The Influence of Apps in Otherwise Screenless Play Sessions

Master's Thesis

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Contents

Abstract

DA: Dette studie havde til formål at undersøge, hvordan digitale komponenter influerer den samtidige interaktion med fysiske komponenter i konteksten af leg. Hertil blev der opstillet 3 hypoteser; 1) forældre er tilbageholdende overfor at involvere digitale komponenter, 2) barnets alder har en indflydelse på deres rolle, og 3) at inkludere digitale komponenter vil ændre legens fokus. Studiet blev skrevet i samarbejde med The LEGO Group og modtog 10 LEGO DUPLO tog sæt (#10428), hvor der er en tilhørende app (LEGO DUPLO Trains), der kan kontrollere sættets fysiske komponenter. Her blev der over en længere periode udført et flerdelt forsøg med de samme forældre og deres børn (3-5 år). Det bestod af observationer i hjemmet (n=10), et retrospektiv interview (n=10) og to opfølgende spørgeskemaer (n=10, n=9). Kvalitativ data blev analyseret gennem tematisk analyse og viste samlagt med supplerende kvantitativ data, et split mellem forældres tanker om brugen af teknologi i leg og deres egentligt anvendelse deraf, der bør studeres nærmere. Derudover sås til tider betydningsfulde, interpersonelle forskelle mellem forældrene, der indikerer, at en større deltagergruppe er påkrævet for at opnå generaliserbare resultater.

EN: The purpose of this study was to investigate how digital components influence simultaneous interaction with physical components in the context of play. Three hypotheses were formulated; 1) parents are reluctant to involve digital components, 2) the child's age influences their role, and 3) including digital components will change the focus of play. The study was written in collaboration with The LEGO Group and received 10 LEGO DUPLO train sets (#10428), which have an accompanying app (LEGO DUPLO Trains) which can control the set's physical components. Over a longer period of time, an experiment with the same parents and their children (aged 3-5), was conducted. It consisted of observations in the home (n=10), a retrospective interview (n=10), and two follow-up questionnaires (n=10, n=9). Qualitative data was analyzed through thematic analysis and, together with supplementary quantitative data, revealed a split between parents' thoughts on the use of technology in play and their actual use of it, which should be studied further. In addition, at times noticeable interpersonal differences between the parents were observed, indicating that a larger participant group is required to obtain generalizable results.

Preface and Acknowledgements

This Master's thesis is the final hurrah to the authors' time spent studying Engineering Psychology at the Department of Electronic Systems at Aalborg University. It was written in the period from February 1st to June 4th, marking 2025 as the fifth and final year at Aalborg University.

We have written this Master's thesis in collaboration with The LEGO Group. Therefore, we would like to express our gratitude to The LEGO Group and Rasmus Horn, Sr. Quality Manager at LEGO, for the LEGO sets (#10428), his creative mind, and great discussions. Thank you for shining light upon interesting topics related to the LEGO set and for your feedback on our exploration of how digital components, such as apps, influence a play session otherwise consisting of physical components such as LEGO bricks and figures through the eyes of parents.

We would also like to express our sincere gratitude to Rodrigo Ordoñez for his expertise, knowledge, guidance and support throughout the project as our supervisor. Rodrigo has truly become a familiar face on campus.

During our time at Aalborg University, we have explored the human psyche through countless hours spent learning about and discussing cognitive-, social-, and experimental psychology. We learned how to develop concepts and iterate on designs following the best practices from user experience design and interaction design. We gained incredible insights into the world of statistical analysis and software programming. We have designed information architecture, rendered 3D images and much more. But the best part must have been learning how to communicate with everyone, achieving the AAU-mindset of "let's explore the complex problems" and meeting the fellow students and teachers. Thank you for having been a part of our journey.

Conflicts of Interests

The LEGO Group donated 10 LEGO sets and we had bimonthly status meetings with Rasmus Horn. The LEGO Group, and Rasmus Horn were not involved in the data collection, data analysis or other discussions of results. They received this study and a presentation after the final submission.

Chapter 1 - Introduction

In the last few decades, the use of technology in the everyday lives of adults has steadily increased, even spreading to those of their children through play with technology-enhanced toys, and mobile phone use. This makes it interesting to understand what play is independent of the rising use of technology and the possible influence of technology on children.

This study aims at exploring digital and physical components in a play setting with children aged three to five years old and their parents. Therefore, this section will include research regarding play theory, technology-enhanced toys, mobile phone habits, and differences in children aged three to five years.

1.1 Play Theory

Playing serves a multitude of purposes for children learning to navigate the world. Although, what these purposes may be and what roles play has in the life of children is widely discussed with two psychologists, Piaget and Vygotsky, leading with two different approaches.

Piaget argues that a child during its first 18 months will perform a series of repetitive action to master motor activities, referred to as practice play. As the child ages, this develops into three new types of play with the first being purposive actions performed to achieve a goal. The second type is pretend play where play becomes symbolic or uses symbolism to some degree. This starts with decontextualized behaviour i.e., performing familiar actions independent of their normal context which moves on to manipulating others' behaviour, then substituting one object for another and finally constructing a make-believe scenario consisting of multiple symbolic actions and manipulations (Nicolopou, 1993, p. 4). When the child reaches the latter months of three years of age, symbolic play decreases and the third type of play is introduced. This is socialized play and rules in play which have the purpose of regulating play in a social setting. Until then, Piaget refers to symbolic - pretend - play as a solitary activity (Nicolopou, 1993, p. 4).

Vygotsky differs from this by viewing play as a social activity even when a child plays alone because it relates to social themes or episodes (Nicolopou, 1993, p. 7). Yet play is in this case defined by two components; an imaginary situation, and rules.

Although this may closely resemble the definition of play made by Piaget, the difference lies in the fact that in Piaget's definition play reflects the child's present cognitive abilities as play develops as the child does while Vygotsky views play as a significant contribution to the cognitive development (Nicolopou, 1993, p. 9). Moreover, Piaget and Vygotsky agree that a change occurs around the third to fourth year as the play - according to Piaget - now entails socialization and rules and - according to Vygotsky - becomes a genuine, social activity (Nicolopou, 1993, pp. 4+7)

As illustrated in figure 1.1, Vygotsky "sees the long-term development of play as a gradual movement" (Nicolopou, 1993, p. 9) from an explicit imaginary situation with implicit rules to an implicit imaginary situation with explicit rules. The child could present to be in a fantasy world on a cloud but the implicit social norms - rules - they know continue to guide behaviour. Nicolopou, 1993 provides chess as an example of play which could be placed further right on the figure 1.1. It is a physically tangible yet highly abstract game with rules provided by the pieces' different roles.

Figure 1.1: An illustration of Vygotsky's view on play as long-term, gradual development (Nicolopou, 1993, p. 9)

Piaget and Vygotsky studied cognitive development and play in children at a point in time where technological add-ons such as toys, in everyday life were not prevalent.

1.2 Technology-Enhanced Toys

Technology has become more available to children since 2010 with the launch of the first iPad (Arnott et al., 2018; Sande, 2010) and has since then spread to other products e.g., toys. As technology-enhanced toys, mobile phones and computers have become common household items (Bourha et al., 2024, p. 1-2), it would be interesting to see how these affect play and components thereof such as imagination, socialization and rules as supported by Johnson and Christie, 2009.

Johnson and Christie, 2009 defines digital toys as; "[...] technology-enhanced battery-operated toys and toys with computer chips installed that make the toys talk or act in certain ways." (Johnson & Christie, 2009, p. 287) and presents three articles on these that showcase vastly different results as illustrated in figure 1.2.

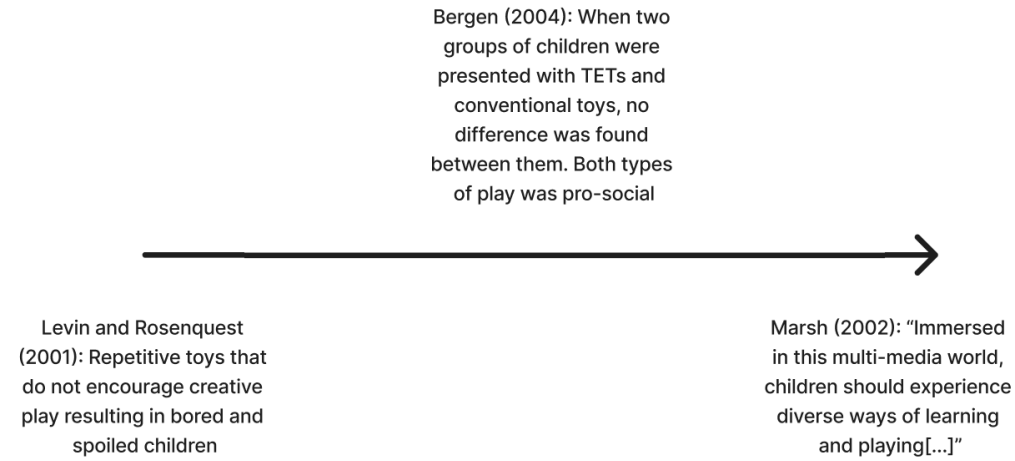

Figure 1.2: Short summary of the three articles described by Johnson and Christie, 2009 placed alongside an arrow to demonstrate positivity about technology-enhanced toys from least (left) to most (right)

Johnson and Christie, 2009 conclude that technology can encourage multifaceted development if the software is "age- and developmentally-appropriate" (Johnson & Christie, 2009, p. 288) - a seemingly Piagetian approach to the use of technology as described in the previous section 1.1. Furthermore, they advocate for balance between "screen-play and actual play" (Johnson & Christie, 2009, p. 288) based on a child's need for real life interactions with both other people and the material world. Although they might have been a bit reluctant, Johnson and Christie, 2009 seem positive towards technology as a supplementary addition to a child's life.

Arnott et al., 2018 collected 12 papers and showcase a holistic approach to understanding digital technologies in childhood. The papers focus predominantly on the positive effects of using digital technologies. These are among others including children in the not just digital but multimodal world that is the 21st century according to Yelland (2018) (Arnott et al., 2018, p. 804), and using gaming to demonstrate peer learning and social interaction according to Danby et al. (2018) (Arnott et al., 2018, p. 805). In spite of the positivity, another paper cited by Arnott et al., 2018, mentions the practitioners' anxiety of integrating digital technologies in early childhood, under 3 years of age, despite them arguing that this practice creates a sense of empowerment and confidence. In spite of the latter, Arnott et al., 2018 gathered papers with a positive view on digital technologies and how they can influence children, especially in play where "digital technologies are widely embraced [as] there are additional opportunities for learning and development" (Arnott et al., 2018, p. 805).

Bourha et al., 2024 define Technology-Enhanced Toys, interchangeable with its abbreviation TETs, as; "[...] toys that transcend physical boundaries, encourage linkages between the real and virtual worlds [...]" (Bourha et al., 2024, p. 2) and explain that the toys may use a range of different technological features such as cameras, sensors and internet connectivity. In some cases, this has made differentiating between digital and conventional toys more difficult as it is no longer based solely on the presence of screens. They found that parents experienced the biggest increase in the child's fine motor skills, language, and creativity. Furthermore, they noted that parents with different educational backgrounds valued the importance of introducing their child to digital technologies for them to develop digital literacy (Bourha et al., 2024, p. 1+11-12).

1.3 Use of Mobile Phones

"Being present emerged as a major theme of good parenting[...]" (Abels et al., 2024, p. 215) and mobile phones have had a noticeable influence on parents' ability to be so.
Abels et al., 2024 describe how parents with children aged 0-5 years, view their own phone use while Shah and Phadke, 2023 explored how parents with children aged 6 months to 4 years of age, view their child's phone use.

After becoming parents, some of them reported unchanged phone use while others mentioned decreasing time spent on their phone. The reasons for this varied. Some made the conscious decision to limit screen time, and others reported having less time to e.g., use their phone. However, most of them experienced feeling guilty for being inconsistent when they had to choose in what scenarios they would use their phone, and what they would use it for (Abels et al., 2024, pp. 220+226). E.g., some parents would be more lenient to check their phone in situations that require less attention. Abels et al., 2024 report that several parents try to shield their children from phones completely as they perceive it as distracting and harmful to their relationship. The guilt and self-criticism is in spite of the fact that most parents otherwise would describe phones as a positive and helpful object in their daily lives. This unacceptable yet helpful device may trigger varying degrees of cognitive dissonance for parents as they try to balance being present, and updated at the same time (Abels et al., 2024, pp. 217+226-227).

Children's use of mobile phones has increased noticeably in the last decade with Shah and Phadke, 2023 mentioning an increase among zero to eight year olds from 38% in 2011 to 72% in 2013. It would appear that the parents in this study have different answers when getting asked two questions regarding the same topic. As figure 1.3 illustrates, the top two reasons for allowing their child to use a phone would be feeding (47%) and crying (42.4%) (Shah & Phadke, 2023, p. 3353).

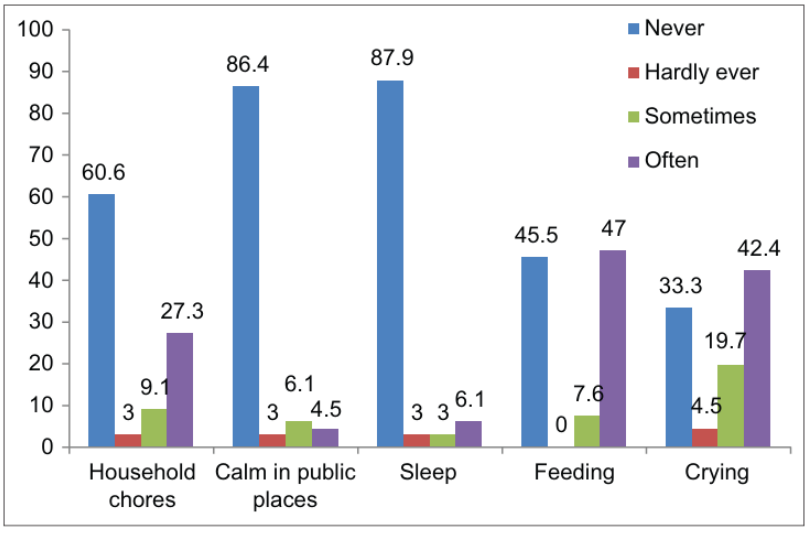

Figure 1: Frequency of mobile phone use with various reasons for allowing a child to use the mobile phone

Figure 1.3: Graph showcasing why children would be allowed to use a phone in a sample of 90 children aged 0-4 years old (Shah & Phadke, 2023, p. 3353)

Although, when parents were asked why their child requires a phone none of the answers reflected the aforementioned two. In this case, educational purposes was mentioned as the major (57.7%) factor (Shah & Phadke, 2023, p. 3353). Supporting the claim made by Abels et al., 2024 that parents experiencing cognitive dissonance in regard to phone use, Shah and Phadke, 2023 found that 84 (93.3%) of the parents did not believe that their child required a phone while 71.4% still allowed them to use one (Shah & Phadke, 2023, p. 3353).

One of the points on which Abels et al., 2024 and Shah and Phadke, 2023 agreed was that only few of their participants mentioned being informed about phone habits and how they might influence both the parents themselves, and their children.

1.3.1 Side effects of Phone Use

WHO, 2019 recommends replacing sedentary screen time with physical movement to improve their physical and mental health. 3-4 years old children should spend at least three hours each day doing physical activities while keeping screen time below one hour. Santos et al., 2022 describes one hour as excessive for children with a mean age of five. This is related to studies that has shown a link between prolonged screen time and "[...]increased sedentary behaviour, obesity, disrupted sleep patterns, and developmental issues" (Shah & Phadke, 2023, p. 3351).

Another issue is that children's phone use may disrupt their "developing ability to regulate [their] emotions" (Abels et al., 2024, p. 216) if the phone is used to distract them when they are experiencing negative, dysregulated emotions. The concern for this is supported by Shah and Phadke, 2023 as parents have rated children crying as the second most likely reason to allow phone use, seen in figure 1.3.
Furthermore, according to Santos et al., 2022 excessive screen time was predictive of problems maintaining attention - inattention - later in life. They went on to explain that likewise, excessive exposure to TV and technological toys seems to correlate with attention problems (Santos et al., 2022, p. 185). Introducing both screens and technology-enhanced toys to young children have negative influence on their attention.

PennStateUniversity, n.d. supports these findings and adds a mention of negative impact on children's cognitive development including their emotional quotient, EQ, and speech development as they may experience fewer conversations in natural settings.

Li et al., 2022a explored the relationship between a child's screen addiction and their parent's. They define screen addiction as; "[...] excessive, uncontrolled, and obsessive media consumption using screen media devices" (Li et al., 2022a, p. 2) with addictions to the internet, digital games, computer, TV, etc as subgroups and mention that screen addiction may interfere with the child's social life and education. Their results highlight parental screen addiction as a positive predictor for children's screen addiction. This may be explained by the fact that children imitate their parents (Li et al., 2022a, p. 2) (Gleitman et al., 2010, p. 563).

Based on the side effects that children may experience from phone use, it should not come as a surprise that many parents are wary of this topic. In Denmark, children are between the ages of 8 years and 5 months, and 9 years and 2 two months old when they get their first phone (Pröschold, 2017) (Uberg, 2017).

1.4 Motor Skills in Children Aged 3-5

Children are born with a limited set of skills that include imitation, social referencing as a guidance to who they should feel, and the ability to attach. Also, the grasp reflex is present in newborn children, and during their first two years of life they learn to roll, sit, and walk (Gleitman et al., 2010, p. 551-552+563). As they grow older, children in the same age group may end up at different stages of their development but one thing is certain: Much happens in the span of two years.

Kakebeeke et al., 2024 studied both fine and gross motor skills in typically developing children (n=101) aged 3-5 with the purpose of providing information on what variability of development is normal and what is not.

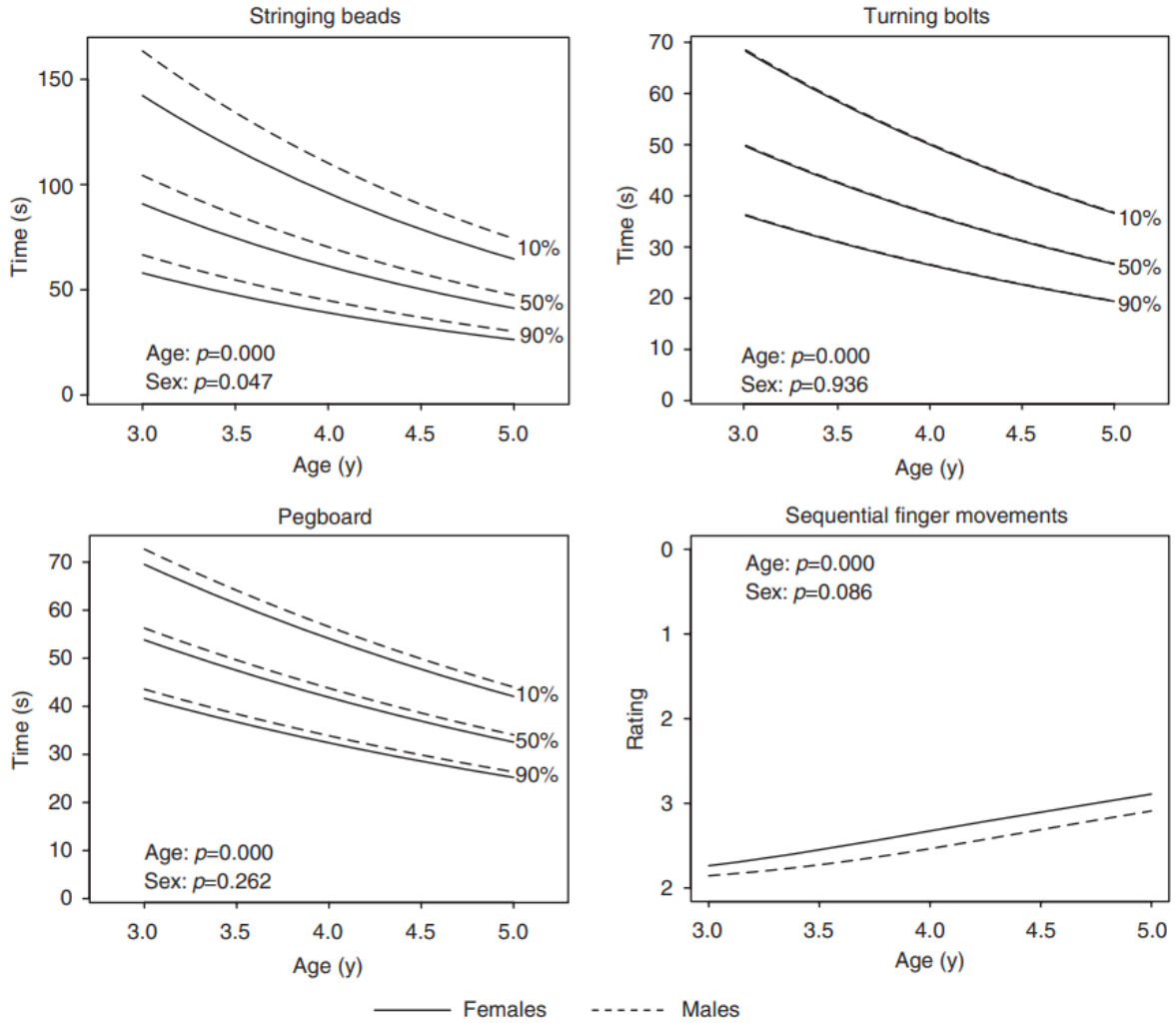

Figure 1.4: Figure showing differences in four tasks targeting fine motor skills in three to five year old children (n=101) (Kakebeeke et al., 2024, p. 250). "Norms of timed performances are summarized with percentile curves for the 10th, 50th, and 90th centiles, with higher centiles referring to better performances." (Kakebeeke et al., 2024, p. 252) as higher centiles indicate less time spent on the task by the children.

In order to interact with technology-enhanced toys, children need to further develop their fine motor skills. Figure 1.4 show the results of four tasks related to fine motor skills. While Sex was a significant factor in Stringing beads with females being faster than males, the most distinct result is that all tasks in figure 1.4 - and nearly all in the study - showed Age as a significant factor (Kakebeeke et al., 2024, p. 248). At the age of five, all children were able to perform all tasks (Kakebeeke et al., 2024, p. 254).

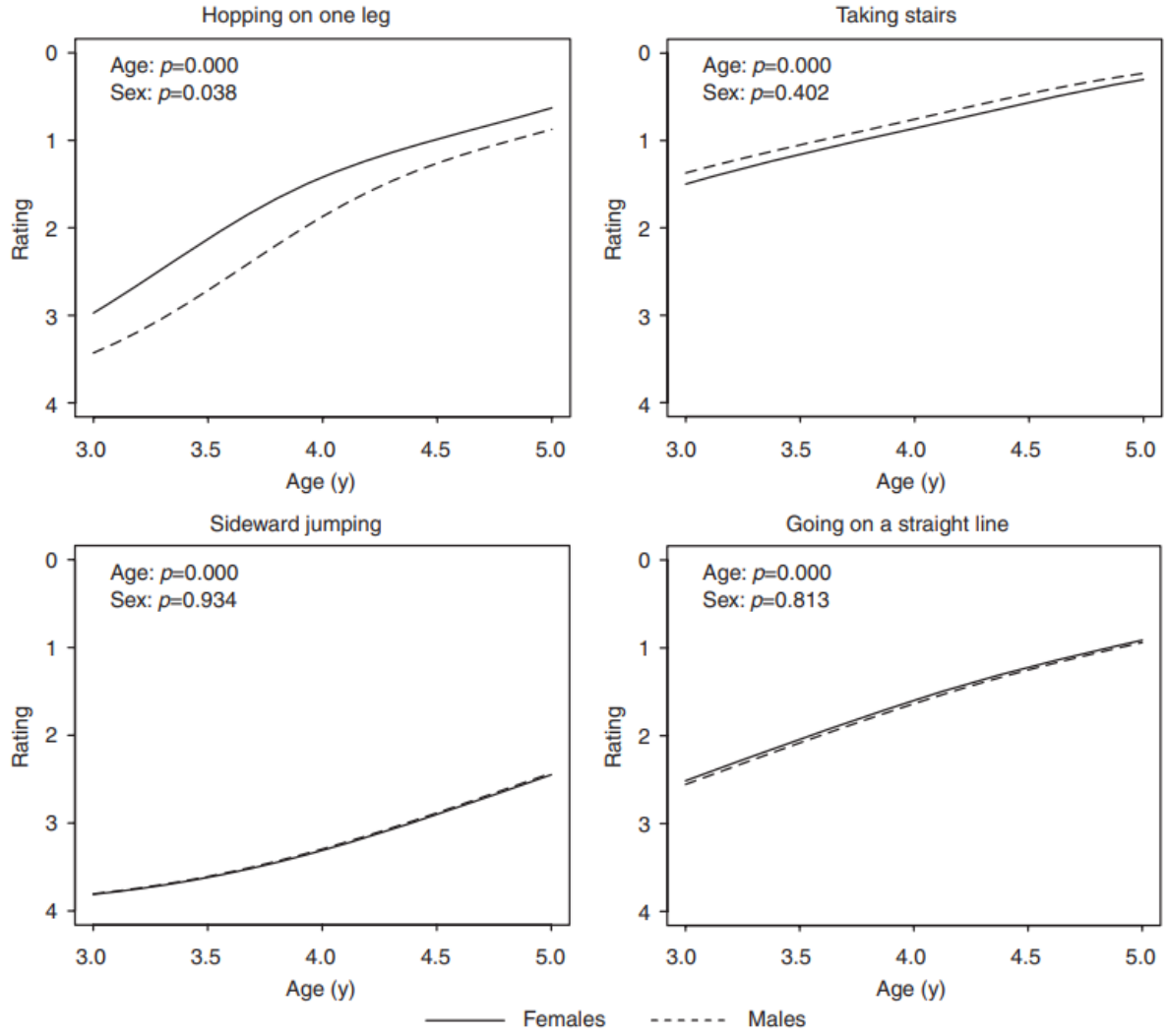

Figure 1.5: Figure showing differences in four tasks targeting gross motor skills in three to five year old children (Kakebeeke et al., 2024, p. 253)

As with the findings related to fine motor skills, Kakebeeke et al., 2024 found that Age is a significant factor when looking at gross motor skills. In both cases presenting $p < 0.001$ for the tasks showed in figures 1.4 and 1.5. Sex was only significant in the task of Hopping on one leg where females outperformed males.

According to Kakebeeke et al., 2024, this indicates a noticeable difference in children's fine and gross motor skills abilities depending on their age. Another study found a similar increase of children's motor skills dependent on their age (Martins et al., 2024, p. 6). Therefore, the difference in children's motor skills should be taken into consideration if children of different ages are exposed to the same tasks in a testing scenario.

Chapter 2 - Scope of the Project

This Master's thesis study explores digital and physical components in a play session between a child and their parent. The research shows that studies of technology-enhanced toys and children's experience with digital technologies have increased over the last one-and-a-half decade as mentioned by Arnott et al., 2018. The aim of this study is to contribute to pre-existing academic knowledge about the use of technology in young children by focusing on play sessions that would normally be dominated by physical components such as when playing with LEGO.

2.1 Problem statement

How do digital components influence simultaneous play with physical components?

This study builds on the opportunity to collaborate with The LEGO Group. LEGO was founded in 1932 by Ole Kirk Kristiansen and has since then become a name known globally for the LEGO brick and is one of the world's largest manufacturers of toys according to LEGO, 2025c. This collaboration granted 10 sets of the LEGO DUPLO Trains Set #10428 (LEGO, 2025d) which will be used to study the relationship between digital and physical components.

The *digital component* is the LEGO DUPLO Trains mobile phone app which can be used to control and change the train, and inspire different ways to play through videos and guides. The *physical component* can be divided into two types: the analogue components which are the LEGO bricks and figures while the electric component is the battery driven train. Apart from these two, the set contains action bricks. They are analogue bricks but causes the train to behave differently depending on what action brick it scanned in the train tracks.

The problem statement will be explored through observations in the parent's home, interviews and questionnaires. This offers both a qualitative and quantitative perspective and gives the opportunity to dive into different aspects of the play session.

2.2 Hypotheses

The problem statement will be explored through three hypotheses. These have been created to narrow down the more thematic focus of the problem statement while ensuring testability. They are based on the research regarding play theory, technology-enhanced toys, mobile phone habits, and differences in children aged three to five years from chapter 1.

H1: Parents are reluctant to include digital components in play sessions with their children.
H1 is based on the many side effects found in studies of children's use of mobile phones.

H2: The age of the child will influence their role in a play session.
H2 stems from exploring differences in three to five year old children.

H3: Including digital components will alter the focus of the play session.
H3 is based on an interest in diving further into how technology-enhanced toys influence play sessions.

Chapter 3 - Heuristic Evaluation

Heuristic evaluations have the purpose of identifying issues with the product's design and interactions through the use of relevant heuristics without including end-users. This is based on the focus of the evaluation, and will in this case be to assess the product's usability because the LEGO set and the related app illustrate a novel approach to the market of technology-enhanced toys. Furthermore it offers a more detailed understanding of the set and app which will both be used in a later test setup.

3.1 Materials

The following is needed to perform the heuristic evaluation:

- LEGO DUPLO Trains Set #10428
- LEGO DUPLO Trains mobile phone app (downloaded)
- One phone pr. evaluator
- An individual document on a computer or piece of paper and a pen kept separate from other evaluators

3.1.1 The LEGO set and app

The LEGO Group and Foundation's mindset "learning through play" (Foundation, 2025) is Vygotskian as he described play as a means to develop the child's abilities. Furthermore, as the complete play experience entails a battery-driven train with photo sensors to detect the colors of action bricks and an app, it is classified as a technology-enhanced toy.

LEGO DUPLO divides their sets into two category; blue and green (LEGO, 2025b). They are designed to help toddlers and young children develop certain cognitive abilities. The blue category is supposed to encourage children to develop their IQ, intelligence quotient, and EQ, emotional quotient, through logical thinking and by expressing themselves. The green category - which the train set #10428 is a part of - supports EQ by motivating the children to keep trying and learning how to be patient which is intertwined with IQ as they strengthen their creative solutions according to LEGO, 2025b.

As displayed in figure 3.1, the LEGO set (LEGO, 2025d) comes with:

- A train consisting of three carts, one if which is electric and powered by four AAA batteries
- Four buildings; a loading/working station, a charging/gas station, a train station and washing facilities
- Five action bricks; these are special elongated bricks that can be placed in the train tracks and upon passing them, the train will react differently depending on which one it passed. The purple action brick is special because it can be reprogrammed and have its functionalities changed in the LEGO DUPLO Trains mobile phone app. As the only element of the set the purple brick can only be customized via the mobile phone app and this necessitates the use of the app
- Figures, flowers, train tracks and other add-ons

Figure 3.1: Two screenshots from LEGO, 2025d displaying the LEGO DUPLO Trains Set #10428 and the front of its box.

3.2 Method and Procedure

This method is chosen as it is a structured evaluation of the product seen through the eyes of end-users. The heuristics are based on an "understanding of human behavior, psychology, and information processing" (Moran & Gordon, 2023) and include (Nielsen, 2024):

- Visibility of System Status: actual information and feedback
- Match between System and the Real World: familiarity in wording, design, mapping, etc
- User Control and Freedom: support clear ways to undo and exit
- Consistency and Standard: best practices, platform conventions and meet user expectations
- Error Prevention: avoid slips and prevent mistakes (Nielsen, 2024)

- Recognition Rather than Recall: minimize memory load through visibility
- Flexibility and Efficiency of Use: have flexible ways to proceed by utilizing accelerators, personalization and customization (Nielsen, 2024)
- Aesthetic and Minimalist Design: prioritize relevant information and visual design
- Recognize, Diagnose, and Recover from Errors: use tradition visuals to inform users of errors, written in a way they will understand while offering solutions (Nielsen, 2024)
- Help and Documentation: both should be easy to find, understand and use in the specific context

It is recommended to have 3-5 evaluators as it is likely that each person may overlook potential usability issues (Moran & Gordon, 2023) increasing the number of missed issues by lowering the number of evaluators. In this case however, two individuals partake in the evaluation of the product. The evaluation acts as the starting point of understanding the information and interactions that the end-users will experience with the product. When conducting a heuristic evaluation, the notes of each evaluator should be kept separate until everyone has finished so as not to bias each other (Moran & Gordon, 2023). In this case, this is done through the use of individual, digital spreadsheets.

In order to focus on different parts of the product, the scope for each evaluation has been narrowed down to four categories: issues with the box, the unboxing, the app, and the train set (without using the app). The evaluators interacted with the LEGO set before conducting the evaluation of the last two categories to become familiar with them. Two hours were set aside to perform the evaluation as per best practice explained by Moran and Gordon, 2023. Both evaluators then examined the set and app, keeping the aforementioned heuristics in mind.

After the individual evaluations, the identified issues found by each evaluator had to be consolidated. This is done through discussions where agreed upon issues are gathered in a new spreadsheet. The two columns consisted of usability issues, and severity rating i.e., how important it is to look into the exact issue from a usability point of view. These are divided into five levels of severity going from lowest to highest; not a usability problem, cosmetic problem, minor usability problem, major usability problem, and usability catastrophe (Nielsen, 1994).

3.3 Findings

A total of 29 usability issues were agreed upon with seven regarding the box, just two regarding the unboxing experience, 11 regarding the mobile phone app, and nine regarding the train set itself. Although it should be kept in mind that only two evaluators took part in the evaluation even though it is recommended that 3-5 evaluate the product (Moran & Gordon, 2023). Therefore some issues may not have been discovered or have been rated differently than they otherwise would. The results will be presented according to their severity rating e.g., "13 were given no priority" as seen below.

Out of these, 13 were given no priority as they did not seem like usability issues or were deemed cosmetic problems e.g., the contents of the bags are mixed which resulted in the user needing to open all bags in search of the correct content (unboxing), and the fact that a user needs to have extension kits for additional levels when they are done with easy, medium and advanced challenges (app) (see attachment 3).
Another four are rated minor usability issues of low priority. These include that the user must recall information instead of being able to recognize it e.g., interacting with the star action brick.

Figure 3.2: Screenshot of the LEGO DUPLO Trains mobile phone app's main page with arrows pointing towards some of the navigation to subpages with usability issues

10 of them were rated major usability issues and should be looked into. These include issues relating to themes such as communication and design e.g., minimal focus on the box regarding showcasing the app and explaining what the action bricks do. The rest of the issues rated at this level were:

- App: Unclickable buttons in UI with "easy, medium, hard, expert" (denoted as 1 in figure 3.3)

- App: No swipe indication on app main page (see main page in figure 3.2)
- App: Lacking explanation of symbols which appear after watching 'inspiration' videos (denoted as 3 in figure 3.3)
- App: By steering the train with the app, it seems like that when the train has come by 1-3 actions bricks it will just continue forever. You can interrupt it, by pressing one of the buttons from the steering. (denoted as 2 in figure 3.3)
- App: You can only use the train's foghorn when the train is not moving. When you are pushing the button, when the train is moving, then it will automatically stop, even if it is on an action brick. Why can't the foghorn be used, when it is moving?
- Train set: The train's behaviour appear odd/seems like a malfunction after interacting with some action bricks
- Train set: How is the user supposed to know where to place the action bricks in relation to the people and 'stations'?
- Train set: The user cannot control the amount of time the train should stop at each 'station', potentially disrupting play and creating issues with other LEGO blocks mid play.

Figure 3.3: Three screenshots of the app's subpages with usability issues mentioned in figure 3.2. 1) The stacked 'boxes' on the left hand side are not working buttons, 2) the design is very simple but is connected to usability issues when interacting with the train, and 3) the information available on this this page as well as the two 'guides' it links to, is very scarce

Lastly, the following two were rated as the most severe issues:

- Train set: The train does not always stop at every action brick.
- Train set: Errors and unexpected events are not expressed in an easy to understand language. The user does not know why the train suddenly ceases to stop at every ‘station’.

Both are in the category; the train set (without using the app) and are directly related to the behaviour of the train when interacting with the action bricks.

3.3.1 Looking for Issues

These findings should read through the eyes of evaluators looking for every kind of issue relating to any of the aforementioned four categories. This does not mean that all parents or children are guaranteed to experience the issues found in this heuristic evaluation. Although some of the issues - especially those with a severity rating of 3 or 4 - would be worth looking into if a remake of the box, unboxing, app or train set was to be considered.

3.3.2 Target Audience

Conversations with Rasmus Horn from the LEGO Group have led to the understanding that the new iteration of the LEGO DUPLO Trains app which was released earlier this year (2025), was designed for the parents. This is opposite to the previous iteration that was designed specifically to be used by the children.
The target audience of the LEGO DUPLO set is children aged three to five years old (LEGO, 2025d). Therefore, it made sense that the app should be used by the parents because of the bias against giving mobile phones to children in that age group.

Although, after the heuristic evaluation, having explored the app, and looked at the website linked to on the back of the LEGO box with the mention of "play ideas", it seems as if the target audience is uncertain.

Figure 3.4: Screenshot from LEGO, 2025a which is the website linked to on the back of the LEGO box. The most interesting part is box and text far left where kid-friendly videos, pictures and interactions are mentioned as a way to promote the app

Looking at figures 3.2, 3.3 and 3.4, the app looks and behaves very kid-friendly with bright colors, big touch areas, short immersive video clips, etc. These are things that attract the eyes of children. Only the settings page is somewhat inaccessible for children and has a more minimalist look with fewer colors and smaller touch areas for buttons. This can be seen in figure 3.5.

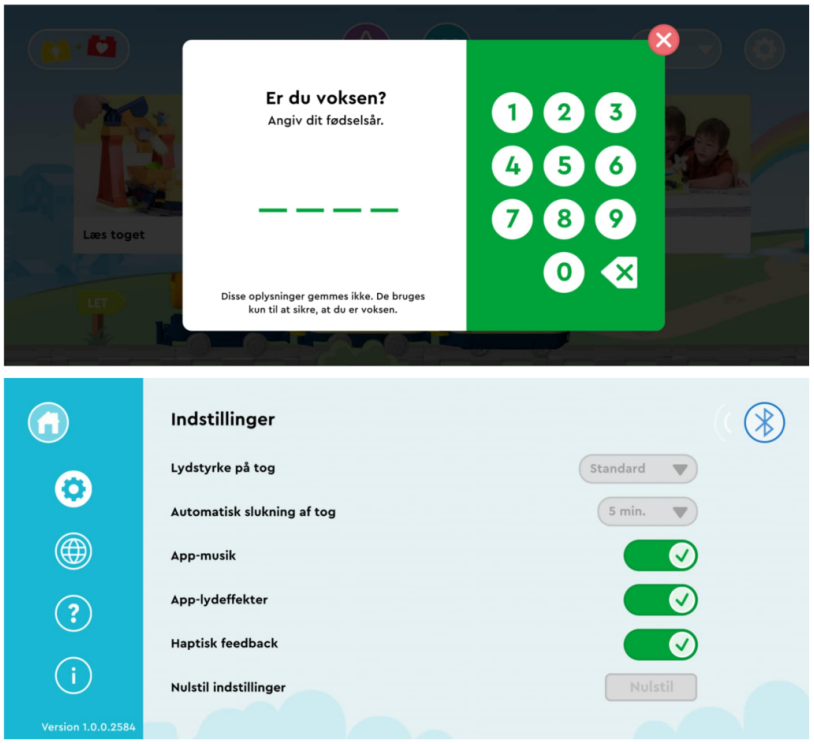

Figure 3.5: Two screenshots from the LEGO DUPLO Connected Train mobile phone app found by pressing the 'settings' icon far right on the main page in figure 3.2. The first screenshot makes the parent enter their year of birth to access settings to control sound, change language, and look at the FAQ

The fact that LEGO wanted an app for the parents yet designed it in a way that would make it attract children, makes it appear like some miscommunication was present in the design process. Furthermore, deciding to place small sized advertisement of the app on the back of the LEGO box could result in it going unnoticed or parents deeming it unnecessary.

3.3.3 Potential Biases

The findings allowed the evaluators to obtain knowledge about the box, unboxing process, app and train set. After discovering a noticeable amount of issues with the app and train set, it could have been interesting to dive into suggestions and solutions to solve these. Although this is not the focus of the study. Because the LEGO DUPLO Trains Set #10428 and LEGO DUPLO Connected Train mobile phone app are used in user tests described in the next chapter 4, these issues should be kept in mind to avoid unintentional influence or bias.

Chapter 4 - Experimental Design

This chapter describes the methods used in this paper consisting of first the overall theory of the methodology and then detailing the chosen approach in this paper. The methods used in this paper are the following:

1. Preliminary questionnaire
2. At-home observation and interview (after answering 1. and setting a time and date)
3. Questionnaire 1 (two weeks after 2.)
4. Questionnaire 2 (two weeks after 3. or approximately one month after 2.)

Furthermore, the participants will be described. An exploration of alternative approaches to the topics presented in this chapter is read in section 7.

When conducting a study with young children and their parents, it is important to keep safety and comfort in mind. In this case, this meant being in a safe place i.e., in their private home, with a child's secure base i.e., their parent (Gleitman et al., 2010, p. 564). The data will be anonymised and stored locally on the authors hard drives following GDPR guidelines (GDPR, n.d.).

4.1 Preliminary Questionnaire

The preliminary questionnaire had the purpose of gathering needed information about parents who would be interested in participating in the study as well as informing them of the terms of the study. **Methods:** Questionnaires are a good and quick way to collect data about the user and their opinions and to reach many respondents at once, since it can be sent out online. A questionnaire consists of closed and/or open-ended questions. To get the best results, these questions need to be clearly formulated. A disadvantage of a questionnaire is that the respondent's level of motivation when answering is unknown, and there may be external factors that could influence their responses. In addition, a balance should be found between the number of questions, the type of questions and the total length of filling out the questionnaire (Sharp et al., 2019, pp. 278-286). These questionnaires were created in Google Forms.

In short, the parents had to agree to the terms of the study written in Danish thereby ensuring all speak Danish before providing their data.

- Their participation is based on them wanting to and having enough time, and that they are expected to partake in all user tests.
- They should expect that participating will take up 2-3 hours over the span of a month.
- Their child and themselves will be in pictures, and in video and sound recordings, solely to be used for data analysis.
- Data will be anonymised after each user test.
- They will host the observation in their private home.

This was done to prevent wasting their time and allow them to fully understand what participating would mean for them and their child. The terms have been summarized and translated to English (see attachment 6 for the entire preliminary questionnaire). Then information regarding when they, i.e. parent and child, will be available for the at-home observation and interview, contact information, demographic information (sex and age), and their frequency of play on a weekly basis, was collected.

4.2 Participants

This section displays the findings from the preliminary questionnaire which is why it will not be part of chapter 5.

A QR code to the preliminary questionnaire along with a short introduction was printed out and put up in three kindergartens in Jutland, Denmark, and handed out to local stores. It can be seen in figure 4.1.

Figure 4.1: The flyer with QR code to the preliminary questionnaire designed in Canva.

Moreover, it was shared on social media in a variety of groups e.g., Facebook pages of local villages, AAU testing, etc. This means that even though the participants must match the study population (Sharp et al., 2019, p. 261) - Danish speaking parents with children aged 3-5 years located in Jutland -, they were sampled based on convenience (Sharp et al., 2019, p. 261).

This study references the same participants throughout due to the within-subject design. Within-subject design uses the same participants in all conditions to minimize the impact of individual differences (Sharp et al., 2019, p. 535).
This means that this section will describe all participants in the preliminary questionnaire, the observation and following interview, and the two later questionnaires at the same time.
Disclaimer 1: As there are only 10 sets available to be used and given as a thank you for participating as agreed upon with LEGO, the number of participants is limited to 10.

When the sampling criteria was created, three aspects were important to consider: individual differences in children and parents, sex and age of the children, and sex of the parents. Age of the parents was not considered important. The individual differences could include but are difficult to account for:

- Personality traits (shy, curious, talkative etc.)
- Mood (happy, tired, irritable, etc.)
- Behavior (distanced, highly involved, controlling, etc.)
- Developmental differences (fine motor skills, gross motor skills, speech, etc.)

The LEGO DUPLO Trains set is marketed towards children aged 3-5 years old. Based on the research in chapter 1 about the drastic development of motor skills in children from 3 to 5 years of age, it was decided to limit the age range to 3-4 years or 4-5 years if possible. Even though only few a studies cited in this study mentioned differences based on sex, it could still influence results. Therefore a 50/50 split of female and male would be prioritized if possible. Alternatively either all male or all female parents and children to minimize differences.

A week after sending out the preliminary questionnaire, only 15 parents had shown their interest. Therefore all of them were contacted. Two ended up dropping out and one did not meet the terms that they had originally agreed to. The 10 first to respond with a time and date were chosen as the participants.

The mean age for the children was 4 years while the mean age for the parents was 34.1 years. 60% of the children were male (40% female) and 70% of the parents were female (30% male). The 50/50 split of 3- and 5 year old children made it possible to collect data relevant for H2: The age of the child will influence their role in a play session (see section 2.2). As illustrated in figure 4.2 the weekly amount of time parents spent playing with their children varied, with a mean time of 8.8 hours to 10 hours a week due answers in intervals of two hours.
Disclaimer 2: Upon answering the first questionnaire sent out after the at-home observation, the age of the parent was collected which is why it cannot be found alongside the rest of this data (see attachment 6). Based on the fact that participants will be described in this section, it was chosen to collect all demographic data here.

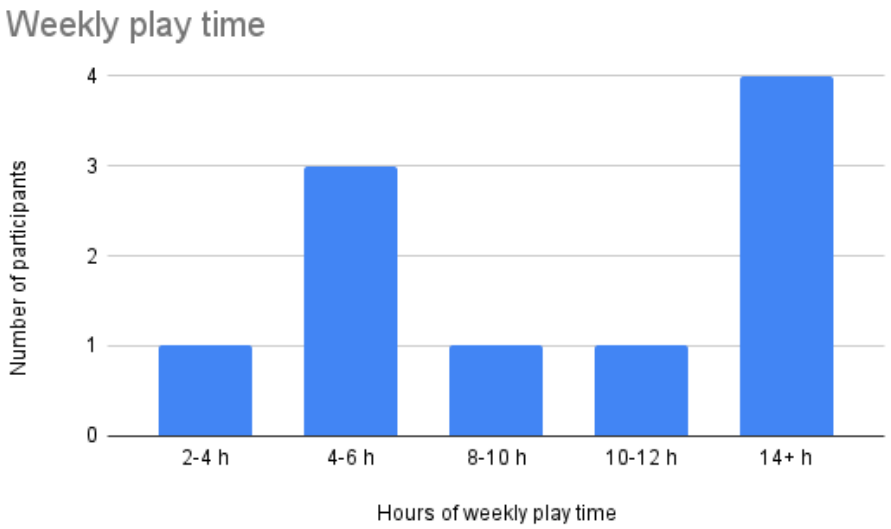

Figure 4.2: Pie chart illustrating hours spent each week playing with their children according to parents (see attachment 6)

Disclaimer 3: Shah and Phadke, 2023 expected a "10% non-response rate" (Shah & Phadke, 2023, p. 3352). This was not accounted for in this study, though the same was seen here as 1/10, 10%, did not answer the second questionnaire they were sent. Here 1 is equal to one parent and their child. This means that the data sample will be based on 10 partaking in the at-home observation and interview, 10 answering the first questionnaire, and 9 answering the second questionnaire. Their data data will be used in the data analysis unless otherwise specified.

4.3 At-Home Observation and Interview

This section will describe the at-home observation of a play session, and the following interview.

Methods: Observations focus on observing someone at work, for example, to gain insight into their context, tasks, and goals. It may be an investigator observing someone directly or it can be recorded and watched afterwards. The observer should distance themselves as to not interfere with the observation. It can take place in a natural setting or a more controlled environment (Sharp et al., 2019, pp. 287-300). A semi-structured interview combines elements of both unstructured and structured interviews. This means there are both open-ended and closed questions. In this format, there are questions that every participant must be asked, but additional questions can be asked if

relevant (Sharp et al., 2019, pp. 268-278). In retrospective interviews, the interviewee is asked to reflect on a recent activity. This type is commonly used in observational studies as it allows for an uninterrupted observation but still gets questions answered afterwards (Sharp et al., 2019, p. 277)

These methods were chosen because it was deemed of high value for this study to experience the parents' and children's interactions with the LEGO set first-hand. The first part of the observation was as ecologically valid as it could be set up with a camera and a set timeframe of approximately 1 hour from entering to leaving their homes, to see how a play session normally would look. The second part of the observation which included the tasks would ensure insights into how different participants interact with the same objects. However, one should be mindful that this approach does not entirely recreate a ecologically valid play session. The retrospective interview was set in place to obtain insights into their perspectives on the experience they have just had.

When creating a test design that includes young children, something to keep in mind is their attention spans. Children have different attention spans than adults which will influence their abilities to partake in studies. According to Neuropsychology, n.d., it is expected that children are able to keep focus for 6-18 minutes at a time depending on their age:

- "3 years old: 6-8 minutes
- 4 years old: 8-12 minutes
- 5-6 years old: 12-18 minutes" (Neuropsychology, n.d.)

As observations often take more than 6-18 minutes it is important to allow breaks if needed and respect children's varying focus. Although parents will be encouraged to try to re-engage their children so as not to exceed the agreed upon time frame too much.

4.3.1 Materials

The user test will be conducted in the homes of the selected families to increase ecological validity (Sharp et al., 2019, p. 518). Therefore the setup is portable and easy to set up.
The following materials were used to conduct the user test:

- Video camera with built-in microphone (SONY 4K)
- Camera Stand
- Computer
- The LEGO DUPLO Trains Set
- Smartphone with LEGO DUPLO Trains app downloaded onto
- 4 AAA batteries
- Screwdriver

4.3.2 Procedure

The procedure used during the at-home observations and interviews can be seen in attachment 7.

First, the time and place were agreed upon. All visits were decided to last approximately one hour to not overwhelm the participants in regard to planning, attention, etc. On the day of the visit, one facilitator would go to the participant's home, introduce themselves, highlight important terms from the preliminary questionnaire, and have the parent sign the consent form (see attachment 8). They signed one for themselves and one as the guardian for their child. While they were doing this, the facilitator set up the camera, camera stand, found a place within eye- and earshot to sit, etc. The camera was then turned on and placed where the play session would be visible.

The parent and child would then be told that they have 20-30 minutes to unbox, build, and play with the set, and that they would get some tasks afterwards. This accounts for the uninterrupted part of the observation.
To ensure that all participants had similar and consistent experiences, 4 tasks of different ways to interact with the LEGO set were created to steer the participants' interaction with the set:

1. Can you see if the train can go all the way around the tracks? - *(Solved if: The train tracks are connected in such a way that the train can move around without running on anything other than the tracks. Not all tracks need to be used to complete the task)*
2. Can you drive the train to the washing facility? - *(Solved if: The blue track, where the washing facility can be built according to the manual, is connected to other tracks that the train runs on. The washing facility does not need to be (fully) built on the track)*
3. Can you make the train stop? - *(Solved if: They intentionally stop the train. This can happen with both their hands and the app)*
4. Can you use the purple star brick to get the train to go to bed? - *(Solved if: They go into the app and change the function of the purple action brick)*

The tasks are only introduced by the facilitator if the participants do not complete them independently and unknowingly during the free-play part of the session, and they will be marked as solved or not solved. If they needed help solving the tasks - asked through verbal or physical expression - the facilitator would offer hints.

After solving - or failing to solve - the tasks, the parent and child were interviewed. This interview was semi-structured so that other relevant aspects that have been noticed during the observation could be asked. The questions aim to get a deeper insight into the play experience with the set, what worked well or not so well and the associated app.

The child was asked 4 short questions listed below:

1. Did you have fun playing with the train set? If no: Why wasn't it fun?
2. What is your favorite item from the train set?
3. Is there a item you didn't like from the train set?
4. Would you play with this train set with your friends or those from kindergarten?

Afterwards, the parents were asked the following 8 questions:

1. How do you think the play experience with the set was for you and your child?
2. Was there something about the set that worked well?

3. Was there something about the set that you don't think works well?
4. What do you think of the app? Did you get anything out of it? What works well? What works less well?
5. Do you feel the set can be used independently from the app? Why/why not?
6. Do you prefer to use it with or without the app?
7. Did you find it easy or difficult to play with your child with this set?
8. How often do you play with LEGO? What type do you usually buy?

Two tasks, number three and four, and three questions, number four, five and six, were set in place to collect data specifically related to answering H1: Parents are reluctant to include digital components in play sessions with their children, and H3: Including digital components will alter the focus of the play session (see section 2.2).

After the end of the retrospective interview, the video camera was turned off and the facilitator packed up. While doing so, they thanked the family for their time and reminded them to keep playing with the set and app due to the questionnaires they were going to receive.

The at-home observations and interviews went as described in the procedure. As the dates chosen had to align with the parents' preexisting plans, this user test was carried out over the span of two and a half weeks. This impacted when they would receive the follow-up questionnaires.

4.4 Questionnaire 1

Two weeks after the at-home observation and interview, the parent was sent a questionnaire, created in Google Analytics, focusing on their experiences with the set after the visit. The two week wait was to give them time to play with the LEGO set and the app, get to know their different functions, and form opinions about them. The questionnaire method used is described in section 4.1.

Most of the questions were directed towards the parents to minimize additional effort spent by including their child in a lengthy questionnaire. Even though some questions were directed towards

the children, the parents are considered capable of answering on behalf of their children if necessary. The exact questions asked along with the answers can be viewed in attachment 4. The overall themes presented in it were:

- How they played with the LEGO set (including preferences)
- Entertainment value
- The action bricks
- Involvement of other toys when playing with the LEGO set
- Use of the app (including frequency, functionality, influence on attention)
- Reflections

The participants were asked a total of 39 questions divisible into three categories; 25 open-ended questions where the participants have to type out their answer, 13 selection list questions in which they could choose one answer, and 1 multiple-choice question in which they could check off one or multiple answers.

4.5 Questionnaire 2

The second questionnaire was sent out approximately one month or two weeks after the first one was answered. Again created in Google Analytics. This time the focus was split into; the last two weeks, and their general experiences from then they got the set up until answering. Some questions from the first questionnaire were reused in the second which allowed exploration of experience over time. The questionnaire method used is described in section 4.1.

Again, the questions were mostly directed towards the parents, just like in the first questionnaire, they were allowed to answer on behalf of their child if necessary. The questions asked along with the answers can be found in attachment 5 but the overall themes presented in it were:

- How they played with the LEGO set (including preferences)
- Entertainment value
- The action bricks
- Use of the app (including frequency, functionality, influence on attention, reflections)

- Behavior
- Gathered information
- Feelings and thoughts regarding different steps in the process
- Reflections

In the second questionnaire, the participants were asked 54 questions which is 15 more than in the first. The same categories were used and they were asked a total of 31 open-ended questions, 10 selection list questions, and 4 multiple-choice questions.
9 open-ended questions and 9 selection list questions were added to gain a more quantifiable insight into the participants' experience while allowing them to describe the reason for their rating via the implementation of a category scale. These results could e.g. be analyzed in a user journey map. If the 18 questions added for this reason were deducted from the equation, the participants had to answer 3 less questions in the second questionnaire compared to the first.

Method: A 5-point category scale was chosen to link the participant's experience to a numerical value which will be useful to quantify the experience pinpointed at some of the different steps of the LEGO interaction. Category scales measure the degree of preference (Lawless & Hildegarde, 2010, p. 152). A picture of color-coded smileys and anchor words (Lawless & Hildegarde, 2010, p. 159) - 1: "green smiley" and 5: "red smiley" - were placed alongside the scale to guide participants in their choice as seen in figure 4.3.

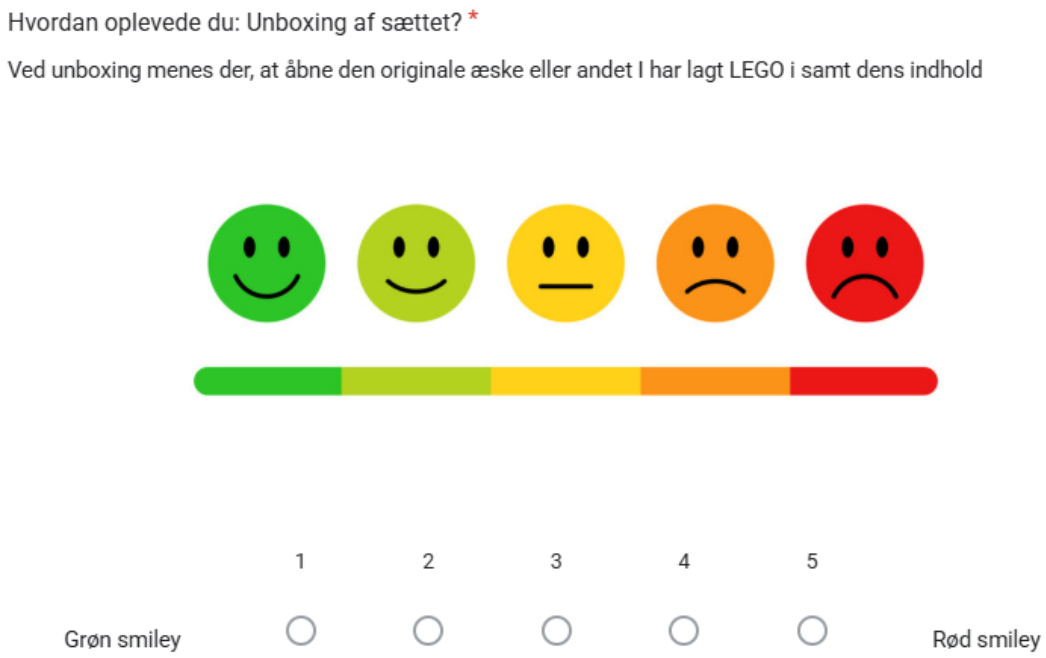

Figure 4.3: A screenshot of one of the questions in questionnaire 2 that utilized a 5-point category scale with smileys as guides

The smileys were added instead of attributes at every point on the scale because they are easy to recognize and reflect emotions which is the focus of these questions. This also means that the scale is bipolar i.e. the intensity described by end-labels can differ (Li et al., 2022b, p. 5), as it is commonly used (Lawless & Hildegarde, 2010, p. 153-154). The scale ranges from a positive/green state to a negative/red state with a neutral/yellow at the center.

Chapter 5 - Results

This chapter will describe the results of the user tests and the data analysis performed to obtain them. Findings deemed of value will be highlighted here while remaining raw data and data analysis are placed in attachments 1, 4, 5, 6, 9 and 10.

The chapter will be split into quantitative and qualitative data analysis which will include the at-home observation, the retrospective interview, and questionnaire 1 and questionnaire 2. Lastly, trends and patterns across these will be explored.

As described in section 4.2, one participant did not complete questionnaire 2. Although their data will be kept in this section about the at-home observation. This avoids unnecessarily removing data points that could add valuable knowledge. In the case of comparing quantitative data from the first and second questionnaire as made possible by using within-subject, their one set of data points was removed to avoid skew the data by having an uneven number of participants. In the case of qualitative data analysis, their data will remain as part of the data set.

5.1 Quantitative Data of At-Home Observation

The raw data used in this section can be found in attachment 10.
As the purpose of an observation is to observe naturally occurring behavior, the variables as displayed in table 5.1 reflect a test design with limited manipulation. Although the second half of the observation utilized tasks to ensure the same points of interaction across the different participants which can be seen in table 5.3.

Dependent variables	**Independent variables**	**Control variables**
The experience of playing with the LEGO set during the observation	Participants (age of children)	Same materials for setup
Actions and behavior (see table 5.2)	Participants (behavior of children)	Private room or part of home
	Participants (behavior of parents)	Same observer behavior due to interview guide despite two different facilitators having executed respectively 40% and 60% of the observations

Table 5.1: This table shows the dependent, independent and control variables of the at-home observation.

The observation conducted in the homes of the participants yielded mostly quantitative data points in post-observational data analysis. This was chosen as an objective measurement to supplement the participants' subjective answers in the following retrospective interview.

Data analysis approach: 9 steps of the playing process were identified pre-observation as a result of familiarity with the set from the heuristic evaluation described in chapter 3. As described in section 4.3 four tasks were given in the second half of the observation. In addition to this, nine different types of behavior were identified although one was deducted, number of interruptions made by the facilitator, was monitored as a check for external influence and will not be found in attachment 10. The purpose of this was to monitor the participants' behavior and explore if it changed depending on what step they were on. The steps, tasks, and behaviors are listed below in table 5.2 while their descriptions can be found in attachment 1.

Steps	**Behavior**	**Tasks**
Unboxing the set	Use of manual	Reprogram the purple action brick
Build the train itself	Use of box	The train runs on the tracks
Build the buildings	Ask for help	The train passes by the washing facility
Build the train tracks	Offer help	Stop the hand (use hands or app)
Use the action bricks and the train's interaction with these	Guide focus on physical	
Use the app to control the train	Guide focus on building	
Use the app to change what the purple action brick does	Guide focus on digital	
The app's other features and pages	Phone takes attention	

Table 5.2: This table shows the steps, tasks, and behaviors that were monitored and counted after the at-home observation.

The behavior Phone takes attention, was monitored to collect data specifically regarding H3: Including digital components will alter the focus of the play session (see section 2.2).

The tasks were rated as either solved or not as displayed in table 5.3 below and can be interpreted as follows:

- S: success, the task was solved
- S*: success, the task was solved but the facilitator gave them one or more hints in order to achieve this
- F: fail, the task was not solved. The task of stopping the train using the app was not a must-ask task
- F*: fail, the task was not solved even after being given one or more hints

	A/a	B/b	C/c	D/d	E/e	F/f	G/g	H/h	I/i	J/j
Reprogram the purple action brick	S*	S	F*	S*	F*	S	S*	S	S*	S*
The train runs on the tracks	S	S	S	S	S	S	S	S	S*	S
The train passes by the washing facility	S	S	S	S	S	S	S	S	S	S
Stop the hand (use hands)	S	S	S	S	S	S	S	S	S	S
Stop the hand (use app)	F	S	F	F	F	F	F	F	F	F

Table 5.3: This table shows the steps, tasks, and behaviors that were monitored and counted after the at-home observation.

Table 5.3 shows that the participants were given noticeably more hints regarding the task of reprogramming the purple action brick. This could be influenced by the way in which the question was asked, difficulties using the app or other unexplored factors. In order to explore this topic, further studies should be performed.

After the observations, the two facilitators analyzed the video data and counted the frequency of behavioral occurrences, noting them according to which step or task it was observed at. Both facilitators analyzed the data to ensure reliable data points following the descriptions as guides as it is important to minimize internal criteria unconsciously set in place by each facilitator. This resulted in four different data types:

- Agreement 1: Both facilitators did not note any behavioral occurrences at that step or task, thereby agreeing on the lack of behavior
- Agreement 2: Both facilitators noted the same frequency of behavioral occurrences, thereby agreeing on the presence and frequency of behavior
- Disagreement 1: The facilitators noted two different frequencies of behavioral occurrences, though agreeing that the behavior was present
- Disagreement 2: One facilitator noted a frequency while the other noted zero, thereby disagreeing on the presence of the behavior

Data analysis review: After reviewing the frequencies counted by each facilitator, multiple accounts of disagreement were found. This may be due to unintentional internal criteria and bias or because of inadequate descriptions such as (both from attachment 1):

> Use the action bricks and the train's interaction with these; *"This occurs when the action bricks are interacted with or talked about, e.g. discussing what the action bricks can do. Likewise, reactions to the train interacting with the action bricks are relevant in this case."*

> Ask for help; *"The person approaches the other person by asking for their assistance. The approach can either be verbal or physical. This is regardless of what the assistance relates to."*

The table below 5.4 displays the summed frequency counts of facilitator 1 and 2 for each step in the process of playing with the LEGO set. To validate the data before performing further testing a difference displayed as both frequency and percent was calculated. The columns with measurements were calculated as follows:

Column 1: The steps and tasks as listed in table 5.2. Each row indicates a new step or task.

Facilitator 1: All frequencies counted by facilitator 1 across the eight types of behavior listed in table 5.2, summing up everything facilitator 1 had counted regarding each step or task.

Facilitator 2: All frequencies counted by facilitator 2 across the eight types of behavior listed in table 5.2, summing up everything facilitator 1 had counted regarding each step or task.

Difference (frequency): Frequency count of facilitator 1 subtracted by frequency count of facilitator 2, using the function ABS() was used to get the absolute value and correct for whether the number is positive or negative, thus giving the difference in a positive percent value e.g. $18 - 20 = 2$

Difference (percent): Calculated difference in percent to spot low percent differences indicated similar frequency counts. Calculated by dividing the frequency difference with frequency of facilitator 2 and multiplying by 100 e.g. $2/20 * 100 = 10\%$. The absolute function was used in this case as well.

This description will also be applied in table 5.5 later in this section.

	Facilitator 1	**Facilitator 2**	**Difference (frequency)**	**Difference (percent)**
Unboxing the set	18	20	2	10%
Build the train itself	53	52	1	1.92%
Build the buildings	128	102	26	25.49%
Build the train tracks	50	37	13	35.14%
Use the action bricks and the train's interaction with these	24	33	9	27.27%
Use the app to control the train	1	2	1	50%
Use the app to change what the purple action brick does	6	2	4	200%
The app's other features and pages	4	3	1	33.33%
Reprogram the purple action brick	22	44	22	50%
The train runs on the tracks	5	22	17	77.27%
The train passes by the washing facility	0	4	4	—
Stop the train (using hands)	0	1	1	—
Stop the train (using app)	0	1	1	—
Total summed	331	323	12	3.72%

Table 5.4: This table focuses on the steps and tasks that were monitored and counted after the at-home observation. The '—' indicates that one facilitator counted 0 for that entire step or task thereby making it incomparable to the count of the other facilitator.

By focusing on the last row "total summed", it would appear that the facilitators frequency counts were quite similar with a difference of only 3.72%. Although that would give the wrong impression of the frequency data as it has high levels of individual variance.

These levels devalue the data noticeably as the only steps but if a cut-off was set to 15% was assumed usable to determine whether or not the frequency counts of facilitator 1 and 2 are similar enough, it would leave two steps - Unboxing the set, and Build the train itself. 15% was chosen as it created room for individuality and minor differences in the facilitators without the frequency counts differing too much from each other, making the data unreliable. Other approaches that might have lessened the differences in frequency counts across facilitators will be discussed in 5.1.1.

It was decided to explore the same four measurements focusing on the eight different types of behavior. This was due to the inconsistency found when exploring frequency counts regarding steps and tasks, and because the steps and tasks, and behaviors are interdependent. This is due to the fact that the behaviors were the ones being monitored and placed according to which step or task they were observed in thereby making it impossible to separate the three. This also means that findings in this table 5.5 will influence the reliability of the findings in table 5.4. The following table displays the behaviors and differences in counts which were calculated as described for table 5.4 but with focus altered to explore behaviors instead of steps and tasks:

	Facilitator 1	**Facilitator 2**	**Difference (frequency)**	**Difference (percent)**
Use of manual	55	93	38	40.86%
Use of box	33	49	16	32.65%
Ask for help	74	28	46	164.29%
Offer help	32	15	17	113.33%
Guide focus on physical	68	34	34	100%
Guide focus on building	40	91	51	56.04%
Guide focus on digital	4	5	1	20%
Phone takes attention	5	8	3	37.50%

Table 5.5: This table focuses on the behaviors that were monitored and counted after the at-home observation.

None of the differences are below the aforementioned 15%. Therefore it is determined that the frequency counts related to all different behaviors are too dissimilar to support further data analysis. This includes the aforementioned two steps as the steps, tasks and behaviors are interdependent.

If additional data analysis was to be performed on this data set, any statistically interesting findings should be disregarded due to the inconsistent and dissimilar results of the data collection.

5.1.1 Discussion of Results of the At-Home Observation

The facilitators' unconscious, internal criteria and biases, along with ambiguous descriptions of what the different steps, tasks and behaviors mean, and of when to count additional frequencies, made it illogic to further analyze the quantitative data gathered from the at-home observations. This is unfortunate as the quantitative data was supposed to supplement the qualitative data from the retrospective interview. If this data had been collected in a more objective manner, it could have been valuable to compare the objective experiences of the participants with their own perception of their experiences.

If more resources and time were available, changes would have been made to obtain reliable, quantitative data. In order to avoid similar errors in future studies, the following aspects should be considered:

Rewrite descriptions: Rewrite the descriptions of steps, tasks, and behaviors along with updating the interview guide to make them unambiguous, with clear indications of when to count a new occurrence.

A new approach to data collection:

- Both facilitators should analyze all video data 2-3 times to ensure internal validity
- More people - enough to make quantitative data valuable - should partake in gathering the data to even out individual differences otherwise discovered in the facilitators during this study
- The sound files from the observations could have been transcribed although as described, the focus of the observations was to observe interactions and behavior making transcription a supplement to the observation as transcriptions only partially showcase behavior and actions. Furthermore during data analysis, it was discovered that some present AI transcribers - NVivo was the software tried for this study - are not able to correctly transcribe speech while differ-

entiating it from noise i.e., LEGO bricks rattling, to produce meaningful text. In the future, AI may be able to do this in which case, transcriptions would be interesting to link specific quotes to specific interactions

More monitoring: More aspects could have been monitored e.g., participants struggling with app navigation or specific interactions with the train set.

Gather more person-specific information: Differences in participants could have been investigated by asking them about their mood, tiredness, etc. Furthermore, the time of day and day of the week may have influenced them.

One facilitator and controlled environment: If possible and deemed beneficial.

- One person should facilitate all experiments to minimize differences caused by the different facilitators
- Minimizing ecological validity and removing the children from their safe place, all participants could have been tested in the same, controlled room which would have allowed control over external interruptions such as by partners, siblings, and pets

Statistical data analysis: If the data had shown internal reliability regarding the facilitators and perhaps more participants were involved, statistical data analysis could have been done to explore any statistically significant findings which could imply interesting points to further investigate. Although this would require more information on how and what statistics should be used and further analysis of the gathered data.

Binomial data analysis: Alternatively the data could have been analyzed by creating binomial data. This could be done by deciding on a criterion what would determine whether or not the data point would be included in the set e.g., 1) disagree = 0: if both facilitators noted an occurrence, the binomial value would be 1 and if none or only one of the two noted any, it would be 0, or 2) disagree = 1: if both or if just one facilitator noted an occurrence and the other did not, the binomial value would be 1, while if none of them noted an occurrence it would be 0.

5.2 Quantitative Data of Questionnaire 1 and 2

The raw data used in this section can be found in attachment 4 for Q1, 5 for Q2 and 6 for preliminary questionnaire.

With the purpose of letting the parents and children explore the LEGO set further, the first questionnaire was sent out two weeks after the at-home observation while the second was sent out two weeks post-answer to the first. This section will include findings from questionnaire 1 and 2 in order to explore trends and search for evolving patterns.

As described previously, one participant did not complete questionnaire 2. In the case of comparing quantitative data from the first and second questionnaire as made possible by using within-subject, their one set of data points was removed to avoid skew the data by having an uneven number of participants. In the case of qualitative data analysis, their data will remain as part of the data set.

Introduction to graphs: This section will contain grouped and ungrouped bar graphs to show frequency distributions (Agresti, 2018, p. 42) that are consistently color-coded to ease interpretation of them. The purple bars are associated with answers to questionnaire 1 while the blue bars are associated with answers to questionnaire 2, e.g., as seen in figure 5.1. In this section questionnaire 1 and Q1 are used interchangeably as are questionnaire 2 and Q2. While used sparingly in figure 5.6, the pink bars are associated with exploration of the LEGO set while the yellow bars are associated with exploration of the app. The teal colored bars of figure 5.7 are associated with different scenarios or use cases. The arrows linking the tops of bars indicate either an increase or decrease which green associated with increase, and red associated with decrease. Instead of displaying a gray arrow if no difference between the two bars was found, no arrows will be present for visual simplicity. The majority of bar graphs are made based on selection list questions meaning that the participants could only choose one answer pr question. The graphs are drawn in Figma as they would only be used for the purpose of visualization.

The data showed no noticeable difference between answers in Q1 and Q2 in who initiated playing with the LEGO set. Eight participants were consistent across the two questionnaires with six choosing "both initiated" and two choosing "my child initiated". One participant, B, answered that both initiated play in Q1 but this changed in Q2 as the initiator became the parent. Expect from this, the consistency of answers indicate that the children were actively engaged in wanting to play with the LEGO set.

Before leaving their homes after the observation and retrospective interview, the participants were asked to keep playing with the set in order to answer the follow-up questionnaires. To measure this, they were asked how much time was spent play with the LEGO set in the span between the home-visit and Q1 for the first questionnaire, and between Q1 and Q2 for the second questionnaire.

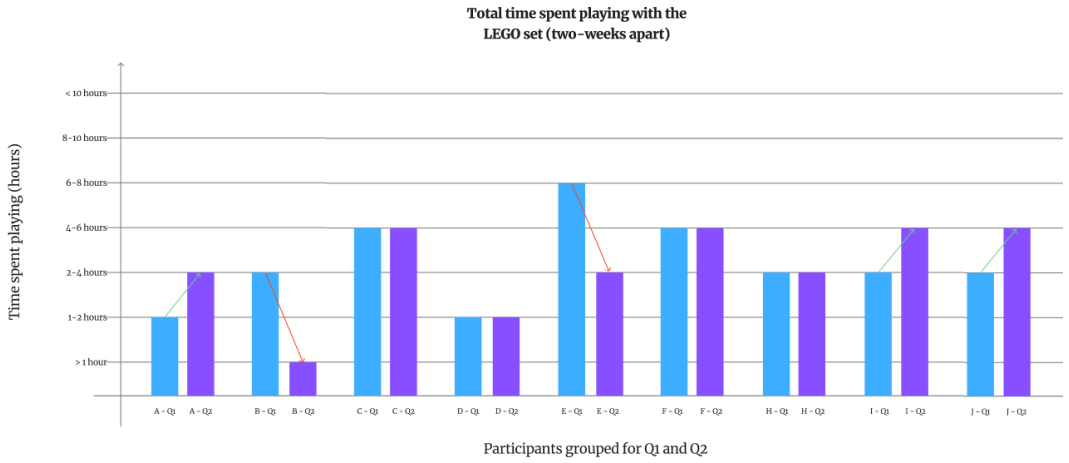

Figure 5.1: Bar graph of time spent playing with the set answered in Q1 and Q2 (n=9). Three participants increased time spent playing (green arrows) while two decreased it (red arrows).

As displayed in figure 5.1, three participants spent more time playing with the set in the two weeks leading up to Q2 compared to their answers in Q1. They increased their time spent playing by one interval, having played with the set approximately two hours more. Figure 5.1 also shows a decrease of two interval by two participants, meaning that they have played approximately four hours less. Due to this and the consistency of the remaining participants' answers, a tendency of slightly decreased use can be observed within one month of getting the LEGO set.

It would be interesting to put the use of the LEGO set into perspective of the participants' typical weekly play time which was gathered in the preliminary questionnaire. The table 5.6 explores how much time was spent playing with the LEGO set under the assumption that this play replaces another type of play or toys thereby not adding more time to their typical weekly play time. The purpose is to view how much time the participants allocated of their usual time spent playing, to using the LEGO set.

Disclaimer: As all answers were collected as interval, the data in this table is calculated using the lowest number in the interval. 0.5 hour will be used to reflect the option of >1 hour. This conservative choice is taken to avoid overestimating the hours spent playing.

The columns in table 5.6 were calculated as follows:

Column 1: The participants

Typical weekly play time (interval): The interval chosen by the participants in the preliminary questionnaire to describe how many hours they spend playing each week

Q1: To see how much time was spent playing with the LEGO set from home-visit to Q1 in relation to the typical time spent playing as displayed in figure 5.1. First, it must be converted from weeks to one, by dividing the lowest value of the interval chosen with 2. It is then calculated by dividing the answer from Q1 with the answer from the first column and multiplying by 100 e.g., $1/2 = 0.5$ followed by $1/14 * 100 = 3.57\%$

Q2: To see how much time was spent playing with the LEGO set between the two questionnaires in relation to the typical time spent playing as displayed in figure 5.1. First, it must be converted from weeks to one, by dividing the lowest value of the interval chosen with 2. It is then calculated by dividing the answer from Q2 with the answer from the first column and multiplying by 100 e.g., $2/2 = 1$ followed by $1/14 * 100 = 7.14\%$

Participant	**Typical weekly play time (interval, attachment 6)**	Q1	Q2
A	14+ hours	3.57%	7.14%
B	14+ hours	7.14%	1.79%
C	4-6 hours	50%	50%
D	14+ hours	3.57%	3.57%
E	4-6 hours	75%	25%
F	10-12 hours	20%	20%
H	8-10 hour	12.5%	12.5%
I	14+ hours	7.14%	14.29%
J	4-6 hours	50%	100%

Table 5.6: This table focus on the behaviors that was monitors and counted after the at-home observation.

This table, 5.6, allows for direct comparison of the participants' typical time spent playing with their time spent playing with the LEGO set. It shows a widespread distribution of time across the participants with some intrapersonal differences going upwards of 50%. Participants A, B, D, H and I all spent less than 15% of their typical weekly play time using this LEGO set while participants C, E, F and J all spent 20% or more. This may indicate that different participants had different levels of interest in the LEGO set.

The higher number should not be interpreted as indications of some participants having spent more time getting to know the set and its different components. This is due to the fact that participants with less hours of typical weekly play time do not have to play as much with the LEGO set as participants with higher levels of typical weekly play would have to in order to achieve the same percent distribution. Furthermore, Q1 and Q2 are not ecologically valid results as the participants were asked to play with the specific LEGO set at least 1-2 times a week. The play should be influenced by the children's varying desires and perhaps the LEGO set just did not attract their interest in these weeks.

In order to more accurately study the interest and engagement in this specific LEGO set, a future study could be designed with weekly questionnaires over a longer time span with more participants.

When asked if their child thinks it is fun to play with the LEGO set, all parents in Q1 answers Yes. This remained almost the same in Q2 as only one, B, changed their answer to No which could be the reason why they were the one who had to initiate play with the set. Thereby indicating that 17 of 18 participants, 94.44%, of parents in this study perceiving their child as finding the LEGO DUPLO Trains set fun to play with across the time span of Q1 and Q2, approximately a month. To validate this result, more participants should be studied.

In order to further explore the parents' perception of their child, a question of how long they believe their child to be entertained by the LEGO set was asked. An illustration of their answers can be seen in figure 5.2.

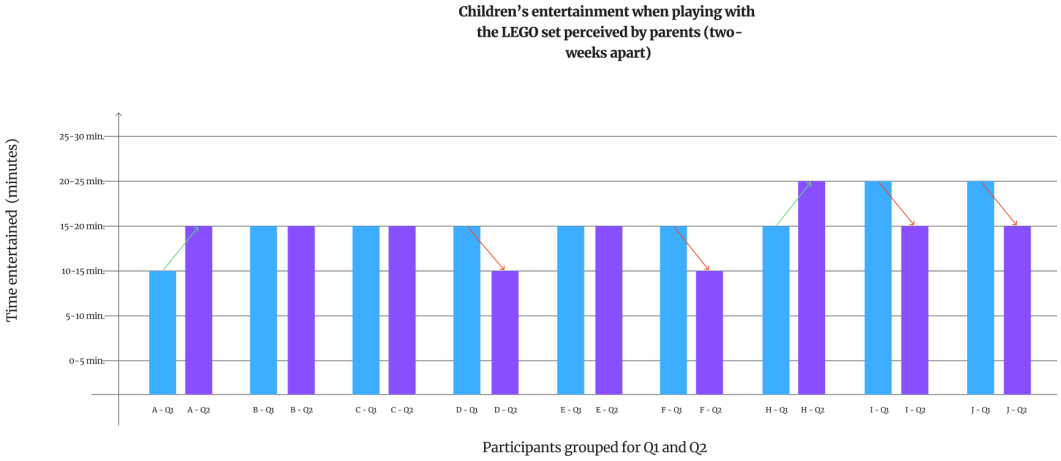

Figure 5.2: Bar graph of how long the parents think their child is entertained by the LEGO set answered in Q1 and Q2 (n=9). Two participants increased time entertained (green arrows) while four decreased it (red arrows).

Figure 5.2 indicates that parents perceived their child to be less entertained by the LEGO set when answering based on Q2, week 2-4, compared to Q1, week 0-2. Participant A and H reported that their child seemed more entertained while participants D, F, I and J reported their children appearing less entertained by the LEGO set. Changes in either direction was of one interval. Half of these participants - one increased, and two decreased - spent more time playing with the LEGO set before answering Q2 referencing figure 5.1 which may indicate a forced increase in play to accommodate the study. The three remaining had consistent answers across Q1 and Q2.

Although a decrease in this question entertainment would have been expected from participant B based on questions; who initiated playing, and do your child thinks it is fun to play with the LEGO set.

Supplementing the previously asked questions, it was of interest to quantify some overall themes of how the LEGO set was used. These were; use of train, approach to building, use of action bricks, and involvement of other toys.

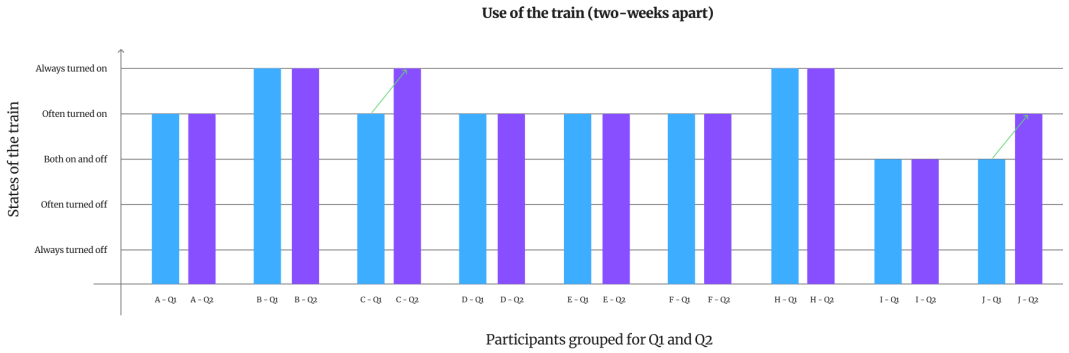

Figure 5.3: Bar graph of whether they used the train while it was turned on or off, in Q1 and Q2 (n=9). Two participants increased time entertained (green arrows) while four decreased it (red arrows)

According to figure 5.3 all participants had the train turned on more often than not with the most frequent choice being Often turned on. It shows great consistency of use across the two questionnaires and indicates a preference regarding the use. Two participants, C and J, do not differ from the overall indication but did increase how often they played with the train from Q1 to Q2.

When asked what approach they had to building the set, most answered that they did not built the set from scratch each time they wanted to play with it but that the kept some or most parts intact from play session to play session. This may have influenced the question of whether or not they used the action bricks when playing with the LEGO set as it discovered that all participants answered Yes to this in both questionnaires. If the inspiration from the manual and box is taken into account and paired with the participants not building the set from scratch at each play session, it could be suspected that the action bricks are always in use because they are honorary parts of the buildings.

When children are playing, imagination and creativity may run wild. Due to this, they may have wanted to include other toys in their play session which is why they were asked if they involved other toys in their play session with the LEGO set. Five answered that their child decided to involve other toys while one answered that both themselves and their child decided to do it. The last three, D, H and J answered that none of them decided to involve other toys but this did not seem to influence the children's entertainment referencing figure 5.2.

As it was of interest to quantify some overall themes of how the LEGO set was used, it was likewise of interest to quantify how the app was used. This included frequency of app use, who wanted to use it, and the pages and functions used.

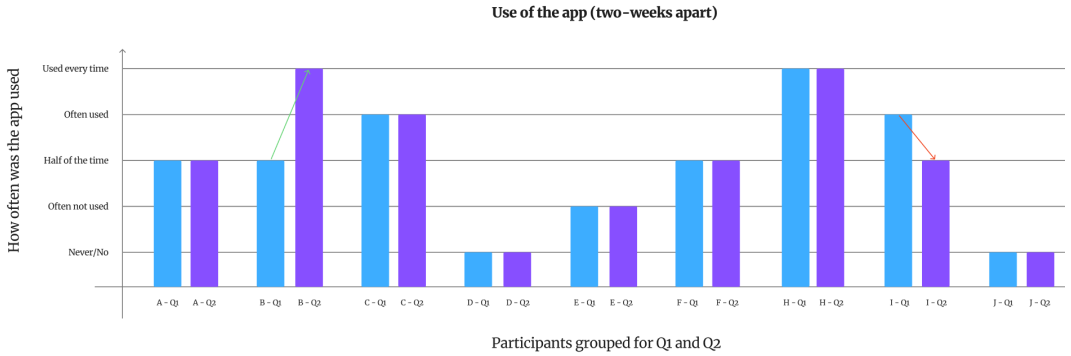

Figure 5.4: Bar graph of how frequently the app was used, in Q1 and Q2 (n=9). One participant increased their use (green arrow) while another decreased it (red arrow).

Viewed across Q1 and Q2, the participants used the app rather consistently with a slight increase due to participant B increasing their use by two intervals, and I decreasing by one. It could be interesting to explore how the increased use of the app influence B's other answers that linger towards a positive experience before answering Q1 compared to answering Q2. They might have used the app increasingly more to motivate the child's engagement in the LEGO set or of other specific reasons unknown.

Out of the seven participants who used the app, the child initiated using the app in four cases while the parent only initiated use in one case. The two others said that both themselves and their child wanted to use the app. Upon asking them if they let their child use the app by themselves, six participants out of the seven answered that they did while the one parent who initiated playing with the app would not let their child play with it by themselves.

The action of letting the child play with the app by themselves argues against H1: Parents are reluctant to include digital components in play sessions with their children.

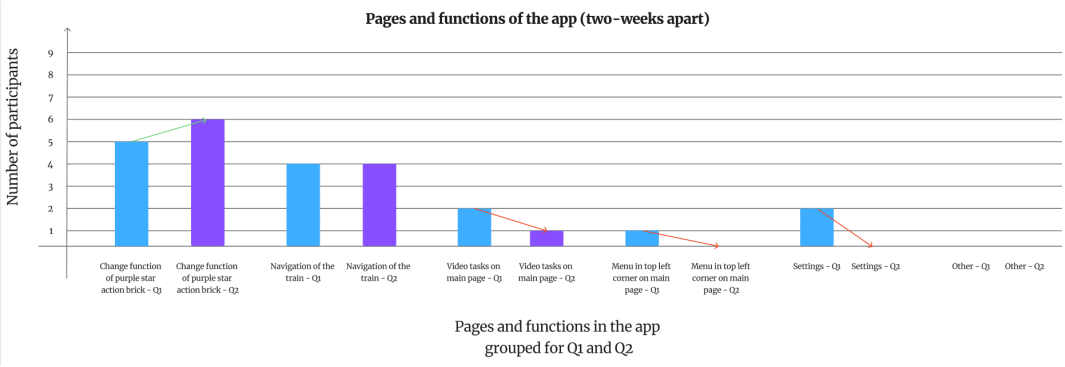

Figure 5.5: Frequency bar graph of which pages and functions in the app was used, in Q1 and Q2 (n=9). One function was used more (green arrow) while three other functions or pages were used less (red arrows). It was a multiple choice question which is why the number of participants who used the pages or functions do not match the total number of participants in this data analysis.

Figure 5.5 illustrates what pages and functions were used by the participants with the purpose of exploring what the most used ones might be. The function of changing the functionality of the star brick was used the most in both Q1 and Q2. This may be biased by the fact that this function was introduced during the at-home visit making it familiar to the participants. One participant, E, added in Q2 that they could not get the Navigation of the train function to work otherwise they would have used in. This would give the two functions the same amount of uses in Q1 and Q2 respectively.

Lastly it was chosen to explore two aspects of the parents; their search for knowledge on new toys, and their daily use of mobile phones. The search for knowledge is based around a doubt that everyone would discover that there is an app if they did not search for it, though the participants were instructed in where they could look in order to find hints about how to solve the task of changing the function of the purple star brick. This means that the data regarding information about the app most likely will biases towards the answers given by the facilitators i.e., look in the manual, look at the box, etc. The question regarding their mobile phone habits stems from the research about phone use in adults and children and serves the purpose of looking at what scenarios they would use their phone on a daily basis.

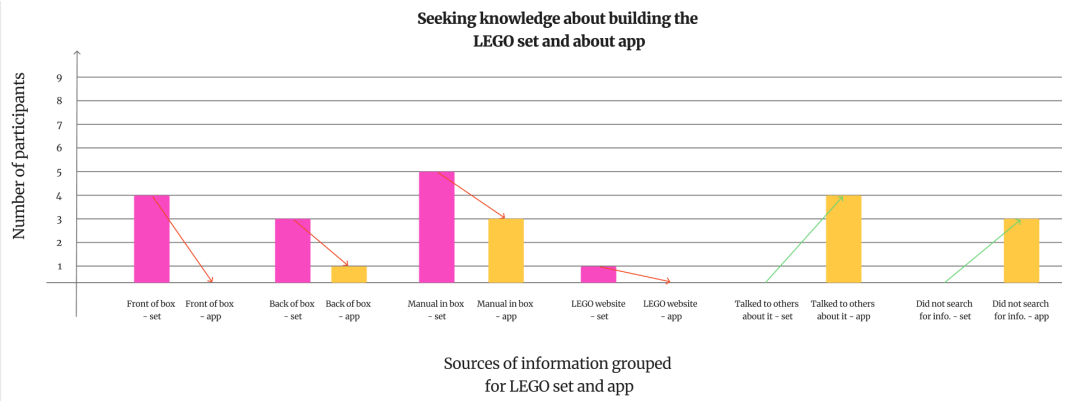

Figure 5.6: Frequency bar graph of where the parents would search for information about the LEGO set and app, in Q2 (n=9). Information about the LEGO set was searched more than information regarding the app. It was a multiple choice question which is why the number of participants who used the pages or functions do not match the total number of participants in this data analysis.

Figure 5.6 clearly displays that the sources of information varies according to whether the parents are looking at the set or app. The most used source for the set is the manual which correlates with what was seen during observations. The most used source for the app was to talk to others. This is interesting due to H's answer as they wrote that the facilitator gave a hint. It is unknown if this is what is meant by the other participants who have also chosen this source but it should be considered a potential source of error. In future studies, it could be asked about more specifically.

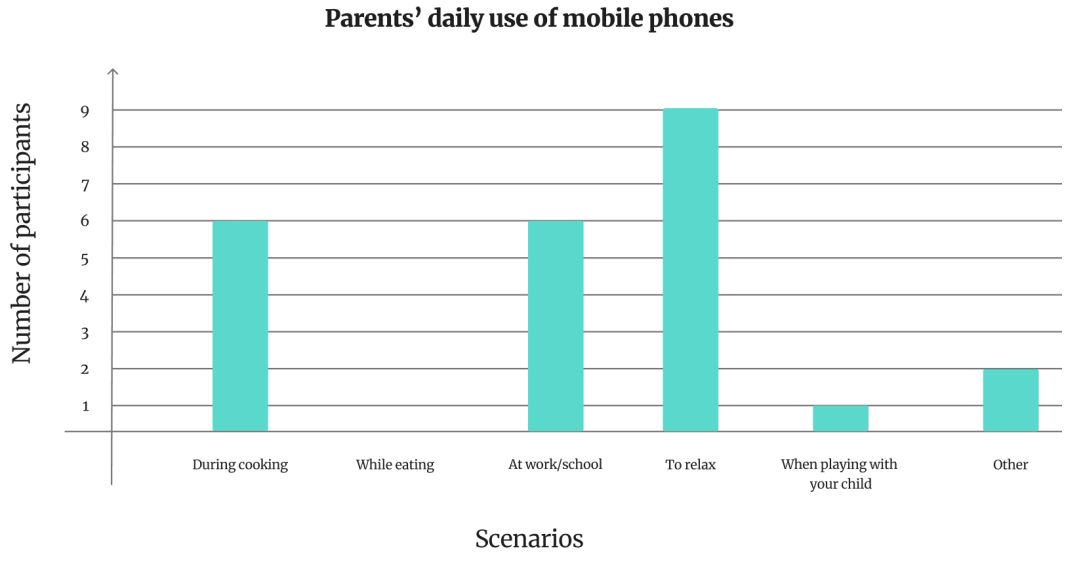

Figure 5.7: Frequency bar graph of when the parents normally would use their mobile phones, in Q2 (n=9). All participants answered that they use it for relaxation. It was a multiple choice question which is why the number of participants who used the pages or functions do not match the total number of participants in this data analysis.

In addition to the data shown in figure 5.7, two participants added that they use their phone while commuting, and as a grocery list and as a calender which supports the research findings about adults' phone habits. Furthermore, one participant, I, said; Rarely when the children are awake unless it is to use the train app. All participants said that they use their phones to relax.

5.2.1 Summary of Quantitative Data Analysis of Questionnaire 1 and 2

The participants answered quite consistently across the two questionnaires with minor variety across the questions. Furthermore, many of their responds were closely related. This may indicate that they had similar experiences with the LEGO set. Although it could also be because of the approach to data collection and biases in the questions asked.

In order to link the quantitative data to this study's hypotheses, it should be viewed alongside the qualitative data which was gathered simultaneously.

5.3 Qualitative Data of Retrospective Interview, Q1 and Q2

The raw data used in this section can be found in attachment 9.
As described in section 4.3.2, the parent and child were interviewed with predetermined questions in the retrospective interview, as well as questionnaires for the parents afterwards. This provided qualitative data to analyze and thereby offering a deeper insight into the play session. To do this, the thematic analysis method was used for the parents data.

5.3.1 Thematic Analysis

A Thematic Analysis (TA) is according to Braun and Clarke, 2008 about finding themes and patterns in qualitative data. In addition a TA is not theoretically bounded like other methods that seek to describe themes and patterns, meaning that TA can be combined with different approaches to identifying themes and patterns. The themes and patterns can be found by either an inductive way (the themes and patterns are discovered by analyzing the data) or deductive way (having predetermined themes and trying to sort the data into it) (Braun & Clarke, 2008).

This analysis was guided by the step-by-step guide from Braun and Clarke, 2008 on how to conduct a TA with a inductive way:

1. Getting familiar with the data (Reading and re-reading the data and writing down initial summaries)
2. Generating codes (The interesting parts of the data will be coded, meaning a short sentence which describes the identified part which is relevant to the research)
3. Finding themes (Finding overall themes for the different codes)
4. Reviewing themes (Going through the themes found for the codes and see if they fit together by checking whether there is any overlap between them and can be combined into one theme)
5. Describing and naming the themes (Clear description of what the theme means and represents)
6. Producing a report (Finishing the analysis by selecting vivid, compelling examples of quotes, making a final analysis of selected quotes and relating the analysis to the research question and the literature)

The data amount was too vast to analyze in full due to limited resources, resulting in a semi-structured approach to the data. This was visible in step 3-5 where they were combined and done continuously while going through the codes. In addition, the quotations from which the codes were created have not been divided into partial quotations; rather, the entire quotation has been included in at times multiple themes. If multiple codes have been created from a quotation, they are displayed as a list of numbers under the code and theme column in attachment 9 and the same applies to the themes.

The thematic analysis was conducted with one evaluator, and based on the interviews with the parents and the qualitative responses from questionnaire 1 and 2. A total of 22 different themes were identified across all the data and descriptions of each theme have been made. The themes contains codes with both negative and positive emotions unless other is stated in the explanation. See table 5.7 for an overview of the themes and the frequency of them in the data.

For a more detailed view on the data, the data can be found in Attachment 9, where the thematic analysis was conducted in Google Sheets. Some of the quotes have not been assigned a code or theme, as they are not considered relevant because the answers lost meaning when taken out of their original or intended context.

Theme	**Interview**	**Q1**	**Q2**	**Total**
Engagement and Enjoyment	12	**37**	**31**	**80**
Functionality and Design	12	17	25	54
Challenges Due to Age	3	5	1	9
Collaboration and Skill Development	1	5	10	16
Accessibility and Ease of Use	9	5	16	30
Negative Attitudes Toward Technology in Play	4	0	2	6
Creative Exploration	3	8	12	23
Understandable Instructions	1	1	0	2
Technological Challenges	2	2	1	5
Age Appropriated Design	2	8	5	15
Variation in Play	3	11	7	21
Technological Influence in Play	3	11	9	23
App Usability and Experience	4	2	3	9
Interaction between App and Physical Components	1	0	0	1
Customizing the Purple Action Brick in the App	1	6	3	10
Interplay between the Physical and Digital in a Play Session	7	1	0	8
Digital Focus	1	21	21	43
Clarity and Availability of Information	1	0	12	13
Physical Play Session	**13**	8	3	24
Guidance and Support	1	1	11	13
Parent-Child Interaction	8	0	3	11
Product Interest and Purchasing	0	0	16	16

Table 5.7: This table shows the 22 themes identified through thematic analysis. The bold values indicate the highest value of the different datasets.

In the following sections, the themes will be reviewed with explanations, related codes and quotes, and how they relate to the problem statement and hypotheses. The quotes are examples of many and tries to reflect the most important parts of the themes. Not all themes in table 5.7, will be shown here, because they do not relate to the problem statement or hypotheses, but still give some valuable insight, see appendix A.

5.3.2 Theme 1: Engagement and Enjoyment

This theme captures the involvement and emotional responses that occur during the interaction with the set/app.

Codes:

This theme was, for example, coded under: *Attention and curiosity about the set (Interview, F)*, *Loving the purple action bricks function (Q1, A)*, *The child leads the play session (Q2, I)*

Quotes:

> "Jeg synes jo, at det fungerer fint med DUPLO, at (f) bliver optaget af noget selv først. Det synes jeg, er en god start på en leg, at (f) selv bliver undersøgende og nysgerrig på, hvad der er at lege med. Og der er nu mange forskellige ting, så det er sjovt at se, hvad (f) bliver optaget af først [...]." (Interview, F)

> "Mit barn elsker den lilla, han og hans ven elsker at optage sammen og så se togene køre forbi og synge deres sange" (Q1, A)

> "Han går levende ind i det og styrer alt til mindste detalje. Han snakker med figurerne og fortæller historier" (Q2, I)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement by giving an insight into the emotional aspects, as well as the involvement during the play session with the set/app. The first quote shows that the set is interesting for the child and highlights that there are many different components in the set. The second quote shows that the child is loving the purple action brick's reprogram function through the

app. The third quote shows that the child is engaged in the play session, as well as leading the play session. This indicates positive signs of using the set/app during a play session.

5.3.3 Theme 2: Functionality and Design

This theme covers the features and design elements of the set/app that impact the play experience.

Codes:

This theme was, for example, coded under: *Functional design (Interview, B)*, *Design constraints affecting play flow (Q1, F)*, *The train is great because of the navigation option (Q2, A)*

Quotes:

> "Det var den der klods, der stopper den ovre ved den læsse-ting, men altså den høje som (b) også godt kunne lide, for så kørte den hen og så kunne man læsse brikker i, og så kørte den lidt længere frem. Det synes jeg, var ret snedigt fundet på." (Interview, B)

> "Jeg synes faktisk de påvirkninger lege oplevelsen begrænset. Tror måske de ville havde mere interesse på en større tog bane. Men når hun ligger den alle ned på den lille bane kører den konstant ind i en ny, går i stå ved nogle af dem eller kører over flere af dem. Tror måske de ville være sjovere hvis der faktisk ikke var hver gang toget kørte over dem at de aktiverede" (Q1, F)

> "Toget, fordi man kan styre det" (Q2, I)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement by giving an insight into if the functionality and design influence the play experience. The first quote shows that the action bricks function are a nice addition, whereas the second quote is more negative about them because of the interaction with the train on such few train tracks. The third quote shows that the navigation function in the app is great. This shows that the components can influence both negative and positive during the play session.

5.3.4 Theme 3: Challenges Due to Age

This theme covers age-related issues, such as the understanding of the set/app during the play session.

Codes:

This theme was, for example, coded under: *Difficulty understanding how to build due to young age (Interview, D)*, *Not age appropriated (Q1, B)*, *Not relevant for a 3 year old (Q2, H)*

Quotes:

> "Jeg synes, det var rigtigt fint. Altså som sagt, (d) er ung, og der er meget, (d) ikke selv kan forstå - det fanger han slet ikke -, men (d) synes, det er sjovt at lege med, og det er måske også et skifte, der sker, for når man bliver ældre, kan man godt lide at bygge det, og når man er yngre, kan man godt lide at lege med det. Og det er jo det for ældre børn kan langt mere, også motorisk." (Interview, D)

> "b er 5 og er lidt for gammel. Han har fundet [det] let når vi har hjulpet ham igang, men han er snart klar til det næste." (Q1, B)

> "[...] Jeg er ikke sikker på, det er relevant for en 3 årig. Måske 4." (Q2, H)

Relation to the problem statement and hypotheses:

This theme relates the hypothesis H2 by giving an insight into if the set/app is giving some challenges to the children or not. Quote 1 and 3 shows that there are some challenges due to their young age (3 years old), when using the set/app. Whereas for quote 2 there is an issue in that the child is too old to use this (5 years old), as there are not enough challenges. This shows that the age of the child influences their role during the play session.

5.3.5 Theme 6: Negative Attitudes Toward Technology in Play

This theme covers negative attitudes toward the use and influence of technology in a play session.

Codes:

This theme was, for example, coded under: *Skeptical about technology in a play session (Interview, J)*, *This theme has not been covered here (Q1, X)*, *Negative attitude about the app (Q2, F)*

Quotes:

> "[...] Jeg er ikke så meget til apps, indblanding i leg. Det synes jeg forstyrrer. For mig er det lidt en unødvendig ting at bringe ind i legen [...]." (Interview, J)
>
> This theme has not been covered here (Q1, X)
>
> "[...] Jeg ser dog ikke appen isoleret som en nævneværdig positiv bidrager og tænker at meget kunne havde haft været fysisk knapper på toget og andre steder i sættet." (Q2, F)

Relation to the problem statement and hypotheses:

This theme relates to the hypothesis H1 by giving an insight into how digital components should not be included. Quote 1 highlights the fact that using an app during a play session is disruptive to the play session and should not be used, whereas quote 2 states that some of the functions from the app, could have been physical buttons on the train instead of. This shows that some of the parents are skeptical about including digital components in a play session.

5.3.6 Theme 7: Creative Exploration

This theme is about being creative in all possible ways or factors that limit creativity during the play session.

Codes:

This theme was, for example, coded under: *Creative mindset (Interview, J)*, *Reduced creativity with phone use during the play session (Q1, F)*, *Positive attitude toward creative play beyond LEGO*

bricks (Q2, A)

Quotes:

> "[...] Jeg kan godt forstå, at det for nogen, der ikke har så meget kreativitet selv, så kan det være en nem måde at komme til at lege med sine børn. Men jeg synes selv, jeg er rimeligt kreativ omkring leg, så jeg har ikke behov for den ekstra del, som det giver at tage en app med eller finde inspiration til, at de skal sove, og så skal man bygge sættet om til noget andet. Det kan jeg godt gøre uden så for mig, er det lidt en unødvendig del, og så hele den ting med, at man skal have sin telefon frem [...]." (Interview, J)
>
> Jeg synes den mindsker den kreative del af legen, da det bliver en mere "mekanisk" leg, der bare handler om at køre toget og trykke på "knapper" (Q1, F)
>
> "Meget kreativ. Jeg kan godt lide at føle berøringen med andet end Lego." (Q2, A)

Relation to the problem statement and hypotheses:
This theme relates to the problem statement and the hypothesis H1 and H3 by giving an insight into how the set/app affects the creativity. The first quote shows a negative response to including the app, because there is no need to get some creativity or inspiration through the app, since the parent can be creative themselves. The second quote also states that it will reduce the creative part of the play session, whereas the third quote is more positive about LEGO including other components than the usual LEGO bricks. These quotes may indicate that including the app could reduce creativity during a play session and therefore is not the first choice of using it.

5.3.7 Theme 9: Technological Challenges

This theme covers the low-level tech-skills one can have and general technical issues.

Codes:
This theme was, for example, coded under: *Limited tech skills (Interview, C)*, *Discomfort with updating toys (Q1, H)*, *Problems with connecting to the app (Q2, E)*

Quotes:

> "Ja, man kan sige det meste - altså jeg er ikke verdens største IT-geni, så det er måske ikke lige mig, men jeg synes, at det er rimeligt fedt." (Interview, C)
>
> "Skræmmende at selv legetøj skal opdateres." (Q1, H)
>
> "Jeg kunne ikke få det til at virke." (Q2, E)

Relation to the problem statement and hypotheses:
This theme relates to the problem statement and H1 and H3 by giving an insight into how technological challenges can have an impact on, whether they include an app or not in a play session. Quote one mentions the limited tech skills and therefore it can be a little hard to learn and include, but it is still a good idea. Quote two is more reluctant and scared about the fact that the toy has to get an update, which can be a technological challenge in using the app. The third quote mentions that there are some issues with getting the app to work, which indicates that they want to try to include an app into the play session. This shows that there are different challenges that can impact if the app is used or not in a play session.

5.3.8 Theme 10: Age Appropriated Design

This theme is about the set/app being rated as age appropriate.

Codes:
This theme was, for example, coded under: *Age appropiated (Interview, E)*, *Almost age appropriated (Q1, J)*, *App is for children (Q2, H)*

Quotes:

> "Det er simple ting som han godt kan samle og aldersmæssigt kan han godt være med [...]." (Interview, E)
>
> "Actions brikkerne og appen er for meget for en på 3 men ellers fint." (Q1, J)
>
> "Børn, den er ret intuitiv" (Q2, H)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypothesis H2 by giving an insight into if the design of the set/app is appropriated for the age of the child. Here quote one shows that the set design is age appropriated for the age (3 years old), whereas quote two is more negative against the action bricks and app for a 3 year old. The third quote is more positive and states that the app is for the children. This shows that there are differing opinions on whether the app is appropriate in a play session, and that its influence depends on the child's age and how it affects the play session.

5.3.9 Theme 11: Variation in Play

This theme is about the many play experiences that you can have with the set/app, such as combining things differently or using it for something completely different.

Codes:

This theme was, for example, coded under: *Multiple play options to make it interesting (Interview, F)*, *The action bricks offer an even greater extended play session (Q1, D)*, *The app provides a more fun extension to the play experience (Q2, I)*

Quotes:

> "[...] Så er det jo rart, at når det begynder at blive lidt kedeligt, så kan man gøre det lidt spændende igen ved at finde ud af, hvad guiden siger." (Interview, F)

> "Fantastiske! De indbyder til meget mere leg med toget end blot at det kan køre rundt" (Q1, D)

> "Han syntes det er meget sjovere med app, da man kan meget mere. Men han leger også med det uden app." (Q2, I)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and H3 by giving an insight into the many different play experiences one can have with the set/app. Quote one mention the manual, which provides more play, when it gets boring. The second quote mentioned the action bricks being a great addition

to even more play. The third quote mentioned the app, since there are more options to extend the play experience with it. This shows that including more components will extend the play experience even more.

5.3.10 Theme 12: Technological Influence in Play

This theme is about how technology, like an app, can influence the way the play session unfolds or is perceived.

Codes:

This theme was, for example, coded under: *Different play experience when the phone is out (A)*, *No need to include the app (Q1, B)*, *Child is frustrated when the train is removed for connecting with the app (Q2, E)*

Quotes:

> "Det er bl.a. det med phone - for jeg synes, når vi leger, så bruger vi ikke phone så meget. Jeg føler, hvis jeg tager phonen op og (a) kigger på skærm, så vil det være en anderledes oplevelse." (Interview, A)

> "Nej, slet ikke. Den bedste leg var faktisk uden brug af app. Det er en sjov gimmick, men ikke super vigtig for legen. De for-programmerede action bricks giver rigtig meget i sig selv." (Q1, B)

> "Lidt frustration over at toget blev taget ud af legen for at blive connected [...]" (Q2, E)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and H1 and H3 by giving a insight into how the play experience is influenced by an app. The parent from quote one is not using a phone during a play session, because the phone will take all the attention of the child, which will give them a completely different play experience and thereby the play session is influenced by it. Quote two is okay with using a phone in a play session, but states that the best play sessions are without the phone. The action bricks are already giving a lot of to the play experience. The third quote says that the child got

upset, when the parent tried to connect the train, which indicates that the play experience is disrupted and the child had no need for the train to get connected. This shows that an app is influencing the play session, both negative and positive.

5.3.11 Theme 14: Interaction between App and Physical Components

This theme covers how the app and the physical LEGO components interact or influence each other during the play session.

Codes:

This theme was, for example, coded under: *The functionality between the app and the action bricks is confusing (Interview, E)*, *This theme has not been covered here (Q1, X)*, *This theme has not been covered here (Q2, X)*

Quotes:

> "Manualen viser jo her, hvor action bricksne skal ligge henne, men [...] når vi ikke har appen tilkoblet, kan vi ikke gennemskue, hvornår den bruger dem, for den kører rundt nogle gange, og så bruger den f.eks. vaskehallen, og jeg ved ikke, om det skyldes appen eller det skyldes tilfældigheder." (Interview, E)
>
> This theme has not been covered here (Q1, X)
>
> This theme has not been covered here (Q2, X)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypothesis H3 by gaining an insight into how the app influences the digital components during a play session. The quote indicates that there is a minor confusion about how the action bricks work and if this is random or if the app is doing something. This shows that a confusion like that can influence the play session.

5.3.12 Theme 15: Customizing the Purple Action Brick in the App

This theme is about the use of the purple action brick's function in the app, including reactions or emotions from the parent or child.

Codes:

This theme was, for example, coded under: *Minor confusion about the reprogram function in the app (Interview, B)*, *Using the app to change the sound of the purple action brick (Q1, C)*, *Having fun with changing the purple action brick (Q2, I)*

Quotes:

> "[...] Inde i den her (goes to pick up the manual) - det er den her customize ting - ja okay, når jeg læser den igen nu her, så kan jeg godt se, at den siger noget om, at det er lyden, men jeg tror, at jeg åbnede den her og tænkte; okay, det er noget med, at når vi har de andre brikker, så jeg kan sikkert også fortælle den, at den skal starte, og den skal stoppe, og sige en lyd og sådan noget. Så jeg kunne ikke helt finde ud af det lige da jeg så det her først, altså hvad er det sker - men så når man trykker på dem, så opdager man; nå okay, det er kun lydene. Men det er fordi, jeg bare lige skimmede det lige måske hurtigt nok - jeg læste ikke rigtigt, hvad der stod [...]." (Interview, B)

> "Fx den lilla funktion hvor vi har brugt den til fx at bruge den som højtaler til at fortælle passagerne hvad næste stop er eller at toget holder pause eller at hvis toget er "i stykker" og vi har brug for en mekaniker" (Q1, C)

> "Han syntes det er sjovt at kunne ændre brikken til de forskellige ting [...]." (Q2, I)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement by giving an insight into the use of the purple action brick's function in the app. The first quote gives an insight into how the reprogram function of the purple action brick in the app is minor confusing for the parent and is not exactly clear on what will happen, when clicking on the different functions. The second quote shows that they use the function to extend their play experience and being creative. The third one also shows that the function is

fun to use. This shows that the purple action brick's function is used and also influence the play experience in a positive way, when they know how to use it.

5.3.13 Theme 16: Interplay between the Physical and Digital in a Play Session

This theme is about how the physical and digital interplay during a play session influence each other.

Codes:

This theme was, for example, coded under: *Interplay between the physical and digital world (Interview, F)*, *The conflict between simplicity and imagination versus the electrical part that appeals more to kids today (G)*, *This theme has not been covered here (Q2, X)*

Quotes:

> "[...] Jeg synes jo særligt, at det med at det går fra skærm og direkte ned - det med at det bliver mere håndgribeligt for barnet, at man gør noget på skærmen, og (f) så fysisk oplever det. Det giver en god sammenhæng, forståelsesmæssigt." (Interview, F)

> "Den er svær - på den ene side kunne jeg godt lide at Lego var mere simpelt og det fokuserede på børnenes egen fantasi (et frirum fra skærm). På den anden side er tiden anderledes end da jeg selv var barn og de "elektriske" dele taler til børn i dag" (Q1, G)

> This theme has not been covered here (Q2, X)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypothesis H3 by giving an insight into how the digital and physical part influence each other. The first quote indicates that it is a positive experience by including something digital, since it gets more tangible for the child, as well as a better understanding. The second quote shows a conflict between figuring out, if the digital part is a good thing for the youth now, because times have changed. This shows that the digital can have a positive influence on the play experience.

5.3.14 Theme 17: Digital Focus

This theme is about how the screen catches/not catches the child's/parent's attention.

Codes:

This theme was, for example, coded under: *The child's attention is on the phone (Interview, G)*, *Phone usage affects the child's focus and imagination during the play session (Q1, C)*, *Phone usage affects the parent's focus (Q2, H)*

Quotes:

> "Det er jo ikke en hemmelig, at der er børn, der er totalt draget af, alt der har med en skærm at gøre, så på den måde var der en interesse - (g) kom tilbage og blev mere interesseret igen, fordi vi kunne bruge telefonen til det." (Interview, G)

> "Set fra forældre billerne: Legen blev mere fokuseret på det appen kunne og blev ikke så meget fantasi men hun synes det var super sjovt at lege med appen." (Q1, C)

> "Ja, jeg vil gerne ændre fx musik, mens barnet insisterer på egen optagelse." (Q2, H)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypothesis H3 by giving an insight into the attention of the parents and children with and without a screen. The first quote shows that the child is more interested in playing with the set, when the app is included. The second quote indicates that the focus from the child was on the app during the play session and also affected the child's imagination, but that it was fun to play. The third quote shows that the parent also changes the focus to the phone and wanted to changed the music, but the child was also focused on it and wanted to reprogram the purple action brick instead of. This shows that the app/phone is taking the focus of both the children and parents during a play session.

5.3.15 Theme 19: Physical Play Session

This theme covers the preference of having a physical play session rather than a digital.

Codes:

This theme was, for example, coded under: *Physical components are preferred (Interview, A)*, *Physical play is preferred over using the app for younger children (Q1, J)*, *Physical play elements are best (Q2, E)*

Quotes:

> "Jeg vil hellere have, at de bare leger, og vi selv sidder og kører toget. Hvis der er nogle knapper på toget, der kan record og synge - det ville være rart." (Interview, A)

> "App- delen. Det siger mig intet at skulle bringe den i spil i leg med mine børn. Især når de er så små. Det var noget andet hvis det var børn med egne telefoner." (Q1, J)

> "Det har aldrig været en favorit, legetøjet er bedst." (Q2, E)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypothesis H3 by giving an insight into what preferences the parents have, when it comes to a digital or physical play session. Every quote states that the physical play session is preferred over a digital, because it is better. This indicates that the digital can have a negative influence on the play session and therefore a physical play session is preferred.

5.3.16 Theme 20: Guidance and Support

This theme is about helping/supporting the child to understand or use the set/app, as well as motivating the child to engage in the play session.

Codes:

This theme was, for example, coded under: *Parental supervision when the child is using the app*

(Interview, F), *Need for parental support while using the app for the play session (Q1, A)*, *Some adult guidance of certain elements is needed (Q2, E)*

Quotes:

> "Det tænker jeg også er fint. Der er umiddelbart forskel på, om (f) leger med det selv, eller om jeg kan være involveret i at lege med appen. For det er ikke noget i deres alder, (f) skal sidde med selv - det er, når jeg er med, at vi kan bruge appen, men det er også godt, at (f) kan bruge det uden appen" (Interview, F)

> "Det er så fint men det eneste problem er, at børn ikke kan bruge appen, når de leger selv, og de har brug for voksne til at ledsage dem." (Q1, A)

> "Hvis der skal bygges en sammenhængende togbane skal der lidt styring på fra ældre personer i familien" (Q2, E)

Relation to the problem statement and hypotheses:

This theme relates to the problem statement and hypotheses H1 and H2 by giving an insight into if the children need guidance or parental supervision when using the set/app. The first and second quote states that the child should not use the app on their own and needs parental supervision. The third quote shows that the child needs guidance when building during the play session. This shows that there has to be some guidance or parental supervision, when using the app or building, as well as that it can indicate that the parents know that the app will take the child's attention during the play session.

5.4 Interview - Children

The children were asked four easy questions and the answers will be analyzed by going through the answers and making a summary based on the answers. This is done because of the short answers from the children.

The first question was: *Did you enjoy playing with the train set? If not: Why was it not fun?*
The conclusion to this question for all children was: Yes, every child taught this train set was fun to play with.

The second question was: *What is your favorite thing about the train set?*
The conclusion to this question for all children was: The answers vary slightly here. Some of the answers refer to the train and its functions, such as the app, the fact that it can play music, or falling asleep using the action bricks. Others refer to the washing facility or loading building.

The third question was: *Is there something you did not like about the train set?*
The conclusion to this question for all children was: Most of the children are saying no. One mentions the loading-building, where the bricks get everywhere, when falling down and another one mentions the suitcases.

The fourth question was: *Would you like to play with this train set with your friends or classmates from kindergarten?*
The conclusion to this question for all children was: Most of the children are saying yes to this.

Based on these answers, it appears that the children are excited to play with this set and using their favorite element from the set even more.

Chapter 6 - Summary of Results

The thematic analysis resulted in 22 themes, 15 of which were presented in the previous while the rest can be found in appendix A. These were used alongside the quantitative data to further explore their relations to the problem statement and hypotheses. For an overview, see table 6.1. Note that several themes may relate to more than one of these.

Taking the themes which are categorized according to the problem statement, into consideration, it can be seen multiple times across the themes that digital components (the app), influence the play session with physical components in both negative and positive ways. A negative influence is, for example, that the app may reduce creativity, shift the focus of both the child and the parent, and, in general, not be appropriate for a child to use while many parents did not think it was designed for them (see section 3.3.2). A positive influence is, for instance, the ability to change the functions of the purple action brick in the app which provided a more fun and extended play experience during the play session.

Looking at the H1 hypothesis;

H1: Parents are reluctant to include digital components in play sessions with their children.

it can be seen that there is a certain skepticism about including a digital component in a play session. This is, for example, due to the fact that it was seen as "scary" that the toy needs to be updated, and that some parents do not want their child to use an app on their own (again due to misunderstanding). There is a noticeable difference between the parents' statements and actions because 6/7 participants who used the app, let their child use the app by themselves.

Regarding the H2 hypothesis;

H2: The age of the child will influence their role in a play session.

there are different opinions about how the child's age influences their role in a play session. Some say that 3-year-olds face challenges when using the set and need guidance, both when using the app and the physical components. On the other hand, 5-year-olds do not find it as challenging and need less support. Their different roles may be influenced by the different age-based stages of development in children's cognition and motor skill as suggested by research.

The quantitative data for children' perceived entertainment offer further insights into the differences between 3 year old and 5 year old children, along with differences between male and female children. It showed a tendency of 3 year olds, and male children perceived the LEGO set as less entertaining when comparing Q1 with Q2, while 5 year olds, and female children did not show any change in their perceived entertainment.

Looking at the H3 hypothesis;

H3: Including digital components will alter the focus of the play session.

it is clear that including a digital component (the app), can shift the focus of the play session in both negative and positive ways. On one hand, the app can help extend the play experience and offer more variation. One parent also reflected on whether including digital tools in play is simply a part of the times we live in, suggesting a more positive take. On the other hand, the app can also take too much focus and affect the overall engagement negatively.

As a widespread distribution of how often the participants used the app, was seen and it might indicate an attempt to control its influence on the play session. Furthermore, 57.14% who initiated to used the app, were the children, which could imply a change in what they will focus on in a play session with a LEGO set and an app.

Problem Statement	**H1**	**H2**	**H3**
Theme 1: Engagement and Enjoyment	Theme 6: Negative Attitudes Toward Technology in Play	Theme 3: Challenges Due to Age	Theme 7: Creative Exploration
Theme 2: Functionality and Design	Theme 7: Creative Exploration	Theme 10: Age Appropriated Design	Theme 9: Technological Challenges
Theme 7: Creative Exploration	Theme 9: Technological Challenges	Theme 20: Guidance and Support	Theme 11: Variation in Play
Theme 9: Technological Challenges	Theme 12: Technological Influence in Play		Theme 12: Technological Influence in Play
Theme 10: Age Appropriated Design	Theme 20: Guidance and Support		Theme 14: Interaction between App and Physical Components
Theme 11: Variation in Play			Theme 16: Interplay between the Physical and Digital in a Play Session
Theme 12: Technological Influence in Play			Theme 17: Digital Focus
Theme 14: Interaction between App and Physical Components			Theme 19: Physical Play Session
Theme 15: Customizing the Purple Action Brick in the App			
Theme 16: Interplay between the Physical and Digital in a Play Session			
Theme 17: Digital Focus			
Theme 20: Guidance and Support			

Table 6.1: This table provides an overview of how the different themes relate to the hypotheses and problem statement

Chapter 7 - Discussion of Methods and Alternative Approaches

The aim of this study could have been tested in a variety of ways. This section will discuss some alternatives to the chosen methods and approaches through additional research, and considerations. Throughout, ecological validity should be prioritized if possible.

7.0.1 Interviews - Unstructured and Structured

Instead of having a predetermined list of questions and the option of asking addition questions.

An **unstructured interview** means there are no strict limitations on following a set list of questions. In other words, it consists of open-ended questions, allowing exploration of other topics if relevant. Such an interview provides a wealth of data and a deeper understanding of the subject. However, a downside is that each interview is different, and the lack of structure can make the process time-consuming (Sharp et al., 2019, pp. 268-278). This method could make it very difficult to find general tendencies in a data sample limited to 10 participants.

A **structured interview** involves asking predetermined questions, which are typically closed questions. This set of questions is used on the same participants. This means that it is not possible to explore the participants' answers in more depth, as in an unstructured interview. This type of interview is good, when the participants do not have a lot of time and the goal of the interview is clear (Sharp et al., 2019, pp. 268-278). To create a more naturally flowing conversation and in fear of missing valuable details from follow-up questions, this type of interview was not chosen for the test, opting instead for the semi-structured interview.

7.0.2 An Increase of Participants - Focus Group Interview, Between-Subject Design, A/B Testing and Convenience Sampling

Instead of gifting one LEGO DUPLO Trains set to a parent and child for each test, alternative approaches to attract more participants could have been implemented.

A **focus group interview** involves gathering a group of people to be interviewed at the same time. Typically, 3 to 10 people participate, with a trained facilitator leading the discussion. The facilitator can encourage quieter participants to speak and manage those who dominate the conversation. The advantage of this format is that diverse or sensitive topics can be addressed which might otherwise be overlooked in an individual interview. Shared problems or experiences can be discussed rather than personal experiences (Sharp et al., 2019, pp. 268-278). This was considered as an approach to data collection but due to lacking response and interest from the contacted kindergartens, it was deemed unachievable within the study's timeframe and with the available resources.

Further elaborating on this point, by bringing two LEGO DUPLO Trains set to a location with much **parent-child traffic** e.g., a kindergarten, it would have been possible to gather more data through a focus group interview and individual questionnaires. Additionally it would have opened the opportunity to research social cognition and inter-child interaction with a technology-enhanced toy. Two LEGO sets would be brought in order to engage more participants at a time. Thereby getting both individual and collective data points. If it had been possible to conduct an observation, the focus group interview, and have all participants answer individual questionnaires, the amount of participants could be expected to increase to 15-50 based on the typical number of participants in focus group interview. This would give better backing to any claims or indications found in the study. If it was decided to bring only one set and thereby increase the number of kindergartens to 10, the number of participants could go up to 30-100. Although this would most likely increase the duration of each test as more time would be needed for everyone to interact with the set, app, action bricks, etc. Moreover it would further complicate the ability for all participants to be a part of all the different steps in the play session process.

Then, the LEGO DUPLO Trains set(s) would be gifted to the kindergarten.

The above-mentioned is based on the fact that the chosen test design is within-subject design. If the number of participants would increase as theorized, the test design could be changed to **between-subject design**. Here, different groups of participants are each exposed to a different condition which would eliminate the risk of order effects, though many participants are needed and individual differences may cause issues (Sharp et al., 2019, p. 535). Furthermore, it would be possible to perform **A/B testing** if e.g., it was of interest to explore the experience of interacting with two different editions of the LEGO DUPLO Trains app. In that case, the participants would be divided into two groups then one will get the present edition and the other will get a redesigned version (Sharp et al., 2019, p. 574). Because no redesigned version of the app is available and the number of participants was limited to 10, between-subject design and A/B testing was not explored further. To understand how different versions of an app made for the same LEGO set are perceived, experienced and interacted with, creating a test design with the aspects mentioned in this section would create value.

If the main priority was to test the app, a user test where facilitators approach people on the street or e.g., in front of a supermarket could be performed with the purpose of gathering data instantaneously. The subgroups of potential participants - adults and children - would be chosen through **convenience sampling** (Sharp et al., 2019, p. 261) and based on predetermined criteria such as; do you have a child in the age range 3-5? or are you a child in the age range 3-5?. Both subgroups should be tested based on the uncertainty of the app's target audience discovered through the heuristic evaluation described in chapter 3. By focusing on **quantitative** aspects of the app and taking screen recordings, it would allow for a high number of participants to partake over a shortened time span. By asking the participants to think-aloud while solving the tasks, the facilitator would know "what is going on in a person's head" (Sharp et al., 2019, p. 296) through additional qualitative data. The approach should be revised before testing as it most likely would led to a skewed number of participants in the two subgroups. A structured setup with tasks would have to be created in order to collect comparable data. Tasks and data points could consist of:

- Tasks; Change the language to Spanish, find one of the assembling guides for the night train, choose a new train, change the functionality of the purple star to rain
- Data points; number of clicks, time spent pr task, wrong clicks, collective heat map for all participants divided pr task

7.0.3 Questionnaire - Net Promoter Score

As an additional question asked to determine how likely the someone would be to recommend the LEGO set.

The Net Promoter Score, NPS, is a metric for the customer mindset and brand health and is based on a singular question: How likely is it that you would recommend [the LEGO set] to a friend or colleague?" (Sven et al., 2022, pp. 67-69). Answers are then given on a scale from 0 to 10 with 0-6 being detractors, 7-8 being passive, and 9-10 being promoters. The result is calculated as displayed in figure 7.1 (Sven et al., 2022, pp. 67-69).

$$\text{Net Promoter Score} = (\sum \text{Promoters} - \sum \text{Detractors}) / \text{Sample Size}$$

Figure 7.1: How to calculate the Net Promoter Score (Sven et al., 2022, p. 69)

If this question had been added, further research of interpretation and use would be recommended. In this study, the last question asked to the children in the retrospective interview at the home-visit, was whether they would like to play with the set with some of their friends. Even though that is not the same as the Net Promoter Score, it was the closest research parameter asked, similar to the Net Promoter Score. At the time of designing the study, Net Promoter Score was not taken into account as it was discovered post user tests.

7.0.4 Scales - Likert, Unipolar, VAS, SUS and UEQ

Instead of implementing a bipolar category scale in questionnaire 2 to quantify the participants' affective experiences.

A 7- or 9-point Likert scale would have measured a more precise level of agreement (Schmidt & Willis, n.d.) and by rephrasing the questions to something like; "I feel like [...] was a good experience", it could have been implemented. This would also mean changing to an unipolar scale (Li et al., 2022b, p. 5) as it would solely measure the level of agreement. It is important that the questions do not bias the participants' answers (Li et al., 2022b, p. 5).

An alternative to the Likert scale could be a line scale e.g., the Visual Analog scale. It seems more continuous and less restrictive for the participants even though their answer would be allotted to one of the predetermined possible answers chosen by the designers afterwards (Lawless & Hildegarde, 2010, p. 155). Using such a scale would have allowed for even more precise affective expressions. One issue could be that participants will choose their answer with varying degrees of care and creating too many possible answers post-test would make it difficult to generalize their experiences. Although by indenting the end-anchor lines on the line scale, it might reduce reluctance of using the ends of scales (Lawless & Hildegarde, 2010, p. 155). Both of these were not chosen because affective testing is commonly done using a category scale and simplicity for the participants was prioritized where possible.

Utilizing a System Usability scale would have allowed insights into a "subjective usability measure" (Drew et al., 2018, p. 357). Although Drew et al., 2018 found that participants who struggled solving the provided tasks had a higher rate of rationalizations i.e., reasons for rating unrelated to usability such as self-blame and minimization, yet continued to give a higher SUS rating than objectively warranted (Drew et al., 2018, pp. 361-364). Even though a usability measure of parts of the system could have been beneficial as an addition to the heuristic evaluation of chapter 3, findings from Drew et al., 2018 suggest that "SUS is a measure of user perception, and not actual usability." (Drew et al., 2018, p. 364).

Furthermore, the focus of that part of the questionnaire was to dive into emotions related to specific parts of the experience which SUS would complicate.

An alternative way of measuring the user experience related to the set could be to use the User Experience Questionnaire, UEQ - a bipolar, 7-point Likert scale (Schrepp et al., 2017, p. 103). Its 26 items can be divided into six interdependent measurements (Schrepp et al., 2017, p. 104):

- Attractiveness; notion of preference, likeability and a measure of the "user's general impression" (Schrepp et al., 2017, p. 104)
- Perspicuity; ease of use, learning and understanding the product
- Efficiency; level of added effort needed and reaction time
- Dependability; control, predictability and confidence
- Stimulation; excitement, motivational and enjoyable
- Novelty; innovative, creative and attention-grabbing

It is supposedly fast to fill out the UEQ and a version with 8 of the 26 questions, the UEQ-S, exists which predicts the behaviour of the entire UEQ (Schrepp et al., 2017, pp. 104+107). Still, none of them were considered for this study due to only having 10 participants thereby decreasing the perceived potential value that could come from quantitative data points as the UEQ. It would be interesting to see how the UEQ would relate to data points in a quantitative usability study.

7.0.5 Thematic Analysis

The conducting and results of the TA could have been improved, by having more time available. This can be seen, when taking the approach to do step 3-5 continuously, when analyzing the data. During the writing of the results of the TA, it could be seen that some themes should have been merged with other themes, for example, "Interaction between App and Physical Components" and "Interplay between the Physical and Digital in a Play Session", as they are similar to each other. This would have given less themes and a better big picture of the data. Furthermore the quotes should have been split up into the most important parts, instead of having the whole quote and parts, which are not as important.

It can be discussed if only having one evaluator to do the thematic analysis is fine, or if more evaluators are needed for at better overview and agreement upon the codes and themes. However, it would have been a good addition to include two evaluators, given the time constraints and the fact that it is an accessible method that is easy to learn, even for evaluators with little or no experience (Braun & Clarke, 2008).

Since this user test uses a within-subject design, the qualitative data analysis should have included investigation of individual differences e.g., finding codes and themes for each parent separately, instead of combining all the data and analyzing it as a group.

Chapter 8 - Conclusion

This study aimed to investigate; *How do digital components influence simultaneous play with physical components?* through at-home observations (n=10), retrospective interviews (n=10) and two follow-up questionnaires (n=10, n=9).

The results indicate cognitive dissonance regarding the app as explained by Abels et al., 2024. This seem to get triggered by the context of using mobile phones specifically when playing with their children. It was made especially clear when comparing the parents' answers, such as parent F exclaiming that they believe that the app did not positively influence the play in a noteworthy way, with the six out of seven who used the app, letting their child use the mobile phone app by themselves. Amplifying this are answers regarding the app's influence on creativity which participants experienced in vastly different ways. It ranged from A referring to the app as very creative to F describing the play session as more 'mechanical' as the app reduced creativity, and J explained the app as a potentially good addition for parents who lack creative thinking but as unnecessary for already creative parents.
This study found intrapersonal contrasts between parents' thoughts about involving a digital component, such as an app, in a play session, and their actions and behaviors. If play is assumed to be relaxing for children while developing their cognitive and motor skills, the findings may indicate an uncertainty about how the topic of digital components should be approached in the context of play with 3-5 year old children as 100% of the parents who answered Q2 mentioned using their phone to relax. The age of which it becomes acceptable to use a phone to relax, is uncertain.
Moreover, interpersonal differences were apparent in the qualitative data as the answers of many participants varied much depending on the question. This could indicates different experiences, approaches to parenting, or biased or leading questions.

The reason for the LEGO Group's choice to design an app to go along with their LEGO sets, has not been disclosed. Although it could be theorized that an app design is a way for LEGO to stay a household name in a world of quickly developing technology which could be gradually normalizing new use cases with technology-enhanced toys. This theory originates from G whose statement translated to English is;

"I liked that LEGO was more simple and that it focused on the children's own imagination (a pause from the screens) but on the other side, the world is different from when I was a child, and the 'electric' parts speak to the children of today". It perfectly sums up the parents' difficult decisions regarding the use of technology in a world changing faster than ever.

This study explored the interesting topic of digital components in simultaneous play with physical components to target the controversial topic of technology use in children of young age made relevant by its increasing normalization. Although, this study does not have enough participants to generalize it findings due to limited resources and the mainly qualitative approach to data collection. Alternative approaches and methods have been suggested with the purpose of improving data reliability and enable further studies on the topic.

Chapter 9 - Future Implication

This study was limited in different ways making further investigation of digital and physical components used in play relevant to understand the complexity of the topic, and its influence on parents and children. This chapter will reflect on ways in which parts of this study could be used in future studies.

Future studies could explore other use cases with a higher number of participants with the purpose of reaching data saturation and approaching the topic from different angles.

One way to approach existing data of this study would be to produce a User Journey Map of which would include 1) a persona, 2) the use case and user expectations, 3) different phases of the journey, 4) actions, mindsets and emotions, and 5) insights (Gibbons, 2018). This would create an overview of the process, the user goes through from start, e.g. purchase or decision to start playing, to when they finish packing the set away. If based on a substantial group of participants, the user journey map could allow insights into specific approaches of sub-groups, in the process of playing with the LEGO set.

A pain point of this study was the miscommunication present in the design of the LEGO DUPLO Trains app as described in section 3.3.2. Based on this study, supplementing data from future studies, and pre-existing research, guidelines about app design for parents of young children and a redesign of the current app could be developed. It could be theorized that a parent-minded app would be vastly different from the present iteration. The split in perceptions between LEGO's parent-minded app, and the child-minded version perceived by the participants, could imply a need for further internal specification within the LEGO Group. Though it could also imply a need to create an app with both user groups - the parents and children - in mind. This would require further investigation.

Another approach to the test design would be to conduct observational studies in kindergartens with the purpose of exploring the influence of the LEGO set on EQ and IQ skills in children. This study would most likely be based on the children being available over a longer period of time and approved ways to measure EQ and IQ. It would require further investigation before initialing testing.

Moreover, a study e.g., an online questionnaire, for validated customers i.e. confirmed buyers of the LEGO DUPLO Trains set could be designed.

The test design in this study is influenced by the fact that it was not possible to access the customer files and intel that LEGO most likely possesses due to industry secrets. If it had been possible to access this information, it would have been interesting to list the customers who have purchased the LEGO DUPLO Trains set #10428 since its launch in January 2025 and then send them a short questionnaire regarding their experience. Initial criteria such as a cut off time of purchase e.g., bought January-April and geographical placement could be set in place. It is uncertain whether or not, LEGO would be allowed to access customer information with the purpose of sending out a questionnaire keeping GDPR in mind but it is still considered for the sake of creative thinking and alternative approaches. Some questions could include:

- Sorting into sub groups: What is your relation to the child that will be using the LEGO set? What is your age, sex, etc.? What is the child's age, sex, etc.?
- Qualitative study of the experience: Would you recommend the LEGO set to others? Did you use the app - if yes, in what ways? Good and bad parts of the LEGO set.
- Quantitative study of the experience: Estimated play time.
- Potentially controversial topics: What do you think about letting the child use a mobile phone when playing with LEGO? How have yours and the child's relationship been affected by playing with the LEGO set?
- Reflections: In what way do you feel that the child's IQ and EQ have been influenced by using the LEGO set? Overall satisfaction regarding the LEGO set. Overall satisfaction regarding the app.

This would yield information from customers who most likely know the LEGO set, the app, the action bricks, etc quite well. This could be compared to some of the other user tests which include participants who do not own the LEGO set already.

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Appendix A | Thematic Analysis

This appendix displays the themes which are not directly related to the problem statement or the hypotheses, but nonetheless offer valuable insight.

A Theme 4: Collaboration and Skill Development

This theme is about collaboration and being able to learn/develop their skills.

Codes:

This theme was, for example, coded under: *Learning to collaborate (Interview, G)*, *Learning patience (Q1, C)*, *No change to their current collaboration skills (Q2, F)*

Quotes:

> "Det er godt for os at lære at samarbejde, for det kan vi godt have lidt udfordringer med. Jeg synes egentligt, det gik overraskende godt." (Interview, G)

> "Hun har svært ved at havde tålmodigheds synes det tvang hende til at have det særligt når hun skulle havde toget til at gentage det hun sagde da det jo lige skal tænke inden da kan det. Det gjorde faktisk at jeg synes hun nu når vi leger med det, har en helt naturlig tålmodighed fordi hun har lært at det har brug for den tænkte pause. Nu leger hun ofte bare videre indtil toget er klar igen." (Q1, C)

> "Vi legede i forvejen en del med Duplo og andet legetøj der handler om at bygge noget sammen. Har ikke tænkt at dette sæt har gjort noget unikt i forhold til samarbejdet, som andre Duplo sæt ikke også gør. Så har umiddelbart ikke tænkt det har ændret sig." (Q2, F)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give insights into learning and developing skills during the play session. The answers are more divided about if the set has helped some of them learned or develop skills. The first quote is saying yes to learning to collaborate together as a parent and child. The second quote is also positive about the fact that

the child has become more patient, whereas the third quote doesn't think that there is a change in learning and developing skills.

B Theme 5: Accessibility and Ease of Use

This theme is about how easy or difficult the set/app is to use and understand, as well as how accessible it is to a broader group of users, including children and parents.

Codes:

This theme was, for example, coded under: *Simple to build with LEGO DUPLO (Interview, H)*, *Frustrations with how to do it / understanding it (Q1, D)*, *Easy to use the app (Q2, A)*

Quotes:

> "Jeg synes, det er mega sjovt at bygge LEGO. Nu er det selvfølgeligt DUPLO, så det er meget simpelt og sådan noget, og det er selvfølgeligt fint nok. Og jeg fik ikke lov til at gå gennem hele brugsanvisningen, men vi byggede bare ud fra tegningen, og det gik fint." (Interview, H)

> "Man kan helt sikkert mærke at han til tider bliver frustreret fordi han gerne vil, men ikke kan eller forstår hvordan." (Q1, D)

> "Lettere, min søn kan nemt gøre det selv" (Q2, A)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give more an insight into how accessible and easy it was to use the set/app. The first quote shows that it is easy to build with LEGO DUPLO and that one can look at the visualizations to build the set. The second quote indicates that it can be difficult to understand how to build and use the set, this can also be a indication of that the age may not be right for a 3 year old. The third quote shows that the app is easy to use for both the parent and the child.

C Theme 8: Understandable Instructions

This theme is about the clear and easy instructions/visualizations within the set/app.

Codes:

This theme was, for example, coded under: *Good instructions (Interview, A)*, *Following the manuals instructions (Q1, I)*, *This theme has not been covered here (Q2, X)*

Quotes:

> "For det første er LEGO god til at lave gode instructions, så det er nemt at få børn på (a's alder) - de kan lære [...]." (Interview, FP)
>
> "De ligger på skinnerne som de skal ifølge bogen og han bruger app'en" (Q1, I)
>
> This theme has not been covered here (Q2, X)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give more an insight into that it is easy for children to look at the instructions and some of the parents followed the instructions/visualizations within the set/app during the play experience.

D Theme 13: App Usability and Experience

This theme covers the usability and the user experience of the system.

Codes:

This theme was, for example, coded under: *The app is user-friendly (Interview, D)*, *The pages/functions of the app are child-friendly (Q1, C)*, *The app is entertaining (Q2, I)*

Quotes:

> "Jeg synes, jeg fik noget ud af appen - det var meget brugervenligt. Jeg synes, den virker meget nem." (Interview, D)

"Ja det var ret gode. De var børnevenlige" (Q1, C)

Jeg syntes det er mere underholdende med appen, da man selv kan vælge ting (Q2, I)

Relation to the problem statement and hypotheses:
This theme has no relation to the problem statement nor the hypotheses, but give more an insight into that the app according to the parents is user-friendly and child-friendly, as well as that the app is entertaining.

E Theme 18: Clarity and Availability of Information

This theme covers the presence or absence of clear and helpful information on the box, in the manual, app, or website, which supports the setup and use of the set/app.

Codes:
This theme was, for example, coded under: *Making it more visible that there is an app (Interview, H)*, *This theme has not been covered here (Q1, X)*, *Sufficient information provided on the manual/app (Q2, F)*

Quotes:

"Hvad var det, der "gave it away" at der skulle bruges en app?: "Det var fordi, det stod her i (grabbing the manual). [...] Jeg synes da nok... det står ikke umiddelbart her foran (on the front of the box)." Ville du forvente, at det stod foran (at man skulle bruge en app)?: "Ja, det ville jeg faktisk." Hvis jeg siger, at der også er tekst osv på bagsiden. Men det er ikke lige noget, man ligger mærke til, eller hvad tænker du?: [...] "Altså jeg har slet ikke kigget på bagsiden." Hvordan kan det være, at du ikke lige kiggede på bagsiden?: "Jeg tror, det er fordi, at det var bagsiden. Den lå egentligt bare sådan her (with the back of the box downwards)." (Interview, H)

This theme has not been covered here (Q1, X)

Ja jeg har ikke haft manglet information, jeg har fået rigelig fra manuel og appen selv (Q2, F)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give more an insight into if the information given from the set/app are clear and visible for the parents and children. The manual is highlighted as covering a good amount of information, but the visualization of the box, for example, the indication of an app should be more visible.

F Theme 21: Parent-Child Interaction

This theme is about how the set/app enables and encourages shared play and interaction between the parent and child during the play session.

Codes:

This theme was, for example, coded under: *Easy to play together as a parent and child (Interview, H)*, *This theme has not been covered here (Q1, X)*, *Good building experience together as a parent and child (Q2, B)*

Quotes:

> "Jeg synes, det var let. Jeg synes, at (h) hurtigt at lege sig over i de forskellige ting, først var det personerne, og så var det "vi mangler den der og den der" (Interview, H)
>
> This theme has not been covered here (Q1, X)
>
> "Børnene er glade for mange slags legetøj, men hos os kan Lego noget mere til voksne også. Det giver gode bygge-oplevelser sammen. " (Q2, B)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give more an insight into the parent-child interaction during the play session when using the set/app. The first quote shows that it was easy to interact with the set together, whereas the third quote also mentions that LEGO is inclusive and giving a good parent-child building/playing experience.

G Theme 22: Product Interest and Purchasing

This theme is about behaviors and factors influencing which toy products are considered or bought, including the price, interest, occasion and emotions from the child/parent.

Codes:

This theme was, for example, coded under: *This theme has not been covered here (Interview, X)*, *This theme has not been covered here (Q1, X)*, *Buying toys after long term interest (Q2, I)*

Quotes:

> This theme has not been covered here (Interview, X)
>
> This theme has not been covered here (Q1, X)
>
> "Hvis der er noget Lego / legetøj han virkelig ønsker sig, så snakker vi om det og aftaler at vente lidt. Er interessen der stadig, så får han lov at bruge sine lommepenge på at købe det han ønsker." (Q2, I)

Relation to the problem statement and hypotheses:

This theme has no relation to the problem statement nor the hypotheses, but give more an insight into the behavior and factors of buying toys. The quote shows for example that the toy will be bought, when the interest for the toy stays over a longer period and that the child can buy it, if the interest still exists.