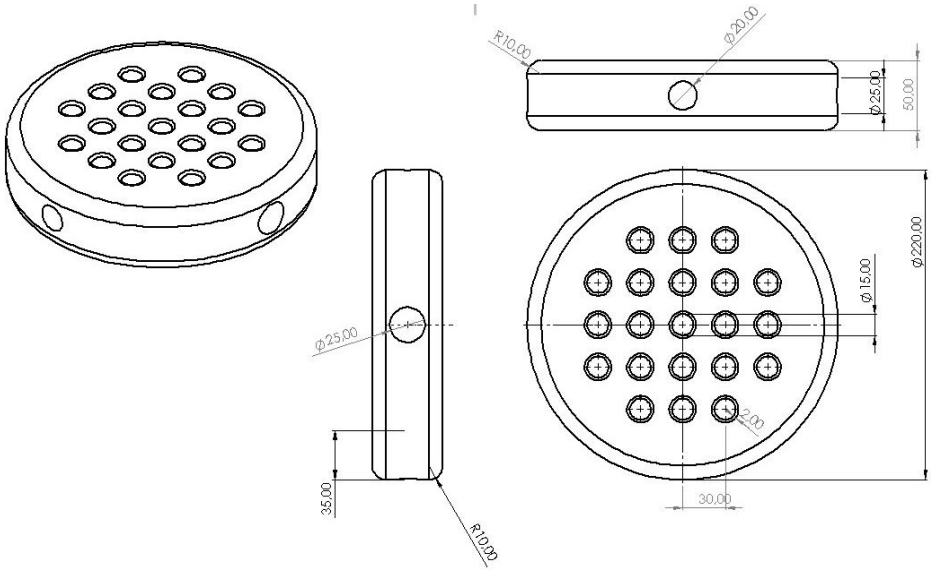
Modular and expandable systems are more effective.
Play elements that can be **combined, stacked, or connected** allow for flexible, varied use, making them more valuable and adaptable in gym or school settings

Appendix U(Dimensions products)

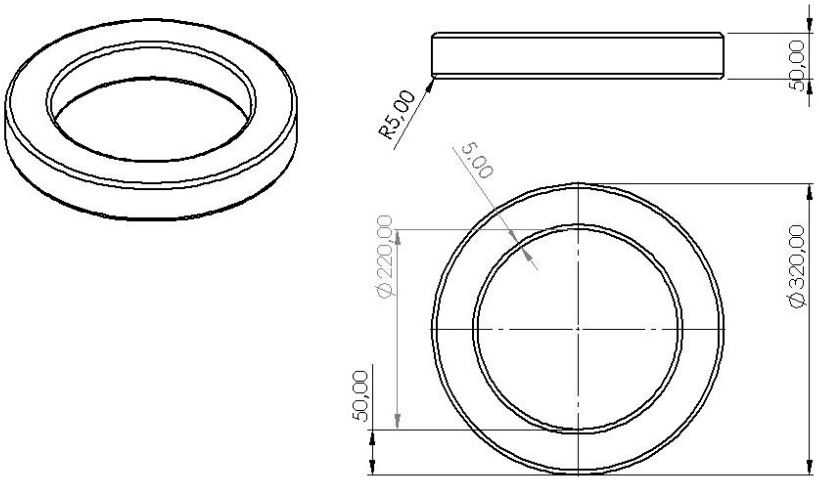
Circle



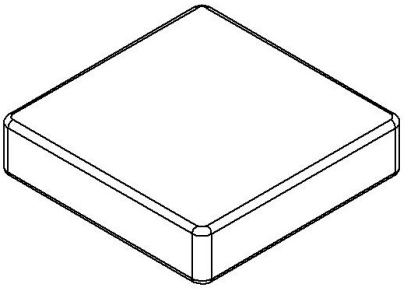
Circle with paddle pattern

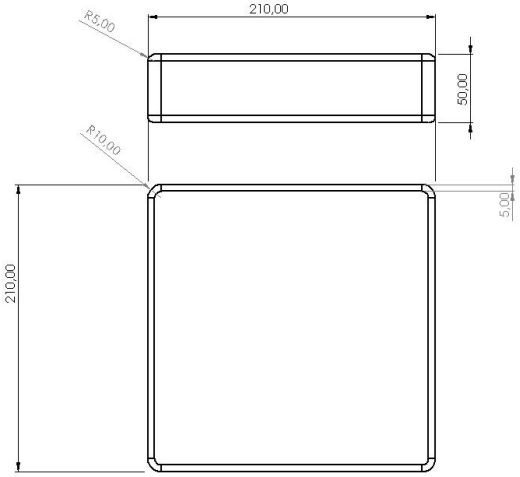


Ring

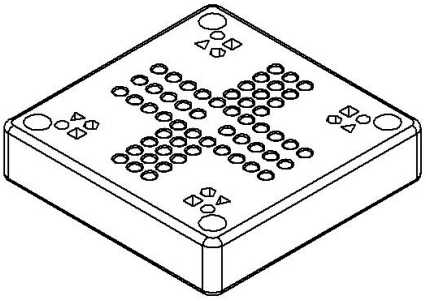


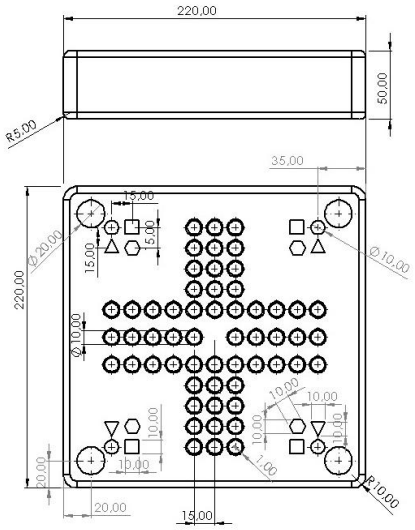
Square



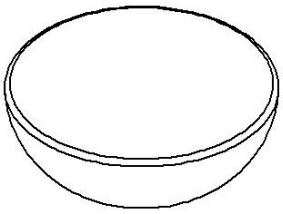


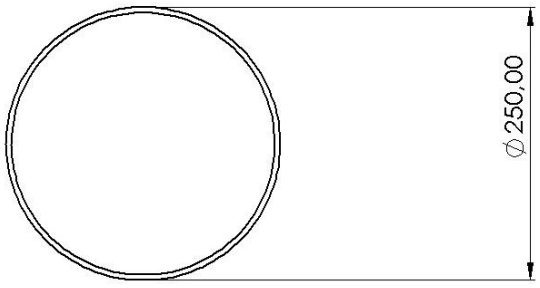
Square with cross/Ludo pattern

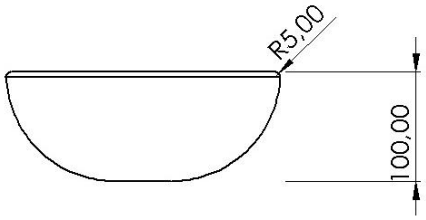




Half sphere







Appendix V(Project brief)

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student: Bart Gerlag

Student number: 4,914,945

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title: Playing is Moving: Designing for Motor skill development in Children

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

In today's society, children are increasingly distracted by screens, such as iPads, game consoles, TV, and social media. This increased screen time displaces outdoor play and physical activity, negatively impacting motor and social development (Iyer et al., 2021) (Figure 1). The level of physical activity is influenced by behavior which plays a critical role in child development. Children who withdraw when faced with challenges ("hide behavior") are less likely to try new sports or persist through difficulty. In contrast, children with "openness behavior" embrace challenges and explore new activities (What Design Can Do, 2017). Consequently, many children quit sports if they don't excel, leading to decreased physical activity. This raises concerns about how early setbacks and inactivity can accumulate over time and have lasting effects.

Research shows Dutch children's motor skills have been declining for decades (Hoofwijk et al., 2020). In 2022, 43.2% of children aged 4 to 12 did not meet the Ministry of Health, Welfare, and Sport's physical activity guidelines (Nederlands Jeugdinstituut, 2023). Developing motor skills at a young age supports a healthy BMI, increases physical activity, and enhances social-emotional and cognitive development (Hoeboer, 2022). A solid motor foundation reduces injury risk, fosters accomplishment, and supports neurological development, making it easier to learn new sports (De Vries & Post, 2021).

Since fundamental motor skills develop between ages 3 and 6, early interventions, such as physical play-based learning, can improve skills and set the stage for healthier lifestyles and better mental health (Figure 2). A variety of activities, from structured physical education to playful learning, can reduce future mental health interventions and enhance overall development (Aadland et al., 2017; Alleen-Herndon et al., 2019; Hoofwijk et al., 2020).

→ *space available for images / figures on next page*

introduction (continued): space for images

image / figure 1 Kinderen bewegen steeds minder (NOS, 2019)

image / figure 2 Kinderen gaan weer meer bewegen(Gemeente Maastricht, 2023)

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

For decades, the motor skills of Dutch children have been declining (Hoofwijk et al., 2020). This issue does not only affects children in their early years but also has significant implications for Dutch adults later in life. Insufficient physical activity at a young age is directly linked to poor sports and exercise habits in adulthood (Hoeboer, 2022).
Motor skill development in children is influenced by genetic, educational, environmental, and parental factors. Early interventions, combined with supportive environments and active parental involvement, are essential for fostering healthy physical development and improving long-term outcomes.
Although many products are designed to develop motor skills in specific situations, there is still a decline in motor skill behavior. An opportunity lies in creating a product that addresses the gap in motivation and usability by offering an adaptable, playful, and appealing solution across various settings. Since learning to move improves in socially supportive contexts, there is also potential for products that promote social forms of play.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a product to improve motor skills that can be used in different settings by children ages 3-6, allowing them to play both alone and with others.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

During my thesis project, the focus will begin with the research phase, exploring literature in more depth and combining it with expert interviews. An overview will be created to identify existing solutions and gaps. Generative research with children will help map out their needs.

Getting in contact with experts who have addressed similar problems, such as design firms and nurses at Sophia Children's Hospital, will provide valuable insights.

The design process will include creative brainstorming methods, such as self-learned ideation techniques, HKJ (Hoe kan je), and other creative approaches to generate ideas. Additionally, I plan to use co-design sessions, which I learned during the course Child and Play Perspectives. Models and prototypes will be iteratively developed and tested with end users to refine the final solution.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	11 feb 2025
Mid-term evaluation	4 apr 2025
Green light meeting	28 mei 2025
Graduation ceremony	27 juni 2025

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

The reason I want to do this project is that during my BEP I had to design toys for children. I noticed that this gave me a lot of energy and fun. During my BEP, I also talked to many people about sports. I myself love sports and practice many different sports. During those conversations I discovered that many people do not play sports. The reason for this was often that they lacked certain motor skills.

This got me thinking. After research, I found out that the foundation for these motor skills is laid at an early age and that people benefit from this throughout their lives. Therefore, I want to design products that allow children to playfully improve their motor skills at an early age, so that society will benefit later on.
During this project, I want to lay the foundation for my future career in this field. During the project I want to develop myself in different areas:
- Conducting co-design sessions with children.
- Visualizing my ideas better with more appealing renders.
- Conducting interviews.
- Delving further into what exactly motor skills are and how best to train them.

My project is successful if I have achieved these goals and if my product actually makes an impact on society by improving children's motor skills at an early age.