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Mobile Devices in the Hands of the Youngest Children

Diana Jones Thomory
Nataliia Mykhailovska

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Supervisor: Farid Naisan
Second assessor: Dimitris Paraschakis
Abstract

It has become modern to use mobile devices at an early age. The study aims to understand the way young children interacts with mobile devices during the first 4 years of life and how mobile devices can help parents gain learning benefits for the youngest children. In order to meet the purpose of the research there were several formulated questions concerning how the stage of children’s development can affect the possibility of interaction and learning with mobile devices and what advantages and disadvantages the parents discovered during their children’s usage of mobile devices. The relevant theory was presented regarding children’s physical and cognitive development from 0 to 4 years old. The mixed method approach (survey and interviews) was effective enough to understand how the children usage of mobile devices differs from year to year as they become older. There were some recommendations for the parents that were presented as well.

Keywords: mobile devices, applications, games, entertainment videos, cognitive development, children development, children interaction
**Sammanfattning**

Det har blivit modernt att använda mobila enheter i tidig ålder. Studien syftar till att förstå hur barn interagerar med mobila enheter under de första 4 levnadsåren och hur de kan hjälpa föräldrar att få inlärningsfördelar för de yngsta barnen. För att möta syftet med undersökningen fanns flera formulerade frågor om hur barnens utvecklingsnivå kan påverka möjligheten till interaktion och lärande med mobila enheter, vilka fördelar och nackdelar föräldrarna upptäckt under sina barns användning. Relevanta teorin presenterades om barns fysiska och kognitiva utveckling från 0 till 4 års ålder. Den blandade forskningsmetoden strategi (enkät och intervjuer) var tillräckligt effektiva för att förstå hur barnens användning av mobila enheter skiljer sig för varje år när de blir äldre. Det presenterades också några rekommendationer till föräldrarna.

Nyckelord: mobila enheter, applikationer, spel, underhållning videor, kognitiv utveckling, barns utveckling, barn interaktion.
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1. Introduction
1.1 Background

There has been significant interest as well as concerns with children that begin using mobile computer technology at an early age. Children’s exploration of computing devices depends on a great variety of factors, for instance: cultural traditions, economic possibilities, and family values [1]. In the past years children’s access to mobile devices has increased dramatically. We are now seeing higher adoption of technology among children - thanks to the intuitive interaction of youngsters with touch-screen technologies and compact devices, which they can carry everywhere and use at any time.

According to the Swedish Media Council report in 2015, every year more and more children use modern digital media technology [2]. Today it can be seen as a clear trend that some form of mobile technology usage begins at an early age. Usage of tablets has increased twice in 2014, as compared to 2012 - 2013. Currently in Sweden, there are 56% of children at the age of 0-1 years, 79% of children at the age of 2-4 years and 84% at the age of 5-8 years have access to a tablet computer. Today it is striking that children at the age of 0 to 12 months use the Internet as much as children at the age of 5 - 6 years did in 2010 [2].

The number of parents who are thinking positively about their children’s experience with a tablet compared to 2012 - 2013, is twice as many (65% for age 0-1 year and 74% for children 2 to 4 years) and they agree that the child learns good things through such interaction [2]. While making age-appropriate media content choice, it is important to pay attention to the content and a message. It matters what children watch and play. According to Hourcade [3], giving the greater exposure of children to these technologies, it is important that they must be designed according to children’s abilities, interests, and developmental needs.
1.2 Problem Description

Technology is fascinating to the children. They want to explore and play with it. Displays that are eye-catching and computer attractiveness naturally captures children’s interest [4]. Today technology has become important for the development of children. It is important to understand technology’s impact on children and their development. We should use these thoughts to improve the use of technology so that it supports children optimally [5].

Although many materials have been written about children’s play, the less attention has been directed to the relations between play and learning in digital environment. Technology is increasingly recognized as an integral learning tool for promoting the social, linguistic, and cognitive development of young children [6]. Computers will never replace the importance of play and learning material such as paint, blocks, sand, water and books. However, technology does provide new and exciting opportunities for childhood activities. If used appropriately, technology can enhance children’s cognitive and social abilities [5].

Unlike many other educational materials, computers are essentially fascinating for children. Sound and graphics capabilities keep their attention. Research has shown that the amount of interactions between child and media may affect the learning development [7].

According to Gelderblom [5] computer activities are highly interactive and can therefore provide learning experiences that are rich in participation, responsiveness and engagement. This is promoted by the fact that children have various control over the context of the interactions.
People opposed to the use of computers by young children have warned against some potential risks, such as:

- keeping children from other essential activities,
- reduced social skills, which might lead to social isolation,
- reducing creativity, etc.

There is a general agreement that young children should not spend long time at a computer, but computers do stimulate interaction rather than suppress it [8].

Gelderblom [5] analyzed that in the 90’s research has refuted the earlier belief that children can only use computers in an appropriate way when they have reached the phase of concrete process understanding (about the age of seven). Hence the important thing is to allow children to perform activities on the computer that are at their level of development. Clements [9] defined developmental appropriateness as follows, “developmentally appropriate means challenging but attainable for most children of a given age range, flexible enough to respond to inevitable individual variation, and, most important, consistent with children’s ways of thinking and learning”.

According to Haugland [8] the benefits of developmentally appropriate computer experience for young children are:

- It provides opportunities to obtain and develop knowledge through active participation.
- It provides a learning environment to obtain knowledge and skills in different areas of development.
- It keeps motivation to learn by supporting children with challenge, control, and imagination, and encourage their curiosity.
- It connects children to the world by providing access to people and resources throughout the world.
- It gives them access to an enormous amount of information.

Arif and Tahir [10] said that children spend abundant of hours in a day with mobile technology. There are worries from parents about that. One of them is how much of the content explored by children is educational.
1.3 Research Questions

To serve the purpose of the study there are several questions investigated during the research. However the following research questions are intended to be the main concern of this study:

- **RQ1.** How do the youngest children use mobile devices?
- **RQ2.** Are the youngest children physically and mentally capable of using mobile devices?
- **RQ3.** What are the learning benefits and the drawbacks of using mobile devices by young children from the parents’ perspective?

1.4 Scope and Limitation

The time limit does not allow us to use time-consuming research methods like observation or case-study. To identify the scope of the study, some terms are defined as follows.

The term “mobile device” refers to the smart mobile phones and tablet computers. They are more common and still increasing its popularity amongst the youngest population according to the Swedish Media Council report [2]. The term “application” refers to any software designed to run on mobile devices and/or inside a web browser. The term “educational video” refers to any series/movies, which primary purpose was to educate or inform children, such as Curious George, Dora the Explorer, Little Einstein, Sesame Street etc. The term “entertainment video” here refers to any series/movies, that holds the attention and interest of the children, or gives pleasure and delight, such as Frozen, Lone Tones, Ninja Turtles etc. Furthermore the term “children” refers to infants and toddlers with the respective age between 0 to 4 years old (0 months up to 59 months) and “parents” refers to the parents of the children within this age group.

The research is limited by the age group from 0 to 4 years. There are several reasons for this matter. The literature study about human-computer interaction showed that there is a lack of research information regarding infants and toddlers. The most investigated children’s age group is from 5 to 16 years old. It can be assumed that at this age children have good speech development and they are easier to communicate with. This makes it easier to research their interactions by means of laboratory testing and direct interviews. On the other hand, childhood is the period of quick individual changes. Just one or a couple of years from one stage of development to the next and that differs much from each other both in physical and mental areas. The study of 4-5 year period is sufficient to see the dynamical changes in usage of mobile devices.
2. Theory
Children become older and develop their skills in many different ways each year. It is not an easy task to select interactive software product for them. It should provide not only appropriate content, but also valuable learning efficiency for them.

Berk [11] describes the following areas of child development that can be related in some way to the use of computer technology:

- Physical development that involves changes in body size, appearance, functioning of body systems and perceptual and fine motor skills.
- Cognitive development that includes development of thought processes and intellectual abilities such as: attention, memory, knowledge representation, problem solving, imagination, creativity and language.
- Emotional and social development that has to do with emotional communication, self-understanding, ability to manage feelings and ethical reasoning and behavior.

2.1 Physical Development: Fine Motor Skills and Visual Perception in Interaction with Technology
A child’s physical size can play an important role in how they approach a mobile device. For instance, an important metric for devices with touchscreens is the user's hand size. So, what is comfortable for an adult could be quite challenging for a child. Touchscreen technologies lend themselves to the sensorimotor stage of very young children. They quickly pick them up and press the buttons and icons with little direction or guidance from adults [8]. This ease of use allows a greater degree of independence for young children who can explore and play with touchscreens fairly autonomously. It is especially different to laptops and personal computers which usually require the assistance of older users to work with the keyboard or mouse [12].

Moreover, children can have limited eye-hand coordination and fine motor skills which affect their ability to interact with a product. This is also called perceptual development and perception itself involves using the senses to construct an internal representation of space and the body. These abilities are the key to make use of technologies and therefore it is crucial for developers to understand how children evolve [11]. Aziz [13] demonstrated that children can master some gestures as early as age 2. In their study, the researchers observed children between the ages of 2
and 12 as they played with five different educational tablet applications and performed seven fundamental gestures: tap, flick, slide, drag and drop, rotate, pinch and spread. Children at the age of 2 and 3 struggled with drag and drop, rotate, and spread. Four year old kids were capable of all seven gestures. A second study of gesture performance of preschoolers demonstrated that children can perform basic gestures from an early age and their accuracy increases progressively between the ages of 3 and 6 [14]. All participants attempted tap, double tap, single-touch drag and drop, and multi-touch drag and drop gestures. 3 year olds were successful 73% of the time whereas children older than 5 year olds were successful 89% of the time.

Regardless of physical development of the eyeball (which is complete by the age of 2) children at this age still have difficulties in perceptual tasks, such as distinguishing objects from a background and tracking moving objects [15]. One way to measure visual abilities is by assessing visual acuity. Visual acuity is the ability to distinguish details in objects. It can be of two types - static and dynamic. Dynamic visual acuity involves observing detail in moving objects, and static visual acuity – in stationary objects. Static visual acuity undergoes quick improvements not earlier than the ages of 5 – 7 and commonly matures by the age of 10. Dynamic visual acuity undergoes similar developments, with a final development between ages 11 and 12. It has been discovered that boys have better visual acuity than girls at each age [15].

Figure-ground perception or the ability to distinguish objects from a background improves during childhood. This perceptive ability becomes constant only by the age of 8 with later additional refinement [15]. Visual-motor coordination is the ability to track and make decisions on how to intercept objects. This improves during childhood as well. By the age of 5 or 6, children can track objects moving in a horizontal plane. By age 8 or 9, they can track objects moving in an arc [15].

Information mentioned above shows that older children are more physical developed to interact with software application while children before 4 years experienced problems with visual perception and fine motor skills.
2.2 Cognitive Development and Technology

The relationship between human-computer interaction and cognitive psychology is very important [14]. Usage of technology requires perception, attention, memory, information processing, decision making, and more. Relevant to the study is the link between child-computer interaction and cognitive development. Heintz et al. [16] mentioned that any interaction young children experience may have an influence on their development. How this happens or whether it is good or bad depends on the characteristics of the interaction. Interaction with computers may improve children’s cognitive skills, although it can also deprive them of other kinds of interaction that may also be beneficial.

Vygotsky believed that one of the most important ways in which children can learn about the world and acquire new skills, is by actively working together with or talking to a more experienced person [17]. In this view, Vygotsky [18] introduced the concept of the zone of proximal development (ZPD). This means that children’s cognitive development can benefit from assistance or instruction and that the limits of their competencies can be expanded with the right kind of assistance. For Vygotsky the zone of proximal development represents the next developmental level that a child will reach. He believes that learning should be in advance of development rather than being oriented toward the current developmental level of the child. Furthermore, he believed that children are highly motivated to master what they can almost do or to understand what they almost grasp.

Young children ages 0 to 6 have a unique set of issues related to learning from media especially screen media. Young children’s cognitive abilities influence both attention to media messages and understanding these messages [16]. Nonetheless, when can young children understand media messages, and when do they have the cognitive capabilities needed for learning from screen media?

There are learning benefits from educational content of mobile devices. A study with iPad touch devices and PBS (Public Broadcasting Service) created content for age 3 to 7 discovered that the children developed in vocabulary and phonological awareness, making the most improvements at the age of 3 to 5 [18].
Haugland [19] presented that 3 and 4 year old children who participated in computer activities developed better than others who had not used the computer in the same learning environment. Children who had opportunities to use computers showed high levels of intelligence, language skills, conceptual abilities, and problem solving. As well as playing games has been shown to be an important component of promoting visual and kinesthetic response-related skills. Games on the computer can feature important elements that enhance brain plasticity [20].

Before the age of 18 months, learning from screen content is challenging [21]. Research shows that children (0 months - 12 months) learn more from live interactions (i.e., when someone is physically present with the child during the learning period) versus interactions modeled by a screen actor [22]. This rare occurrence is referred to as the “video deficit” and it has been observed across a number of learning examples such as imitation, problem-solving, and language-learning [21].

Screen media are often used to represent particular persons, objects, or events not physically present. Children under the age of 1 have difficulty learning from any symbols because they cannot simultaneously process contents as both a concrete object and a symbol of that particular object, a rare occurrence labeled dual representation [21]. The “video deficit” effect is similarly reproduced in other symbolic media such as books or pictures [23]. For instance, children under the age of 1 have difficulty in learning from picture books, so it also can be said that they experience difficulty in learning from screen media too [22]. According to Barr, he referred the deficit as a “transfer” deficit, meaning children (under the age of 1) experience difficulty transferring their understanding of two-dimensional content to a three-dimensional learning situation [23].

Children between the age of 0 - 12 months learn more from interactions with human beings. For that reason creating screen content that incorporates more realistic descriptions or situations should result in more learning. Evidence indicates that learning from screen media, pictures, and picture books was more likely to happen with content that was more realistic when compared with animation or cartoons [22].
Current research has begun to unravel the variety of production signs found in media to determine which signs help and which prevent learning. For instance, Barr and his colleagues [23] determined that background music prevented learning, sound effects matched to key content helped learning, and a combination of background music and sound effects helped learning as long as the sound effects were matched to key content. Generally, this research suggests that production techniques can support learning when used appropriately to mark main content or to improve the match between onscreen content and real life.

Lemish [21] concluded that repetitive exposure to screen media has been causally linked to babies’ increased learning from screen media across several experimental contexts including imitation, problem-solving and word learning. As babies have very little background knowledge and experience with screen media, repeated exposure is important for efficient learning process. Parents interact in a variety of ways with their infants while co-viewing screen media, especially child-directed educational content. Interactions consisted of labeling and descriptive content responding to infant-initiated verbalizations, and extending content beyond the screen to make connections with infants’ everyday lives. Three experimental studies found that infants of parents who used these strategies while co-viewing showed better language outcomes.
2.3 Emotional and Social Development Using Technology

According to Bracken and Lombard [4] during the preschool years children learn about their social world through play. They develop friendships and relationships and learn social rules. They also develop a strong sense of identity, realizing that there are different genders and characteristics that belong to a specific gender. They begin to behave more socially, imitating the social behavior of parents, caregivers and characters they encounter on television and other media.

Fishel [25] believes that 4 and 5 year old children already display gender-related preferences in their play. They can imitate adults in their world through imaginary play. However they will generally not play non-traditional roles. They can separate themselves mentally from their physical surroundings and can therefore engage in absurd imaginary play or accept strange characters and events in stories.

A child’s emotional state influences his or her skill acquisition. A media content designer does not have control over factors outside the game environment that may influence the child’s emotional state, but can use game elements to evoke emotions that may enhance skill development [17].

The study conducted by Radesky et al. [26] shows that 9-months old infants and 2 year old toddlers with self-regulation difficulties (ie, excessive fussing, poor self-soothing, difficulties with state changes, such as sleep, emotional regulation, and attention) view significantly more daily hours of media. They were more likely to exceed 2 hours of media use per day, compared with infants with no or mild problems. Early childhood self-regulation problems are associated with slightly increased media exposure and understanding this relationship may provide understanding into helping parents reduce their children’s screen time.
3. Methods

3.1 Method Discussion

There are a lot of different methods to consider when writing a research paper. No particular method is privileged over any other. Rather, the choice must be driven by the research questions. The research questions of this study are about human experience and behavior during mobile device usage. To find answers to the research questions, both quantifiable and qualitative data is to be collected from the users. The scientific research methods generally can be classified into three main categories - qualitative, quantitative, and mixed methods approaches [27].

Quantitative research is based on observations that are converted into discrete units, which can be compared to other units by using statistical analysis. Qualitative research, on the other hand, generally examines people's worlds and actions in narrative or descriptive ways more closely representing the situation as experienced by the participants [28]. While the quantitative data may reveal that things are happening, the qualitative insights show why or how they happen. It is interesting for authors to apply in practice the mixed methods approach, using the benefits of both qualitative and quantitative methods. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. The use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone [27].
Advantages of mixed method [27,30]:

- It incorporates the strengths of both qualitative and quantitative approaches.
- It provides a more comprehensive view of the phenomena being studied and compares quantitative and qualitative data. Mixed methods are especially useful in understanding contradictions between quantitative results and qualitative findings.
- It reflects participants’ point of view. Mixed methods give a voice to study participants and ensure that study findings are grounded in participants’ experiences.
- It provides methodological flexibility. It is adaptable to many study designs.

Disadvantages and limitations of mixed method [27,30]:

- It requires expertise in both methods.
- It requires extensive data collection and resources. Mixed methods studies are labor intensive and require greater resources and time as compared to a single method study.
- It is popular to claim the use of mixed method design even though one method is used superficially

Ayiro [30] described different examples of scenarios for a study, where the researchers collected and analyzed both quantitative and qualitative data, mixed the data, and reported the studies as a single mixed methods study. Here is the description of scenario which was used in this research:

“A researcher mixes quantitative and qualitative approaches to research throughout a study. Both qualitative and quantitative questions are posed, both forms of data collected and analyzed, and a quantitative and qualitative interpretation is made. In reading the sections of the study, the reader finds a mixing of both approaches threaded throughout the study” [29].
The authors of this study follow concurrent procedures for mixed methods strategies described by Creswell [28]. In concurrent procedures the researcher converges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. In this strategy, the investigator collects both forms of data at the same time during the study and then integrates the information in the interpretation of the overall results. Also the researcher nests one form of data within another, larger data collection procedure in order to analyze different questions [27].

To implement mixed method scenario the list of 9 questions was prepared (see Appendix A). It consists of a number of structured questions calling for a quantitative analysis (questions 1-5) as well as a number of open-ended questions calling for a qualitative analyzing (questions 6-9).

To answer the research question RQ1 the answers on the questions about child’s age (question 1), access to mobile device (question 2), how often mobile device is in use (questions 3 and 4) and which type of media content is used (question 5) were summarized for analysis and presented in graphs from 1 to 4.

To answer the research question RQ3 the analyses of answers on questions about advantages of use (questions 6, 7) and disadvantages of use (questions 8 and 9) was done. It was possible to summarize and represent collected answers in graphs from 5 to 7.

To answer the research question RQ2 the answers on questions about which type of media content is used (question 5) and advantages of use (questions 6, 7) were compared to the known theory about children’s development. It was made through analysis of media content which is used from year to year, and which type of learning benefits parents found for their children.
3.2 Method Description

3.2.1 Survey

The survey questions were created using Google Documents. That made parents’ access to survey easier through Internet. The main delivery of the survey is done through social media Facebook group pages, such as International Parents in Sweden, Mammor i Malmö, Parents in Skåne, Parents in Malmö. Some parents who were not registered in the mentioned groups of Facebook, received the link to survey via email. It was relatively easy to administer the survey online. It is a time efficient way to collect a large amount of data in a short period, because one does not have to wait for paper surveys to come back. The response time is almost instantly.

Seventy one parents responded to the survey in total. There were two parents whose children were 5 years old. They were not included in the results, and the total number of survey participants was 69. Some of the parents had two children of the required age group and answered about each of them separately. Data about 70 children was collected by the survey. The survey was reviewed and data about each age group were sorted out for further analysis.

One of the limitations we had was the respondents’ incomplete answers. Some were not elaborated and thorough enough to understand, some were unclear and some questions in the survey were not answered or just answered with a yes or no. However, the respondents with such unusable data represented only a small portion of the total (0.5%) and therefore the given answers from this group were neglected. Such small amount does not affect the total results.

3.2.2 Interview

Among the general advantages of using interview as a research method, there are two main reasons to conduct interviews. The first is to find those parents who don’t use Internet or Facebook. This makes the researched group wider reaching participants with different background. Thus, the generalization of results becomes more reliable. The second reason is to collect more detailed answers encouraging the parents to reflect over the open-ended questions. The parents for the interviews were selected through the researchers’ personal contacts. A total of 32 interviews with parents were conducted. Some of the parents had two or three children of the required age group and answered about each of them separately. Data about 44 children was collected by the interviews.
Some interviews were face-to-face and others were through messenger chat via Facebook. Each of the interviewee was interviewed separately with the same set of questions mentioned earlier in the paper. The questions were open and close ended. The goal was to document the opinion and experiences of each child’s parent. The participants were recorded throughout each interview. However the selected participants who were not able to meet for the face-to-face interview due to personal reasons received the interview questions through email with instructions to give a detailed response as much as possible. The answers were come back through email.

As a threat to the validity of the evaluation which can affect the results, is presumable due to the fact that some of the participants may not reflect objectively about their children. The possible way to avoid this is to use an observation qualitative research method. This method was, however, not used due to high resource consumption and child’s privacy.

3.3 Ethics

The participants were informed in advance regarding the purpose of the survey/interview and research. The participants gave their consent to participate in an interview and to be recorded with audio recording equipment. The participating respondents were asked to elaborate their answers to certain questions. To maintain the confidentiality of the participants they were informed that they appear completely anonymous. Furthermore, it has been informed to the participants that the interview will be recorded, and will be deleted once the study is finished. The participants have the opportunity to listen to their own recording of the interview at any monitoring time or via email.
4. Results

This section presents the results acquired through the survey and interviews conducted with the parents who have children between the ages of 0 – 4 years old.

4.1 Number of Children

The accumulated data contained information about 114 children in total. The number of children according to each year group is presented in figure 1.

![Figure 1. Number of children respective to age](image-url)
Overall there were 114 children:

- 19 children below the age of 1
- 27 children were at the age of 1
- 40 children were at the age of 2
- 16 children were at the age of 3
- 12 children were at the age of 4

The different number of children in every group can be explained by random choice of participant for research. In general the group can be identified if the number of participant is high enough (at least 10 - 20 persons). Otherwise even one participant with unusual or remarkable skills for his/her age (both under- or overdeveloped) can strongly affect the whole representation of the group.
4.2 Frequency of Mobile Device Usage

Figure 2 presents how often children of every age group use mobile devices. The following trend can be seen - 72% of children below the age of 1 year never had access to a mobile device. 7-8% of children who never use the devices reduced dramatically at the age group of 1 and 2. At the age of 3 and above they start using mobile devices.

![Figure 2. The frequency of mobile devices usage respectively to age in percent](image)

The age group up to 1 year has nearly 75% of the parents that think it is very early for children to use mobile devices. There are only 16% (only three children) in this age group that have access to a device every day and the same number of children accesses it occasionally. The parents’ motivations mostly are to become familiarized with children’s songs or to entertain the child during long trips.

The number of children who use mobile devices occasionally is about the same for 1 and 2 year old. It remains at the rate of 26-30%. However it decreases to 25% and 17% at the age of 3 and 4 respectively. The older the child becomes the more often they use mobile devices. As a result the number of children who use mobile device every day increases from age 3. 67% and 63% of children at the age of 1 and 2 accesses it every day. This number increases to 75% and 83% at the age of 3 and 4.
4.3 Daily Use of Mobile Device

Figure 3 presents information about how many children access devices respectively to the duration of daily use.

![Figure 3. Distribution of children according to daily use of mobile devices in percent](image)

As children become older it can be observed that each year the time, which they spend every day on with the devices, increases dramatically. Children become more involved in the digital world. The first two years of life the short usage is more common for children. 16% of children before the age of 1 and 37% of 1 year old children use it less than 30 minutes a day. 13% at the age of 2 use devices less than half an hour per day. Although the long consumption from 30 minutes to 2 hours a day increases each year. It is reported to be at the level of 30% of children at the age of 1, with continuing growth to 40%, 63% and 67% respectively to the next year of life.

From the age group of 2 there is a new category of children that use technology more than 2 hours a day. This happens when parents do not control the limit of time their child uses the devices. The tendency of the growth is typical for that segment. It starts from 10% of children at the age group of 2 and increases up to 13% and 17% following the next two years of life, involving more children to overuse digital devices.
4.4 Children's' Usage Preferences

To analyze the children’s interest the mobile content was divided into five categories. They are:

- YouTube videos
- Learning videos
- Entertainment videos
- Learning games
- Entertainment games

The research does not have an aim to define any popular game or video but only the common activity within the mentioned categories of content.

Figure 4 reflects upon the childrens’ preferences in mobile device contents. The pillars of the graph present how many children use the specific content of mobile device they have access to.

You Tube is quite specific content which can include both learning and entertainment videos. It was found difficult to distinguish exactly what children preferred to watch on YouTube. Due to explorative nature of YouTube children follow their own curiosity selecting different types of content suggested by the service.
The child’s interest can change quickly each week. The usage process of YouTube cannot be controlled by the parents if the child is left unattended when using the mobile device. This can lead to inappropriate content usage. From that perspective the games installed by the parents will have more beneficial experience for the children.

A few conclusions regarding popular content for each age group can be done:

- The learning video usage increases during the age group of 2 and 3 years, however decrease the next year. It is interesting that this type of content is less preferable among all age groups.

- YouTube reaches its top popularity at the age of 2 and 3. It decreases the next year giving away their positions to other categories such as entertainment videos and game applications.

- Entertainment video keeps its popularity at a high level from the age of 1 to 4 years. It attracts many children each year and it reaches 83% of children at the age of 4.

Educational and entertainment games have the same growth trend each year as well as entertainment video. The increasing popularity of games can be explained by the interactivity of the touchscreen enjoyed by the children. The fine motor skills and cognitive development makes it easier for children to understand and perform the tasks.
4.5 Parents’ Attitude towards Effect of Mobile Device Usage

The parents have reported both positive and negative children's experiences with digital explorations. Figure 6 presents the number of parents whose children use the devices and have reported any advantages or disadvantages they observed. Their number increases from 64% for 1 year olds to 81%, 94% and 86% for next three years of life. The group of children under the age of 1 was not included in the next three figures, as there were only 3 children that access mobile devices daily for a short period of time. This small number of participants cannot reflect the general situation for that age group.

![Figure 5. Parents’ attitude towards effect of mobile device usage on children in percent](image)

The increasing dynamic is observed for the age group of 1 and 2 year old. It can be explained by the low level of the child’s cognitive development. Children at the age of 2 become more capable to interact with technology. It is striking that the positive experience is closely followed by disadvantages from the usage. The trend of changes is nearly the same for disadvantages and advantages. As for the age group of 3, the disadvantages level differs from 16% against the advantages level, however it is still high at 78%.
4.6 Health and Behavioral Problems

Figure 6 presents the level of behavioral and health problems, discovered by the parents. The most common behavioral problems, that the children have, are addiction, ignorance, tantrums and tiredness. There were a few parents that noticed their child had health problems, such as neck pain or eye problems.

![Figure 6. Distribution of health and behavioral problems among disadvantages in percent](image.png)
4.7 Learning and Motor Skills Improvement

The advantages reported by the parents can be divided into two main groups: learning improvements and motor skills improvements. Figure 7 presents the distribution among reported advantages. Learning improvements, specified by parents, are learning new words and songs, alphabets, numbers, counting, shapes, colors, logic, understanding of contents, improved memorization. The fine motor skills improvements are described as better coordination of fingers on both hands, its nimbleness and speed, great motor skills when it comes to handling an electronic, learning dance movements etc.

Figure 7. Distribution of learning and motor skills improvements among advantages in percent

- Learning improvements
- Motor skills improvements

<table>
<thead>
<tr>
<th>Age</th>
<th>Learning improvements</th>
<th>Motor skills improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>100</td>
<td>13</td>
</tr>
<tr>
<td>2 years</td>
<td>100</td>
<td>17</td>
</tr>
<tr>
<td>3 years</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td>4 years</td>
<td>92</td>
<td>25</td>
</tr>
</tbody>
</table>
5. Analysis and Discussions

According to the collected data, the use of the mobile devices by children under the age of 1 year is at the lowest level among the researched groups. There are 72% of parents that believe their child is too young to gain any benefits from mobile device usage. 11% of children under the age of 1 use the digital content occasionally and 17% on a daily basis. Daily usage is at the lowest level and it is up to a half an hour per day. Children from 0 to 1 year mainly watch children songs on YouTube together with their parents. They have a lack of concentration and understanding of video materials. For this reason their interaction with mobile devices is minimal. Children listen often to song melody and play with their parent or a toy. For example, a child is watching a YouTube video and leaves for a while to play with his/her toys and then comes back and watches another YouTube video. Children at this age are far from the possibility to accept properly visual information from the device. Only audio content can be consumed. However this is not the words they understand or learn. The child becomes familiar with the rhythm or melody.

One of the advantages that the parents described was that their children learned physical movements, such as dancing, clapping, raising their arms up and down. This type of activity is also shown to the child by adult who follows the video content. They demonstrate and sing to their child. There was only one child who watched cartoons alone during trips, such as car rides. The parent considered no advantages except keeping their child entertained while driving the car. Therefore the digital content only complements the parents’ activity with music. The children soon become familiar with it and react to it with learned movements. That was mentioned in the theory regarding young children - they learn from communication with human, not technology.

The disadvantages of usage are reported by 3 of 5 parents whose children are under the age of 1. They are identical in all families – the child becomes angry and screams when the activity on the device ended or when the device is taken away. Although it can be that the child enjoys the process of communication with the parent using the technology, but not with technology itself. In addition to an early age there are not many instruments for babies to communicate with. Children have a difficult time expressing themselves by words as they cannot understand why the activity had ended or when the device was taken away. There is no special connection with the mobile device specific nature.
At the age of 1 year the number of children who has access to the device increases rapidly. 93% of children explore the computer technology including 67% of all children on a daily basis. The situation is very similar for the next age group of 2 year old children.

Approaching to the next age groups of 3 and 4 years old children it is remarkable that all children have access to a mobile device. This means that the parents are more accepting with children experimenting with mobile content starting from the age of 3. Furthermore 75% and 83% of respective age 3 and 4 explored the mobile devices on an everyday basis. The first sign of the hazardous overusing mobile devices is the trend of steady increase of the usage time. From 10% at age 2 to 17% at age 4 the children use mobile devices more than 2 hours a day. In this period of the children’s life physical activity is needed for their growing body.

With no doubt children enjoy spending time with mobile devices. That conclusion is supported by figures 2 and 3 regarding the increased duration of children use. This also means that this time was taken from other life activities, such as physical or art activities. Parents want to develop the creativity and imagination of children by introducing technology with the widest content of information. They expect that children will go out and explore the world with new ideas from the digital world or socialize with peers playing new imaginative games inspired by mobile device content. But instead, children become addicted to the technology, preferring to stay home with mobile device in hands.

The interests of 1 year old are very narrow. It seems they cannot explore the mobile device content on their own. They use the content the parents have found to be appropriate for them. The entertainment videos and educational games are the most popular. The parents’ motivation here is to show cartoons as new entertainment for children or play simple word games instead of the book. One of the participants mentioned during the interview that her child does not have any interest to learn names of animals from books. Although she used an application on a mobile device the same way as the book, her child liked its interactivity and kept a high interest to such activity.
At the age of 2 the number of different content usage increases to all possible types. It includes YouTube, educational videos and entertainment applications. Children spent more time in a daily basis interacting with devices and that contributed to the expansion of their interests. This was not the only reason to trigger such activity. It is known that children at the age of 2 develop a magnificent approach in their cognitive and physical development. They become more capable of accepting information from screens, to interpret and discover connections with real life experiences. Children develop the very first steps in logical decision and can accept information from the digital technology at a more complicated level than previously. Parents can achieve advantages in helping their children develop new vocabulary when carefully selecting appropriate content according to child’s development level.

The development from 8% to 41% of usage of entertainment games at the age of 2 reflects that children develop and progress to the next stage of their cognitive development. They can understand and follow the plot of common non-educational children application. The popularity of YouTube among the 2 year olds increased from 31% to 62% and can be a result of the previously mentioned capability of understanding of the plot of a video. According to further research reports, children between the age of 0 - 18 months experience problems with transferring video content from real life [21]. Later, when this mental limitation at the age of 2 years is passed, the children can open the world from a different perspective. Leading their curiosity and selecting different alternatives that YouTube offers to them actively. However it is often that YouTube contents are not suitable for the age group of 2 year old.

In regards to the parents’ attitude only 64% of parents see some advantages of use for children at the age of 1 year. Though children at the age of 2 years figures increases up to 81% and indicates that the more appropriate age for exploring the device starts after the age of 2.

All parents in both groups describe the advantages, such as increase of vocabulary. For example, names of colors, counting, names of animals, names of musical instruments etc. This is as well supported to learn at Swedish preschools e.g. learning new English words, learning songs etc.
For non-Swedish speaking parents the device is the opportunity to support language development for their children at home. The repetitive style of watching the same content repeatedly is a natural way how children learn new things. There were some parents that answered that new words were acquired only from the device content. A few parents mentioned that they also read books with the same terms and the use of the device can only have supportive effect in memorizing them.

It was reported by 17-19% of parents from both age group of 1 and 2 year olds that there are some progress in physical development. The digital media content are far from the purpose to stimulate fine motor skills – there are quite a few videos, which encourage children to move and there are no any applications that can help with physical movement. The development of fine motor skills is a very specific area for the mobile device world. Children are more used to interact with the digital technology rather than improving, for example, the ability to manage properly a pen or a spoon.

The number of discovered disadvantages is very close to the number of advantages. So what is the downside of the progressive mobile technology used by the youngest children?

Almost all participants reported examples of disadvantages for 1 and 2 year olds and they are similar behavioral problems. They are addiction, children seem absorbed into the screen, tantrums when switching off the device. At the same time there are no reports of any sleeping disorders or emotional regulation. Most parents mentioned that it is easy to turn off the device if they offer another activity. That is very specific moment for this age. The later results of older children will show that the method does not work with the age groups of 3 and 4 year olds. There are no deep self-regulation difficulties that are reported by earlier research in theory. However there are short difficulties with switching between activities which parents used to overcome with little effort. These can be explained by spending less time with mobile device thanks to the restrictions settled by parents.
The older children at the age of 2 and 3 year olds have very similar content preferences except for one thing – the entertainment games continues its expansion and increases from 41% to 75%. This type is the leader among all other type of content. At the age 4 children actively start using mobile devices for entertainment or for fun purposes. They are less repetitive in their everyday content. As it was previously mentioned in the theory chapter, the children at the age of 4 are able to do all types of finger movements used in touchscreen applications. That is why they enjoy the easy active interaction with touchscreens and prefer entertainment and learning games much more than learning videos. It can also be assumed that the learning video is presented only in limited age groups related to 2-3 year olds. However there is no videos that provide learning benefits for children who already know colors, shapes, animals and can count, but yet too young to begin to understand math, reading or more scientific topics, such as geography or physics.

There is a reduction of learning advantages that children receive from the age of 3 to 4 year olds despite the fact of high popularity of educational games. The parents mentioned a few new things added, such as learning the alphabet, speech development through using more phrases, other languages words. However it is still the same for 2 and 3 year olds – colors, shapes, counting numbers, etc. The parents do not notice significant qualitative learning development.

The parents seem to have difficulties to identify educational program their child can benefit from. Initiative to choose content is at the children’s hands. They use mobile device independently from parents. This situation can be definitely changed by designing the recommendations of what parents should focus their attention on, when selecting educational games. This should be based on the last research in children psychology and designing applications for children.
25% of parents found some physical development advantages concerning fine motor skills. They are impressed how quickly children can type simple passwords or necessary manipulation to navigate the device or games. Definitely, it will be beneficial for children in the future as the mobile device are going to follow the children’s development impartial to change required by new interests of content.

14% and 9% of parents of 3 and 4 year olds children mentioned some physical problems as the downside, when using mobile devices. This is the first sign that parents notice possible health related problems and limit or interrupt the use of devices. For that reason some time limit is also needed. A few behavioral issues for this age are similar to the other age groups. It is difficult to end device usage. It helps to set rules of device usage because the older children are able to follow them. When children overuse device they experience self-regulation difficulties, excessive fussing and sleeping problems. Many parents understand the possible negative effect of regular long lasting use of mobile device by children. It is needed to inform parents regarding these kinds of disadvantages.

Technology designed for children often carries aspirations for ideal behavior such as learning, exploration, and self-expression. These aspirations often come from adult perspectives in the context of what they consider an ideal way for children to spend time with technology. When comparing children's’ actual behavior against technology’s potential benefits, these aspirations can turn into disappointments.
Here are some key moments that parents should take into account if they want to achieve learning benefits from mobile device:

1. Select appropriate time to start.

   Infants may stare at the bright colors and motions on a screen, but their brains are incapable of understanding the pictures. It takes 2 full years for a baby’s brain to develop to the point where the symbols on a screen come to represent their equivalents in the real world [21]. However, the research shows that even children between 1 and 2 years can benefit. They become acclimated to familiar sounds. They can also benefit if applications are designed with photos from the real world, rather than drawn by hand symbolic pictures. It is worth to mention, that there are no discussions regarding the latest time the mobile technology should be introduced to a child. Older children found it easy to adapt to mobile technology quickly.

2. Use it together.

   Co-viewing with parent can increase learning effectiveness of using mobile devices. By asking questions about on-screen content or relating it to prior events, adults encourage children to retrieve from memory and repeat information. They may support vocabulary development by asking children to repeat words shown on the screen, or support symbolic insight by drawing direct connections between on-screen and real-world items. This is known from the theory that it is natural for young children to accept new information from a parent. Unfortunately the survey did not include question about co-viewing with parents and there are not any statistic about it. But during interviews it was obvious that parents, whose child use mobile device together, are more confident about learning benefits. They know how their child progress with new achievements.
3. Limit a time.

Today, it is difficult to follow well-known recommendation of the American Pediatric Society from the year 2011 [31] - no television (or screen media such as computer games, videos, or DVDs) for children under 2. For children over the age of 2, the recommendation is 1 to 2 hours per day for television (or any screen media). It is obvious, that time limits defined by parents will discipline the child and avoid or at least reduce the problems, which were reported during our research. Unfortunately, our study is not enough to declare which limits are appropriate for every age group and further research of this subject is needed.

4. Choose the right content.

First and foremost the child should be capable to interact with the application. After the parents’ example how to interact with an application, the child should be able to proceed with minimal assistance. When the child continuously flounder or is confused, it is not beneficial to learning, nor does it encourage a positive feeling of using mobile devices. Understandable and appropriate to the child's developmental level instructions, which are integrated in application by support and prompts, are essential. It is also important for children to get help when they need. Independence does not mean playing alone all the time. The second is the appropriate difficulty level. This occurs when the parent chooses a predetermined level. Alternatively, the program presents the appropriate level of activities after the child accomplishes each task, or the parent can change the level manually as the child is ready for new challenges. Children will not gain any benefits if the tasks are very easy. They will become uninterested and bored if they are not challenged. Children will also not gain any benefits if the tasks are very difficult, because if children repeatedly fail with a task they will lose interest.
6. Conclusion
In this thesis we have investigated the way young children age 0 - 4 year olds interacts with mobile devices and how mobile devices can help parents gain learning benefits for the youngest children.

The theory - how physical and cognitive development of children influences the interaction with mobile devices - was relevant enough to research the topic. It was difficult to summarize the large amount of information regarding children’s development and their interactions with mobile devices. The Vygotsky’s theory of cognitive development is an old theory. It was presented almost 90 years ago. The modern theories which were derived from his research are more up to date. However, they do not cover children’s interactions with new technology and their development through it. The mobile device technology with touchscreens and age-appropriate applications for very young children is adequately recent. There are a lot of articles and researches made, but just a few about the youngest children. There is a need to summarize all published academic material and form general conclusions or theory about children's cognitive development in era of new technology. Therefore, further research and observations in this field is needed.

It was effective to use the mixed method approach to answer the research questions. The results are credible enough because of high number of participants. This allowed us to present the general trend and understand how the children usage of mobile devices differs from year to year as they become older. However, the interviews didn’t present us so much quantitative information as expected. It was not possible to summarize the personal experience of mobile device usage of every family. During interviews we got parents’ answers which, we know, didn’t reflect objectively about child. May be they did not want to present themselves and their child in a negative manner. There was only one family and it did not influence our results. For this reason observation is the better research method.
It would be interesting in future research to learn how older siblings can influence their younger sibling to use a mobile device. During the interviews we have noticed that if a family has several children, the youngest child begins using mobile devices at an earlier age, more often and with non-appropriate content of his or her age. However, they have more support from their siblings during interaction with mobile devices.

This paper can be interesting and helpful for parents of young children and for others researches in the field of human-computer interaction.
7. References


8. Appendix A

The list of questions from the interviews and survey.

1. How old is/are your child/children? (years and months)
2. Does your child have access to any mobile device?
3. How often does your child use mobile device?
   - Never
   - Every day
   - 2-3 times a week or less
4. How long does your child use mobile device at a time?
   - Up to 30 minutes
   - Between 30 minutes and 2 hours
   - More than 2 hours
   - Other, please specify
5. What type of application or videos does your child use often?
6. Are there any advantages your child receives through using mobile devices?
7. If yes, what are they?
8. Do you see any disadvantages or problems your child receives through using mobile devices?
9. If yes, what are they?