Comparing traditional and digital learning methods to improve the learning outcomes of young children

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Abstract

Children are getting more and more involved with interactive technology during their daily activities, both at home and in classrooms. However, little is known about the effect of using interactive technology in classrooms on young children's study results. Does the use of interactive technology for education actually improves children's knowledge? Besides, there is little evidence that children and teachers actually hold positive attitudes towards the integration of digital learning methods in classrooms. This study will give more insight in how both traditional and digital learning methods affect the learning outcomes of children between the age of 6 to 8 years old, by comparing traditional and digital learning methods. Furthermore, this study will present the attitudes of children and teachers towards the use of interactive technology for educational purposes.

24 children from a Dutch elementary school participated in a three-week experiment. In the first week, children were divided into a traditional learning condition and a digital learning condition and both groups learned English words for colors. In the second week, children switched conditions learned English words for animals. Their knowledge was tested after each week. The results of the knowledge tests showed that children's learning outcomes were significantly better in the traditional learning condition, in comparison to the digital learning condition. In the third week, children's attitudes towards interactive technology were measured with the help of three evaluation methods. The findings showed that children hold more positive attitudes towards digital learning methods. After the three-week experiment, five teachers of the elementary school were interviewed to get more insight in their attitudes towards interactive technology use in classrooms. All teachers indicated that they support the use of digital learning methods, but assistance and feedback from teachers remains important.

Three important implications can be derived from the present study. First of all, interactivity of technology does not guarantee better learning outcomes, since children performed better in the traditional learning condition. Secondly, successful integration of technology in classrooms nowadays is not hindered by attitudes of children or teachers. Finally, the role of teachers in achieving desirable learning outcomes continuous to be a central factor, even if technology is implemented to existing education systems.

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1. Introduction

Nowadays, interactive technology is more and more embedded in children's daily activities (Markopoulos, Read, MacFarlane & Höysniemi, 2008). Children make use of interactive products, such as games, toys or educational applications, both during leisure time and in school environments. All these technological products have in common that they are specifically designed to facilitate interaction, encourage social activities and enhance creativity (Dix, Finlay, Abowd & Beale, 2004). Whereas games and toys particularly focus on entertainment, educational products mostly focus on improving children's knowledge and competences (Dix et al. 2004). As reported by the European Commission, the past few years have seen an enormous increase in the use of these interactive products for educational purposes. Schools are dealing with a growing trend of using interactive technologies in their classrooms. In 2013, the report 'Survey of schools: ICT in education' was published to reveal the numbers of technology use in schools across 27 countries of the European Union. It was reported that 50% of children between 12 and 17 years old use laptops, tablets and mobile phones in classrooms at least every week. Moreover, the number of computers at schools in 2011 has doubled since 2006.

According to Goodwin (2012), the development of interactive technology introduced a new generation of educational tools, that have been praised as revolutionary devices that hold great potential for transforming the traditional learning environments. The emerging use of these tools causes a transfer of the traditional learning model where the classroom is the central place of learning driven by the teacher, to a modern learning model in which the teacher is no longer at the center of the learning process. For example, the portability and connectivity of mobile devices, such as tablets or laptops, provides children access to a broader and more flexible source of learning materials than materials that are offered in traditional classroom settings, such as blackboards or books (Goodwin, 2012). A report of Schuler (2012) showed that more than 500.000 applications designed for learning are available to download from Apple's App store, which gives schools access to a wide range of learning materials for mobile devices such as the iPad.

One of the great challenges for those who create these interactive products for education, is to develop effective tools or learning environments that help children to use their inborn learning abilities and to improve learning when comparing to traditional forms of teaching (Blackwell, Lauricella, Wartella, Robb & Schomburg, 2013). There is emerging evidence to suggest that these products have a significant potential to support the learning process (Shuler, 2012). However, to date, little research has been done to investigate young

children's use of touch screen devices in classrooms and their educational impact. There is a lack of empirical evidence to confirm that interactive educational applications are valuable for better learning outcomes, when compared to learning outcomes from traditional methods (Shuler, 2012). This study seeks to provide evidence-based information to check if implementing interactive technology in education is actually beneficial for young children. Do digital teaching methods provide positive learning outcomes for students, when compared to more traditional teaching methods?

With the help of this study, evidence-based insight will be given in how learning outcomes of emerging digital teaching methods such as tablet applications, relate to learning outcomes of more traditional, maybe old-fashioned, teaching methods. In addition, this study will explore children's and teachers' perceptions of and attitudes towards interactive technology for educational purposes. Since teachers and students are the ones who have to work with new technologies, they are expected to hold positive attitudes towards the use of interactive products to successfully implement them in existing learning methods. Currently, there is still a large knowledge gap in existing literature about how interactive technology affects education in elementary schools. Therefore, this study aims to collect valuable insights in what effect interactive technology has on children's learning achievements and how teachers and children evaluate the use of interactive technology in classrooms.

2. Theoretical Framework

This thesis' theoretical framework first defines interactive technology and describes the role of interactive technology in education. To clarify how technology is used by children, the differences among several age groups and their relationship to technology are described. The focus will be on children between the age of 6 and 8 years old, since this age group is the target group of this thesis. Next, some results on learning outcomes that follow from using interactive technology for education will be discussed, including the knowledge gap in this area that will be dealt with in the present study. Furthermore, the importance of investigating children's attitudes towards interactive technology is explained, followed by how these attitudes should be evaluated. The theoretical framework will be concluded by describing the important role of teachers for implementing and using interactive technology at schools.

2.1 What is interactive technology?

Getting qualitative education has never been more important than in this era (Goodyear & Retalis, 2010). Education is the road that children follow to reach their full potential in life. Moreover, education is actually the key to prosperity for individuals, for organizations in which they work, for the competitiveness of national economies, and for global stability and survival. As a logical consequence of this era's digitally rich culture, young children get in contact with interactive technology more often during their learning activities at school (Goodyear & Retalis, 2010). First, interactive technology will be defined in order to understand the implications for getting qualitative education.

When looking at the field of information and communication technology, interaction can be defined as 'interaction mediated by technological artefacts or products' (Caroll, 2014). This means that interaction via technology indicates that there is communication between the user and the technological system. Possible interaction with technological systems relies on the ability of the system to demonstrate interactive behavior (Dix, Finlay, Abowd & Beale, 2004). Consequently, the technology-user must be triggered to interact with the product by specific features. Humans are mainly triggered through five senses: hearing, sight, touch, smell and taste. Since taste and smell are not present in technology, interactive technology always needs to have communicative features such as sound, touch or visuals. The process of communication via these features is receiving information that is output by the technology, and responding by providing input to the technological system. In this way, the user's output becomes technology's input and vice versa.

The market offers a large variety of interactive products for children, ranging from products that are developed for entertainment to products that are more focused on education. The most important factor of these products is that children should be triggered to interact with the technology (Dix et al., 2004). Some examples of these interactive products are video game consoles such as the Wii (www.wii.com), applications such as Playtime with Dora (by Nickelodeon, https://play.google.com) and robots such as Nao (by Aldebaran community, www.aldebaran.com). While interactive technology for leisure activities is still a large target sector, the use of interactive technology is increasingly emerging in the field of education (Goodwin, 2012).

2.2 The use of interactive technology for educational purposes

There are many different types of interactive technology that can be used to help children learn by developing knowledge and skills. Technology in its broadest sense can include both hardware, such as interactive whiteboards, and software, such as educational games (Goodyear & Retalis, 2010). The development of hardware technology for education keeps changing drastically. For example, schools and other educational institutions have been investing in what is called smart furniture. Interactive whiteboards are one aspect, but designers are also adding intelligence to classroom furniture in other ways such as smart tables. Smart tables offer eight students the opportunity to learn together at the same time, interacting with activities on the multitouch table surface. In addition, software technology is also developing rapidly and in consequence, new uses of software technology, such as applications are emerging. Applications are, for example, educational games that can be downloaded on mobile devices which help the child learn about a concept in an interactive way. These new technologies, both hardware and software, can be used to improve student learning or prepare children for effective technology usage in their further lives.

In many Western countries, interactive technologies like smart whiteboards or tablets already have a high adoption rate among schools and school-aged children (Chan et al., 2006). However, over the next 10 years it is expected that personal and portable wirelessly-networked technologies, such as tablets, will become ubiquitous in the lives of these students. Therefore, designers and scientists are investigating what kind of technologies are used for educational purposes and which characteristics make these technologies effective vehicles for education (Goodyear & Retalis, 2010).

The most commonly used term to define the use of interactive technology for education is *one-to-one technology-enhanced learning*. In general, the term *technology-enhanced learning* is used to refer to learning supported by interactive technology (Chan et al., 2006). It covers all those circumstances where technology plays a significant role in making learning more effective, efficient or enjoyable. The notion of *one-to-one* refers to a ratio of at least one computing device for each student. For example it is argued that desktop computers are not personal to children in school, since they have to share it with other students. When they could own a personal computing device, it would change the way of learning, as similar to when one owns his own pencils and books. Since the most well-known *one-to-one technology-enhanced learning* device is a tablet, this thesis will focus especially on the use of tablets for educational purposes.

Several researchers have enumerated a number of features that make tablets interesting for education (Klopfer, Squire & Jenkins, 2002). In comparison to traditional teaching methods, the features that make wireless computers like tablets especially attractive platforms for studying include: the portability of the handheld, the potential for social interactivity and customization, the ability to gather unique data from the environment, the connection between other handhelds for a shared environment and the combination of physical and digital worlds. For example, children can use their tablet both at school and at home, they can personalize their tablet and they can practice learning matters with their tablets while teachers are discussing the particular concepts in class. Furthermore, learning with tablets gives children the opportunity to study at their own individual level. Tablets allow children to practice learning matters at their own level and pace, without affecting the rest of their classmates. All these features should make the tablet an ideal device to improve contemporary, traditional learning methods (Klopfer, Squire & Jenkins, 2002). Therefore, the goal of this thesis is to investigate if the use of these *one-to-one* devices is actually beneficial for qualitative education when comparing the digital learning method to more traditional learning methods. The target group of this thesis are children between the age of 6 to 8 years old. The next section will firstly describe the difference between age groups and their use of technology, in order to understand which kinds of interactive technology are suitable for the education of young students. Furthermore, it will be explained why this study will focus on this particular age group.

2.3 Different stages in child development

In order to develop the most effective interactive technology for educational purposes, the differences in children's development stages should be taken into account (Markopoulos & Bekker, 2003). Not all children respond to interactive technology in the same way. Children's intercourse with technology varies at different life stages, due to their changing interests, characters, humor and contexts. As an example, children around the age of 4 oftentimes like to play games with a fantasy setting and stereotype characters, whereas children around the age of 12 prefer more contemporary concepts and characters that are similar to themselves. To make sure that children are not treated as a homogeneous user group of interactive products, four stages of child development are distinguished below. These stages of development describe the skills, needs and knowledge of children and how technology for children in these age group should be designed.

The dependency/exploratory stage is the first stage of development (ages birth-2 years). In this phase, children experience discovery, exploration and learning. They mostly have physiological, love and safety needs and they prefer parallel play (Markopoulos & Bekker, 2003). In parallel play, children play alongside other children without much interaction with each other. The children play alone, but they are very interested in what other children are doing. Technology that is designed for children in this development stage should be based on simple concepts, stimulate learning and give a feeling of safety. Furthermore, the products should be round in shape, have friendly colors and support active exploration to meet the needs of children in this phase (Markopoulos & Bekker, 2003).

The second stage of development is the emerging-autonomy stage (ages 3-7 years). Children of this age group enjoy fantasy and magic, they are fairly self-centered and they do a lot of parallel play (Markopoulos & Bekker, 2003). They have mostly stimulation, love and safety needs, though they are developing a greater need for autonomy. Simplicity is still a key factor for development in this age group, technology should be based on concepts that are not too abstract. Themes playing in the present and close to home are most appealing (Acuff and Reiher, 1997). Educational games for this age group can be placed in the context of a fantasy world, in which the children have to search for items that enable them to reach a final goal, such as finding something. Along the way, children need to solve riddles and play games that allow them to practice for example basis math, language or logical skills.

The third stage of development is the rule/role stage (ages 8-12 years). The interest of children in this phase gradually shifts from fantasy to reality (Markopoulos & Bekker, 2003). Children become more interested in competition, they learn to play in groups and they start developing a sense of logic and reasoning. Furthermore, they have a need for acceptance and success, there is a shift from a main influence of parents and school to a bigger influence from friends. Technology for children in this age group may be more challenging, complex, varied and competitive. The children become more aware of the age-appropriateness of products and more sensitive to acceptance by their friends. When developing products for children in this age group, the design should therefore be more mature and serious than for younger age groups.

The last stage of development is the early and late adolescence (ages 13 years and up). In this stage children become independent of their peers and parents and they develop their abstract thinking and logical skills (Markopoulos & Bekker, 2003). They have mostly identity and sexuality needs. Between the age of 13 and 15, activities become more socially and goal-oriented. Adolescents can handle problems that are abstract and complex. They mostly relate

with realistic characters and therefore prefer realistic settings. From the age of 14, they are also able to understand more difficult concepts and develop the ability to integrate new ideas, points of views and concepts. Technology for this age group can be very similar to technology designed for adults. The look of the technological products should be mostly realistic and have to contribute to the user's image; the look must correspond to how the user wants to profile himself towards other people (Markopoulos & Bekker, 2003).

As stated before, this study will focus especially on children around the age of 6 to 8. Children in this development stage are in general very eager to learn (Piaget, 1929). They want the knowledge of knowing everything: they become very curious and ask many questions. In addition, getting qualitative education in the early stages of life is essential for future development (Goodyear & Retalis, 2010). According to the Dutch school system children learn how to read and write around the age of 6 (Nederlands Jeugdinstituut, 2015). In this phase children learn a lot of new words, they learn grammatical rules and they learn that words can have several meanings. Moreover, reading stimulates their fantasy and their thinking abilities, which indicates that learning about language is an important basis for cognitive and social development (Nederlands Jeugdinstituut, 2015). It is therefore highly demanded to get more insight in the effects of using interactive technology for the education of this particular age group.

With the help of this study, it will be possible to get valuable insights in the learning abilities of these children when comparing traditional teaching methods to digital teaching methods. Besides, children in this development stage also learn how to think independently and they are developing the basic skills that are necessary for a successful verbal exchange, since their language use becomes more mature. This makes it easier to find out how children think about teaching methods, since they are able to verbalize their thoughts.

2.4 The effect of interactive learning methods vs. traditional learning methods on learning outcomes

According to Shuler (2012), there is emerging interest among scientists in acquiring knowledge about how interactive technology affects the learning achievements of children between the age of 6 to 8 years old. Previous research indicated that the implementation of technology in education promotes student-centered learning practices, which developmental theorists support for early childhood education above more didactic teaching styles (Clements, Sarama & DiBiase, 2003). Traditional didactic teaching styles differ from student-

centered learning in that the focus of instruction shifts from the teacher to the student. The main focus of student-centered learning is that the student develops autonomy and independence by making the student responsible for its own learning path. These findings indicate that interactive technology in general could alter classroom practices and have implications for teaching and learning (Blackwell et al., 2013).

The meta-analysis of Haβler, Major and Hennessy (2015) supports the view that students' learning outcomes will improve when gaining knowledge via education is assisted by technology. In their study, literature reporting the use of tablets for education by primary and secondary school students is reviewed. The aim was to determine if, when and how using tablets in school might impact on learning outcomes. Among twelve highly methodological trustworthy studies that are reviewed, nine studies report positive learning outcomes and three studies report no difference in learning outcomes when children were assisted by tablets. Thus, the majority of the included studies report positive learning outcomes while using tablets for educational purposes, and the affordances of the tablet appeared to be a relevant factor for these results.

However, none of the reviewed studies examined whether the learning outcomes improved more with the help of a tablet when comparing them to the learning outcomes of a control group, in which children got education via traditional teaching methods. The majority of the reviewed studies only compared children's knowledge before extra practice with tablets to their knowledge after extra practice with tablets. Riconscente (2013), for example, investigated whether the iPad game *Motion Math* would improve fouth graders' knowledge of fractions. The results show that their knowledge test scores improved by playing the game for 20 minutes daily over a 5-day period, when comparing the results to a control group that only had regular mathematics instruction without target on fractions. The control group is therefore not representative and comparable to students who learned fractions each day over a 5-day period. Fernandez-Lopez, Rodriguez-Fortiz, Rodriguez-Almendros and Martinez-Segura (2013) also found positive learning outcomes when using their learning platform *Picaa* on mobile devices like the iPhone or the iPad. However, they also did not compare their findings to a control group and their platform was specifically developed for students with special educational needs. These results about learning outcomes therefore cannot be generalized to children in the age group of 6 to 8 years old who go to a mainstream elementary school. The study of Furio, Gonzalez-Gancedo, Juan, Segui and Costa (2013) examined learning outcomes of children between 8 and 10 years old, by comparing the use of an educational game on an iPhone to a tablet. Their results show that the mobile device that is used is not a

decisive factor for learning outcomes. They also had no control group for learning via traditional teaching methods.

Carr (2012) examined the learning outcomes of elementary-aged students around the age of 10-11 years old, and added a control group to the study design. For a period of nine weeks, the experimental group used one-to-one iPads during mathematics while the control group learned via traditional teaching methods. However, at the end of the study there were no significant results found, indicating that there was no difference in learning outcomes between traditional teaching methods and digital teaching methods. This result indicates that there is no added value of implementing technology to traditional teaching methods.

As stated before, there is a lack of knowledge about the affordances of using interactive technology on children's learning outcomes (Shuler, 2012). It is important to know if implementing technology in the classroom is actually beneficial for students' study results. Does the implementation of technology cause better learning outcomes, when comparing to current traditional teaching methods? All previous studies did not compare learning outcomes of digital teaching methods to learning outcomes of traditional teaching methods. Carr (2012) did compare his results to a control group, but the findings were not beneficial for better and more qualitative education. Moreover, the participants in the study of Carr (2012) were older than the target group of the present study. Since education in the early stage of life is essential for child development (Goodyear & Retalis, 2010), more insight in the implications of using tablets for education is highly required. Therefore, the first research question of this thesis focuses on the comparison of learning outcomes of children who learn the same information in the same timeframe in both a tablet teaching condition and a traditional teaching condition.

> RQ1: Do learning outcomes of children between 6 and 8 years old differ when comparing a tablet-based learning method to a traditional learning method?

To make sure that the findings on learning outcomes are reliable, researchers should take the context of the study into account. The context of the study refers to the principal of Ecological Validity: let the users test the product in the natural environment, because this is the context in which they will eventually also use the product (Trivedi & Khanum, 2012). It is assumed that while conducting experiments in the user's natural environment, for example at home or at school, the participants might be more comfortable. Khanum and Trivedi (2013) compared sessions in an experimental lab setting with sessions in the user's natural environment. Children were instructed to express their thoughts by thinking aloud while they were doing a

task with a test product. Next, the amount of verbalization and the behavioral observations were analyzed. The findings indicated that children behaved more formal in the experimental setting than in their natural environment. It seemed that children felt more casual and talked more in their natural environment. In this thesis, the principle of Ecological Validity will therefore be taken into account, and children will be tested in a classroom inside their own school.

2.5 Children's attitudes towards interactive technology

Next to the importance of beneficial learning outcomes, another important aspect of integrating interactive technology in elementary school education is the attitude of the children towards using technology. Even if the learning outcomes of digital teaching methods are very positive, the students of the age group of 6 to 8 years old have to accept these methods for beneficial outcomes. As Berman (1977) stated "Designers of new technologies for children sometimes forget that young people are not 'just short adults' but an entirely different user population with their own culture, norms, and complexities".

The most obvious way to learn about the students' attitudes towards interactive technology is by asking their opinion and evaluating their answers (Borgers, de Leeuw & Hox, 2000). However, there are some challenges regarding the ability of children to verbalize their thoughts and to provide meaningful input about what is going on in their heads. Young children are known for having difficulties verbalizing what they think, especially about abstract concepts and actions (Piaget, 1971; Piaget, 1973). According to Piaget, children's cognitive development evolves in a fixed sequence of stages: (I) development of sensory-motor intelligence, from birth until 2 years old; (II) development of pre-conceptual thought, from 2 until 4 years old; (III) development of intuitive thought, from 4 until 8 years old; (IV) development of concrete operations, from 8 until 11 years old; and (V) formal thought, development between 11 and 15-16 years old. The development of thinking and the ability of verbalizing thoughts differs in each stage, which makes it important to understand the characteristics of each stage when evaluating children (Borgers et al., 2000).

The target group of this study, children between the age of 6 and 8, are categorized in the third development stage. In order to develop useful evaluation methods to find their opinion about learning with tablets or learning traditional, it is necessary to understand their process of thinking and verbalizing thoughts. First of all, when a question such as 'What did you think about the game?' is asked, children in this development stage have to understand the intended meaning of the question to give useful answers. After that, children have to retrieve

relevant information from their memory, for instance of when they were playing, and use this to formulate their answer. Finally, they have to complete their answer, by for example verbalizing their thoughts and choosing a suitable response category (Breakwell, 1995). During the entire process, children in this development stage also evaluate their answers for social desirability and adjust them to their context, as described earlier. Children will demonstrate different behavior in presence of a researcher, a teacher, their parents, or friends. Researchers should take into account that social context might influence the input children provide during an attitude evaluation.

A few recommendations are made concerning the question wording when conducting surveys and interviews with children (Borgers et al., 2000). First of all, questions should be very easy and clear and should include words children use themselves. Furthermore, researchers should be aware that children in the age group of 6 to 8 years old take things very literal. In addition, researchers should pay attention to the non-verbal behavior of children. According to Druin (1999) much of what children 'say' may be in their actions and non-verbal behavior. Next to difficulties in verbalizing and handling questions, children between 6 and 8 years old have a very short concentration span and they might easily lose focus. This has consequences for the reliability of answers; children will give short and satisfying answers when they lose interest in the topic (Vaillancourt 1973, referred to in Borgers et al. 2000). Therefore, researchers should consider shorter or different design and evaluation sessions when working with younger children.

Since children, not teachers or authorities, are the ones who have to learn with interactive products, it is important to know how they feel about using technology for education. When their attitude towards interactive technology for educational purposes is negative, it is unlikely that the integration of technology will be successful. At the moment, almost nothing is known about how children see the use of technology in education, probably because it is taken for granted that children accept these developments. Further research is needed to discover the attitudes of children towards interactive technology to make the integration in education successful. Therefore, this thesis will investigate the attitude of children between the age of 6 to 8 years old towards their experience of learning with interactive technology. In order to properly evaluate their attitudes, it is necessary to consider contextual factors and age specific characteristics. Many tailored evaluation methods for children are developed, in which traditional research methods are adjusted to the capacities of children of this target group. The tailored evaluation methods to answer the following research question of this thesis are described in the next section.

RQ2: What are the attitudes of children between the age of 6 to 8 years old towards using interactive technology for education?

2.6 Evaluation methods to measure children's attitudes

One of the evaluation methods that will be used in this study is observing the children. This means that the researcher observes a child while he or she is using or interacting with a product. There are two types of observations: structured observations and unstructured observations. An observation is structured when the researcher focuses on predetermined constructs that are derived from earlier research or constructs that represent user requirements. An unstructured observation is more open and the researcher focuses more on the whole experience. This can for example be done when a researcher is interested in how children respond to a product or device on a whole (Durrant, Hook, McNaney & Williams, 2013). For example, Durrant et al. (2013) learned about practical challenges of using interactive technology in a group of children with complex needs with the help of their observations. In this study, children will only be observed to discover if there are any problems with the experiment that is especially designed for this study.

Another evaluation method that will be used in this study is conducting an interview. Interviews are post task evaluations in which the researcher asks the child how he or she would evaluate the tested product or device. This method is mostly used to investigate product acceptance. While focusing on product acceptance, the researcher for example asks if the product fulfilled the expectations (Fernaeus, Håkansson & Jakobsson, 2010) and to what extend the child liked or disliked certain features (Lamberty, Adams & Biatek, 2011). By conducting semi-structured interviews, the researcher can ask for elaboration on certain answers given or on events seen during observations. With the help of interviews it can be understood why a child likes and dislikes something and how he or she feels about the whole product and experience (Grunet & Bech-Larsen, 2005). However, there is also a downside on conducting interviews with children. The questions should be the least suggestive as possible, and therefore the formulation should be taken care of. As Druin (1999) stated, children between the age of 4 and 8 take things very literal, so it is possible that the interview questions can direct the child in giving a certain answer. When formulating the questions, researchers should aim to use words that children use themselves. To make sure that the children in this study will understand the interview questions, the questions will be short and simple.

The third evaluation method that will be used for this study is conducting a survey. Most surveys that are used for evaluation these days are conducted via internet tools. However, surveys used for evaluating children are mostly paper-pencil surveys which children have to fill in themselves. The strength of these surveys is that they gather quantitative data about the children's attitudes in a short period of time. In general, surveys are used to measure degrees on how much children like or dislike something (Vanden Abeele, Zaman & De Grooff, 2012). Moreover, surveys are also very suitable to measure product acceptance and product usability. Special survey methods have been developed especially for children, since it is proven that younger children have difficulties reflecting on their attitudes and indicating degrees when filling out a traditional survey (Borgers et al., 2004). The survey methods that are designed for young children present the answer options in a visual way, which make the degrees easier to understand. An example of a visual survey is the smiley-o-meter such as used in Vanden Abeele et al., (2012). This survey method will also be used in this study to make the survey more understandable for children between the age of 6 and 8 years old. However, regardless of the visualized and adjusted questions and answer options, Read and McFarlane (2006) still found that when using a 5- or 7- point survey scale young children tend to give extreme answers to the positive side. The results of the survey used in this study will therefore be checked for biases.

The last evaluation method that will be used to measure the attitudes of children in this study is the This or That method. The This or That method is highly suitable to measure product preference. The procedure of the method is argued to be the least cognitively demanding questioning style for children (Zaman, 2009), since children have to compare two for example two products and point out which one they prefer. The researcher asks a question such as 'Which product would you like to use again?' and the child indicates which one he or she prefers. Vanden Abeele et al. (2012) compared the validity and reliability of the smiley-o-meter survey with the This or That method, and stated that the This or That method is a reliable tool to gather valid responses from children aged four years and older. Therefore, this evaluation method is seen as a valuable tool for this study.

2.7 The importance of teachers' attitudes on the implication of technology in classrooms

The attitude of children is not the only obstacle that should be conquered to successfully integrate interactive technology into the education system. An important factor that hinders integration of technology in education is that there is often resistance by schools, in order to

maintain current teaching practices (Collins & Halverson, 2009). Despite increased access to technology, studies still report the underuse of technology in the classroom, especially in early childhood education (Blackwell et al., 2013). These constraints are not only caused by institutional barriers, such as lack of time and money, but oftentimes teachers encounter personal constraints towards the use of technology.

In terms of the use and acceptance of technology, there are several factors that influence interactive technology use in elementary education (Teo & Noyes, 2008). According to Pelgrum (2001), computer skills and knowledge of teachers are determining factors that withhold teachers from implementing technology in their classrooms. It can be assumed that older teachers are less inclined to use interactive technology during their daily activities, since they grew up in another generation. Therefore, it is possible that younger teachers might have more technological skills and knowledge to successfully add interactive technology to their teaching style. Furthermore, teaching philosophies, attitudes and beliefs, perceived value of technology, comfort with technology and personal use cause more difficulties to change the role of technology in education than institutional constraints (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). According to Ertmer et al. (2012), teacher's own beliefs and attitudes about the relevance of technology had the biggest impact on their success. Most teachers indicated that internal factors, such as passion for technology, and support from others played key roles in shaping their teaching styles.

Given that the majority of teachers are trained in traditional teaching methods, it is important to note that the internalization of the regulations, rules and norms that go along with traditional methods likely influences how they use technology for education (Russel, 2003). Previous research indicated that teacher beliefs and attitudes closely align with their classroom practices (Etmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012), which is also supported by Blackwell et al. (2013). Their study proved that elementary educators who held more positive beliefs about the potential of technology to aid learning practices also used a wider variety of technologies compared to their colleagues with more negative beliefs. They also found that even if people have access to use technology and technical support, they do not use technology unless they possess positive attitudes towards it. It is recommended to refocus teachers and change their existing attitudes and beliefs.

The Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989), displayed in Figure 1, helps to predict if people would accept or reject the use of technology. Acceptance or rejection is determined by people's intentions, and their intentions are explained in terms of attitudes, subjective norms, perceived usefulness of technology and perceived ease of use of

technology. With regards the Technology Acceptance Model, teachers will probably integrate more technology in their daily teaching activities, if they hold positive attitudes towards technology and they see the usefulness of technology.

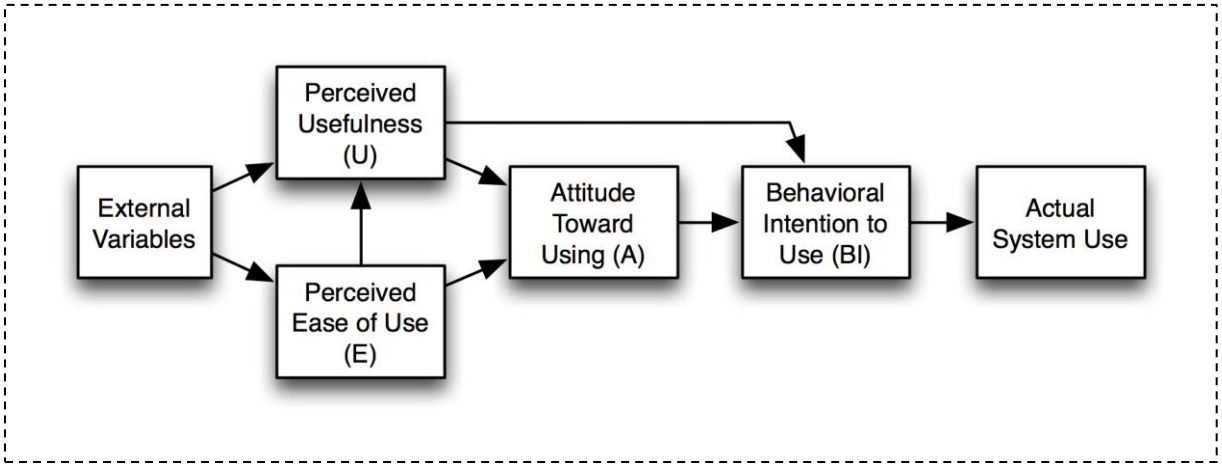

Figure 1. Technology Acceptance Model

It may be clear that teachers can play an important role in deciding whether to use technology in classrooms or not, depending on their attitudes. However, little is known about the actual attitudes of teachers towards the implementation of interactive technology for educational purposes. Since these attitudes are important to successfully integrate technology in the education system, studies need to focus on how teachers think about using technology in their classrooms and how they want to use interactive technology in the future. This thesis' final research question will therefore give more insight in the attitudes of the teachers towards interactive technology.

RQ3: What are teachers' attitudes towards using interactive technology for educational support?

3. Method

This chapter gives insight in the methodology of the present study. The chapter consists of a detailed outline of the participants, the experimental design, the materials and the procedure.

3.1 Participants

A total of 24 children between 6 and 8 years old were recruited from an elementary school in the south of the Netherlands. Out of these participants, 16 children were in class 3 (age: *M* =

6.31, *SD* = .48) and 8 children were in class 4 (age: *M* = 7.25, *SD* = .46). The classes refer to the Dutch school system; kindergarten is the same as class 1-2, class 3 is the year in which children start with education. Before the start of the experiment, parents received a consent form and extra information about the study (Appendix I). All children got permission to participate in the study anonymously.

All participants were asked if they had prior knowledge about the English words for colors or animals. Three of the children had prior knowledge about the colors and therefore were excluded from the sample during the color tests. None of the children had prior knowledge about animals. During the last week, one child was sick so she did not attend the evaluation session in the last week of the experiment.

3.2 Experiment design

The study lasted a total of three weeks, divided into two weeks of learning and one week of evaluation. The experiment in the first two weeks focused on learning English with a tablet-based method or a traditional method. Before the start of this experiment, children of class 3 and 4 were randomly divided into two groups (Figure 2).

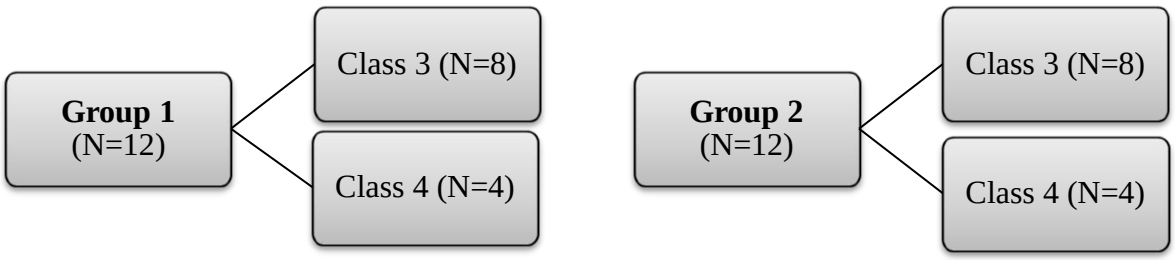

Figure 2. Participants were divided into two equal groups

This design of this study's experiment was both between participants and within participants (Table 1): 2 (group: 1 vs. 2) x 2 (method: tablet vs. traditional) x 2 (subject: colors vs. animals), with group as a between participants factor, and method and subject as within participants factors. Group 1 and group 2 were both as well in the tablet-based condition as in the traditional condition. Furthermore, they also both learned the English words for colors and animals. However, the groups did not learn about the same subject in the same condition.

During the first week, participants in group 1 had to learn the English words for colors with the help of the tablet-based method. Group 2 had to learn the English words for colors via the traditional method. In the second week, group 1 had to learn the English words for

animals via the traditional method and group 2 had to learn with the help of the tablet method. This division per week and per condition is shown in Table 1. In the third week of the experiment, children were asked to evaluate the learning activities. All children went through the same evaluation methods.

Table 1. The experiment design in week 1 and 2

	Week 1 – subject: colors	Week 2 – subject: animals
Tablet condition	Group 1	Group 2
Traditional condition	Group 2	Group 1

3.3 Procedure and materials

Before the start of the experiments, the researcher introduced herself in the classroom to all children to reduce possible anxiety or shyness. A separate, quiet space inside the school building was set-up with a table with an iPad, traditional learning cards, a laptop and a notebook for observations. The experiment took place in this room to make sure that the experiments took place in a natural school environment and to make children feel more comfortable. The children were brought to the room one at a time and were asked to take place on the seat next to the researcher. The laptop, with audacity installed on it, was used to record the audio fragments of all learning and evaluation sessions.

The children were told that they would take part in a English-learning project for three weeks. In the first two weeks, children visited the researcher every Tuesday and Thursday for 10 minutes per day. At the beginning of both Tuesday sessions in week 1 and 2, children were told that this week they were supposed to learn either with the traditional method or with the tablet-based method. Furthermore, children were also introduced to the learning subject: colors in week 1 and animals in week 2. All children in the tablet condition received limited instructions on how to use the tablet and what they could expect from the exercises, since the tablet game gives these instructions. Children in the traditional condition were extensively explained what they could expect from the learning sessions. The following section describes the procedure of both learning methods.

3.3.1 Tablet-based method

The Pili Pop application was downloaded on an iPad and used as learning method in the tablet-based condition. Pili Pop is designed to help children become bilingual by practicing their English oral skills. Therefore, this application is based on oral practice and is suggested

for children aged between 6 and 8 years old. Pili Pop can be installed only on Apple devices by downloading the app via the App Store. The content of the application consists of 24 engaging games and more than 350 English words. The available games are interactive in a way that they direct and encourage users to play and respond to what is shown on the screen.

For this study, two Pili Pop games were selected. The goal of the first game is to teach children 11 English words for colors, playing together with character Jamie. The colors that they learn are: pink, blue, black, yellow, purple, orange, red, grey, green, brown and white. The goal of the second game is to teach children 10 English words for animals, playing together with character Zack. The animals that they learn are: cat, dog, bird, fish, rabbit, mouse, turtle, guinea pig, hamster and parrot. The subjects colors and animals were chosen because they relate to the interests of children in this age group. Depending of the subject in week 1 or 2, the child enters a new menu in which he or she can choose from 6 exercises: three hearing exercises and three speaking exercises (Figure 3). Game number 1 represents the most simple exercise, game number 3 represents the most advanced exercise. Every exercise is begins with a small instruction video, which explains the children how to play the game. Children in the tablet condition were instructed that they were free to choose which of these six exercises they wanted to play.

In the three hearing exercises of the color game, children had to play color-memory by combining color cards with ‘sound’ cards (Figure 4). In the three speaking exercises, children were asked to say the right name of the color of the painting (Figure 5). In the three hearing exercises of the animal game, children had to feed sick animals to make them feel better. They had to combine the right food box with the right animal (Figure 6). In the three speaking exercises, children were asked to say the right name of the animal who needs an x-ray (same principle as Figure 5). Every hearing and speaking exercise lasts 90 seconds, which is indicated with a count-down in the upper left corner. During these 90 seconds, children collect points by giving the right answer. The total number of collected points was also displayed in the upper left corner. Children were, according to their total number of collected points, rewarded with 1, 2 or 3 stars after each exercise.

Figure 3. Six games to choose from

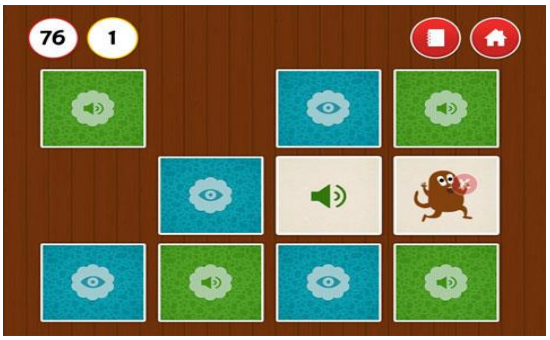

Figure 4. Color hearing game

Figure 5. Speaking exercise

Figure 6. Animal hearing game

3.3.2 Traditional method

In the traditional condition, stimuli from the Pili Pop application was used to design the traditional learning method. All images of the colors and the animals that were presented in the games in the Pili Pop application, were printed and cut into paper cards (Figure 7). Some of the learning principles of the application were also imitated in the traditional method, to make sure that both methods have the same goal. First of all, the researcher introduced children to every exercise and explained that they would learn to hear and speak. Then, the researcher showed the paper cards and chatted with each child about, for example, their favorite colors or animals to make them feel more comfortable.

Thereafter, the researcher started with hearing exercises, because hearing was also presented first in the tablet application. Children practiced hearing by pointing out the right card when the researcher mentioned the English word for a color or an animal. When children recognized most colors or animals by hearing the English words, the researcher shifted to speaking exercises. Speaking was practiced by letting children mention the right color or animal that was pointed out by the researcher. Each hearing or speaking exercise started with a set of 3 to 5 cards (Figure 7). The difficulty of the exercise was increased by adding more colors or animals to the card set, until the children knew all the right answers (Figure 8). This

method was developed to create an increasing difficulty of exercises, such as in the tablet game.

The researcher focused most on hearing in the Tuesday sessions and on speaking in the Thursday sessions, to make sure that children would achieve decent results in both hearing and speaking. When children experienced difficulties with recalling the right color or animal, the researcher took more time to practice the most difficult words at the end of the session. All difficult cards were taken apart and practiced until the child had the feeling that he or she could recall all of them. Independent of wrong or right answers, children always received feedback from the researcher, such as ‘good job’, ‘are you sure?’ or ‘you can do this’. The goal of the feedback was to motivate children to achieve the best results and to learn them as much as possible. This is the part where the traditional method shows some important differences with the tablet-based method. In a tablet-based learning setting, children work individually on their tablet, they are free to choose their exercises and they receive less personal assistance and feedback from a teacher. In a traditional learning setting, a teacher decides what children are learning and children receive more personal assistance and feedback.

Figure 7. Traditional learning method

Figure 8. Total card set traditional method

3.4 Knowledge tests

After the learning sessions of both colors and animals, children’s knowledge was tested individually in the beginning of the next week. Knowledge of colors was tested in week 2, just before the start of the Tuesday session. Knowledge of animals was tested in week 3, also just before the start of the Tuesday session. A custom made knowledge test was designed specifically adjusted to the contents of the tablet-based and traditional learning methods

(Appendix II). First, all cards that were used for the traditional condition were sorted on the table as in Figure 8. Thereafter, in the first part of the knowledge test, the researcher asked the name of 5 colors or animals by pointing out the particular images. The child had to pronounce the right English word. In the second part of the knowledge test, the researcher pronounced the words of 5 particular colors or animals, and the child had to point out the right image. The test results were not shared with the children, they were all told that they did a very good job.

3.5 Evaluation methods

After all learning sessions and knowledge tests, children's attitudes were evaluated in week three. When children entered the experiment room in week three, they were told that this session was be the last session of the project, and that I wanted to know how they experienced the learning exercises. This section presents the materials used during the evaluations.

Each child started with a printed survey, followed by an interview and finally the *This or That* method. The questions of all these evaluation methods were designed to measure attitudes towards using tablet-based learning methods and traditional learning methods. Next to measuring the attitudes towards the learning conditions, the aim of all the evaluation methods was to make the evaluation feel natural. To do so, the language that was used in the questions was adjusted to a level that children would understand. Below, the materials of the survey, the interview and the *This or That method* are presented. Please note that the evaluations were in Dutch, all materials are translated for the purpose of this thesis.

3.5.1 Survey[1]

The printed survey focused on measuring which learning method children prefer or liked the most. The first two statements were scored on a 7-point smiley-o-meter, the last four statements were scored on a 5-point smiley-o-meter (Appendix III). An example of a survey statement that was used in the present study is: 'I liked learning English with the tablet'. The statements and the use of the smiley-o-meters were based on previous research (Zaman et al., 2011).

3.5.2 Interview

The five interview questions served as leading questions to get more insight in the children's' attitudes towards several concepts (Appendix IV). The questions are based on the learning

[1] Note: It was decided to delete 9 items from the survey after the evaluation sessions, because they were found to be less interesting for the purpose of this study (Appendix III).

experience, the method preference and the subject preference and question whether the child had a positive or negative attitude towards these constructs, followed by 'why?' or ‘what?’ questions based on Zaman et al. (2010). Note that interview responses were encoded for analysis (Appendix V).

3.5.3 This or That method

This method was based on Zaman (2009) and questioned method preference (Appendix VI). The questions were to a large extent in accordance with the questions asked in the interview and survey and measured the children’s attitudes towards learning methods. For each question, children had to choose between either the tablet-based method or the traditional method, represented by pictures of the tablet and the traditional method printed on two cards. Following Zaman et al. (2011) children had to indicate a preference. If a child answered 'I don't know', 'both' or 'none', the researcher asked which game the child would pick if he or she really had to choose.

3.6 Procedure and materials of teachers’ interviews

After the three experiment weeks in which children’s knowledge and attitudes were tested, the researcher interviewed four teachers and the principal of the elementary school. Two teachers were responsible for class 3 and 4, two other teachers were in the schools’ IT-workgroup, together with the principal. The goal of the interviews was to figure out how teachers and the school management think about the use of interactive technology in the classroom. Teachers were interviewed in the same room as the experiments took place, and all conversations were recorded with an audio recorder. First, every teacher was introduced to the study and the findings were presented. Thereafter, teachers were asked to give extensive answers to 4 interview questions, which can be found in Appendix VII. After the interviews, teachers were thanked for their contribution.

4. Results

This section will first show the results that were found with the help of the knowledge tests. Thereafter, the results of the three evaluation methods will be presented, followed by the results of the teachers’ interviews.

4.1 Knowledge tests

During the three-week experiment, 24 children between the age of 6 and 8 years old learned the English words for colors and animals. After each child finished the learning period for both colors and animals, their knowledge about these words was tested.

Four statistical test were run to answer RQ1: 'Do learning outcomes of children between 6 and 8 years old differ when comparing a tablet-based learning method to a traditional learning method?'. First of all, it was tested if there were knowledge differences between the two groups. An independent samples t-test was conducted to compare the overall number of correct answers between group 1 and group 2. There was no significant difference found between the scores for group 1 (M = 14, SD = 2.97) and the scores for group 2 (M = 14, SD = 3.51); $t(19)$= .00, p = .999. This result indicates that there was no difference between the learning performances of children in group 1 and group 2.

Next, the learning outcomes for both the tablet-based method and the traditional method per learning subject (i.e. colors or animals) were examined. The first independent samples t-test was conducted to compare the number of correct answers for the color subject between the tablet-based condition and the traditional condition. A significant difference was found between the number of correct answers in the tablet-based condition (M = 6.00, SD = 1.90) and the number of correct answers in the traditional condition (M = 8.00, SD = 1.89); $t(19)$= -2.42, p = .026. This result indicates that children gave more correct answers in the traditional condition than in the tablet-based condition when they learned the English words for animals.

The second independent samples t-test was conducted to compare the number of correct answers for the animal subject between the tablet-based condition and the traditional condition. A significant difference was found between the number of correct answers in the tablet-based condition (M = 6.33, SD = 1.92) and the number of correct answers in the traditional condition (M = 8.00, SD = 1.67); $t(21)$= -2.21, p = .038. This result indicates that children gave more correct answers in the traditional condition than in the tablet-based condition when they learned the English words for animals.

Finally, a paired-samples t-test was conducted to compare the total number of correct answers in the tablet condition to the total number of correct answers in the traditional condition. A significant difference between the scores for the tablet condition (M = 6.0, SD = 1.84) and the traditional condition (M = 8.0, SD = 2.01) was found; $t(20)$= -5.48, p = .001. These results indicate that children gave more correct answers in the traditional learning condition than in the tablet-based condition, independent of the learning subject.

4.2 Measuring Attitudes

Three evaluation techniques were used in this study to answer RQ2: 'What are the attitudes of children between the age of 6 to 8 years old towards using interactive technology for education?'. The results of the surveys, the interviews and the *This or That methods* will be described in the following section.

4.2.1 Survey

A survey was conducted among all children to examine their method preferences and learning experiences. The first thing the survey measured was children's preference towards a learning method, i.e. liked learning English with the tablet and liked learning English with the cards (= traditional method). A paired-samples t-test was conducted to compare the answers on method preference for both the tablet method and the traditional method. There was no significant difference between the answers for the tablet method (M = 1.6, SD = 1.03) and the traditional method (M = 2.0, SD = 1.15); $t(22)$= -1.34, p = .195. This result indicates that children liked learning English with the tablet as much as with the traditional method.

The next thing the survey measured were learning experiences, i.e. learning English is easier with the tablet than with the cards and learning English is easier with the cards than with the tablet. Children answered the question a 5-point scale, ranging from 'Totally true' to 'Totally not true'. A paired-samples t-test was conducted to compare the answers on learning experiences for both the tablet method and the traditional method. There was no significant difference between the answers for the tablet method (M = 3.3, SD = 1.45) and the traditional method (M = 3.0, SD = 1.30); $t(22)$= .58, p = .570. This result indicates that children found learning English with the tablet as easy as learning English with the cards, regardless of the subject colors or animals.

The third survey measurement was again about method preference, but this time about method preference at home. This question was also answered on a 5-point scale. A paired-samples t-test was conducted to compare the answers on method preference for both the tablet method and the traditional method. A significant difference is found between the answers for the tablet method (M = 4.0, SD = 1.31) and the traditional method (M = 3.1, SD = 1.25); $t(22)$ = 2.08, p = .050. This finding indicates that when children are at home, they prefer learning English with the tablet over learning English with the traditional method.

4.2.2 Interview

All children were interviewed to get more in depth responses about their method preferences, subject preferences and how they experienced the learning activity. The categorization and summary of the responses per subject is given in the following section.

The learning activity

The purpose of the first interview construct was to find out how children thought about learning English. An analysis of the responses gave more insight in how the children thought about participating in this project. The analysis showed that all children who participated in this project indicated that they enjoyed learning English. The majority of the children responded that they liked learning English because it is new to them, or because they always wanted to learn some English words. Only one child was not able to indicate why she liked learning English.

[Child 6] 'Yes, because we often go on holidays to countries where people speak English, and most of the time I have to ask dad or mum about everything, but now I know some words myself, then I don't have to ask them again'

[Child 20] 'Yes, because in this way I learn a lot of new English words'

The learning methods

The second construct gave more insight in the children's preference for teaching method. The children were asked which teaching method they liked the most. In total, 12 children (52.17%) indicated that they preferred learning with the tablet over learning via the traditional method. For instance because they liked the fact that they could play games, or because of the interactive features.

[Child 16] 'Tablet, because I could play a game and I could talk more often'

[Child 24] 'I liked the tablet sooo much, because the animals came on screen on the tablet and then I could say which animal it was!'

Only 6 children (26.09%) indicated that they preferred learning via a traditional method over learning with the tablet. Most children preferred the traditional method because they could practice together with the researcher, others were not able to indicate why they preferred the traditional method.

[Child 4] 'Cards' [Researcher] 'Can you tell me why?' [Child 4] 'I find it hard to say, … , I liked practicing with you'

[Child 5] 'With the cards, because we could work together. And it was also handy that you could help me when I needed some help. With the tablet it was not really possible to work together, I had to find out everything myself'

Five children (21.74%) did not prefer one method over another. The main reason is because they liked both methods, since they learned new things in both methods.

[Child 2] 'Both, because in both ways I could learn new things'

[Child 8] 'I liked them both. I liked the fact that with cards I could point out things myself etc., and with the tablet I could slide with my finger. I liked the fact that they both had a different way of working'

The final construct was not about method preference, but children were asked from which method they have learned the most. In total, 6 children (26.09%) indicated that they learned the most from the tablet, 14 children (60.87%) indicated that they learned most from the traditional method and 3 children (13.04%) indicated that they learned most from both methods. The first children that were interviewed were asked why they learned most from a particular method after giving their response, but none of them was able to give a reason. Since the children were struggling so hard, it was decided to stop asking why. However, a few children gave a reason by themselves.

[Child 19] 'From the cards, because I performed better with the cards than with the tablet'

[Child 21] 'From the tablet, because I did not now pink and now I know it!'

The subject

The purpose of the third construct was to check whether children had a strong preference for a particular subject: colors or animals. If the majority of the children would have a preference, it could be that they scored better while being in that condition. However, it turned out that there were no large differences in subject preference. In total, 8 children (34,78%) indicated that they preferred colors, 9 children (39,13%) indicated that they preferred animals and 6 children (26,09%) indicated that they liked both colors and animals. All children were asked

to explain their answer option, but most children were not able to give clear reasons why they preferred one subject over another. Only a few children were able to explain themselves, but there was no trend found in why they had chosen that answer.

[Child 2] 'Both, because I didn't knew the colors and the animals'
[Child 12] 'Colors, … , I liked the words'

Learning experience

The fourth construct of the interview gave more insight in whether the children found that they learned something during the project, since the intention of the study was to measure learning outcomes. In total, 22 children (95.65%) indicated that they have learned something from the experiment days. The majority of the children responded that they have learned something because they have learned a new language, because they have learned new concepts and because they have learned not only the words but also how to pronounce them. One child indicated that he did not learned anything, but it is doubtful if he really understood the question. When he was asked why he did not learn anything, he indicated that he only learned the animals. Only animals is of course also something that he has learned.

[Child 5] 'Yes, many new words'
[Child 21] 'Yes, well uh, uhh, I have learned how to call the animals and uhh, the colors. And I liked it a lot!'

4.2.3 This or That method

The *This or That method* consisted of 8 items in total. The first part of the items, such as 'which method was the most fun' and 'which method was the most difficult', were used to measure which learning method children preferred. The last part of the items, such as 'which method made you learn the most', were used to measure the children's learning experiences. The results of all constructs can be found in Table 2.

Table 2. This or That method frequency distributions and Chi-Square tests

	Tablet	Traditional	χ^2	*p*
Method preference	N (%)	N (%)		
Most fun	17 (73.9%)	6 (26.1%)	5.25	.022*
Most difficult	8 (34.8%)	12 (52.2%)	0.80	.371
Use again	13 (56.5%)	10 (43.5%)	0.39	.532
Most stupid	7 (30.4%)	11 (47.8%)	0.89	.346
Use at home	11 (47.8%)	11 (47.8%)	0	1.00
Most boring	7 (30.4%)	12 (52.2%)	1.31	.251
Learning experience				
Learn most	5 (21.7%)	18 (78.3%)	7.35	.007*
Performed best	11 (47.8%)	11 (47.8%)	0	1.00

N = 23, missing N were not able to indicate a preference. *$p < .05$

Frequency distributions show that a significant larger part of the children indicated that they had most fun with the tablet-based method (73.9%), in comparison to the traditional method (26.1%). Furthermore, frequency distributions show that the traditional method was also found to be most difficult method (52.2%) in comparison to the tablet-based method (34.8%). Children responded that they found the tablet-based method (30.4%) less stupid than the traditional method (47.8%). The tablet-based method was also found to be less boring (30.4%) than the traditional method (52.2%). However, these results of the last three statements are not significant.

Even though most of the children indicated that they found the tablet-based method more fun, there are no significant differences between the methods that the children want to use at home (both 47.8%). However, they preferred using the tablet-based method again (56.5%) over using the traditional method again (43.5%), but this result is also not significant. Furthermore, a significant larger part of the children (78.3%) indicated that they learned the most from the traditional method, in comparison to the tablet-based method (21.7%). However, when they were asked to indicate with which method they performed best, there were no significant differences between the tablet-based method and the traditional method (both 47.8%).

4.3 Interview with teachers

After the three-week experiments with children, five teachers were interviewed to answer RQ3: 'What are teachers' attitudes towards using interactive technology for educational support?'. The teachers were asked to give their opinion on the results that were found in this study and on the use of digital technology and digital methods in the classroom. Furthermore, they were asked how they would see their ideal teaching methods with regards to digitalization of the classrooms. Their findings will be presented in the following section. The teachers' responses were not quantified and translated into frequencies, since only 5 teachers were interviewed.

The first construct considered the teachers' opinion about the significant difference in learning outcomes between the tablet-based method and the traditional method**.** In general, teachers indicated that they expected this outcome or hoped for this outcome, because they find the role of the teacher still very important. It is the teacher who involves the children in the actual learning and gives feedback when needed. Digital technology cannot replace the function of the teacher, it is only suitable for extra practice.

[Teacher 1] 'This outcome seems logical to me, I expected this outcome. I think it is the power of the teacher to keep the children involved, for example by raising their voice. The tablet calls on the independence of the children, but being involved with the assignment is more intensive when the teacher helps the child to focus. The power of the teacher is that he or she can register the non-verbal behavior of a child, they can see when they are paying attention or when they find it too easy or too difficult. Teachers can adjust to this information by involving the child or give extra explanation. In this way, you can make sure that most of the children are paying attention to what is taught, and I see that as an added value of the teacher in comparison to a tablet.'

[Teacher 3] 'I think that when children have to learn 'live' and they can hear you speak, and look at you, can ask you something: that makes it more tangible. There is more communication, and that is especially needed for younger children. Your feedback and communication probably led to better results in the traditional condition.'

[Teacher 5] 'I was hoping for this result. I am not in favor of learning via tablets. I was hoping that you would find that the teacher is still necessary to transfer knowledge and that they would learn more from the teacher than from the tablet. I think that the feedback of the teacher is very important. The tablet only shows when something is

wrong or right, but then keeps going with its program. As a teacher you can respond to the needs of the child, you can help them when needed and you can give them more feedback.'

The teachers were also asked in what kind of scenario the experiment would have led to better results in the tablet-based condition. Most teachers stated that the children first need to be familiarized with the subject via traditional teaching methods. For example, the teachers need to discuss the subject in class before the children will practice with computer or tablet software.

[Teacher 4] 'I think that as a teacher, you first have to give oral instructions to give a particular context. The teacher can be very explicit: name the subject, pointing at the subject, telling stories around the subject etcetera. After those instructions you maybe give another instruction movie on the tablet, and after that the children will work with the tablet. The pre-instruction of the teacher is very important.'

[Teacher 5] 'I think that there is a need for combination. First the children will get instructions about the subject from the teachers, and after that they can practice on the tablet. Children should always get background information and instructions from the teacher, but they can practice on devices like computers or tablets. In this way the teacher controls the situation, but on the tablet they can practice at their own level. Those two things should be combined.'

Another construct in the interview examined how teachers think about the use of digital technologies in the classroom. In general, the teachers see digital technologies as a great added value to their teaching practices. Digital technology serves as an extra and interactive dimension to teaching: the transferring of knowledge can be supported by for example movies, sound, games, quizzes etcetera. Adding digital technologies to existing teaching methods also prepares the children for using technology in the future.

Furthermore, the teachers were asked what kind of specific contents are taught with the help of digital technology at their elementary school. In all groups except for kindergarten, there are digital methods used for literacy and mathematics. These methods are available to use with digital devices such as the *digiboard* or the computer. However, since each classroom only has two computers available, the children can only spend around 10 to 15

minutes per day on practicing with a digital device. There also digital methods available for the other courses, but unfortunately it is too expensive to purchase them.

[Teacher 1]'Digital technologies serve as an added value. The digiboard that is used in all our classrooms serves as an important support for instruction, but also for imagery and sounds. There are so many ways to keep the lessons interesting. This digiboard can also function as a great way to give more direct feedback to the children. When all the kids solve 10 questions, the answers can be shown on screen immediately. In this way children directly see what they have done wrong, which has a great added value to existing methods.

[Teacher 2] 'I find it great to work with digital technologies to move on in education. Some things you want to explain are not within reach, but you can explain it or show it on the basis of digital technology. In this way you immediately reach your goal and it is clear to the children. I think that it is important that children experience these kinds of technology. We have special digital methods for literacy and mathematics. These ` methods come together with the traditional methods such as books, so they fit perfectly together.'

The next construct considered how teachers experience children's' view on the use of digital technology in classrooms. The teachers stated that children are very excited about using technology. In their opinion, technology is not yet used enough and they would love to use it more on a daily basis. Children also find the use of technology in classrooms a matter of course, they cannot compare their current lessons to older and more traditional lessons from 15 years ago. With the help of technology it is possible to keep children involved and they are more willing to pay attention.

[Teacher 1] 'Children see the use of technology as a matter of course. They cannot compare to 10 years ago, it is something that is normal to them. And probably, they are a step ahead with the use of technology at home. Unfortunately we cannot provide them enough technology at this point, there are no resources for that.

[Teacher 3] 'The children love to interact with technology. If they had to choose they would use digital devices all day long. When it is not possible to work on the computer that day, they always want to catch up with their computer-time another day.'

[Teacher 5] 'Children find technology very interesting. For example when I was teaching the children about which animals come out of an egg, I show them a movie of a chick coming out an egg. There are other ways to show them the process: with words, or with gestures. But a movie that I can show on the digiboard is much more interesting to them.

The teachers were also asked to give more insight in their opinion about the digital methods that they use for education. In general, they are very satisfied with the existing methods, because they are easy to use and are available for both *digiboards* and computers. In this way, teachers can explain the content with the help of the *digiboard* and the children can practice with the help of the computer. The only problem that they face is money to buy more methods. They are looking forward to adjust more lessons to digital methods, but the school has not enough resources to supply all classes with extra methods. According to teachers, the only downside of digital methods is the vulnerability of the system.

[Teacher 3] 'I really see a great advantage in using digital methods, but only when the system does not fail. Sometimes when it does not work, it is very hard to continue the lessons. But in general I think that the methods are very fun and easy to work with and they fit the needs of the children. For example, with the help of technology it is also easier to teach children about the threats of using internet/social media, which is an extremely important topic these days.'

[Teacher 4] 'The software that is used for the computers and digiboards fits in perfectly with the books and the workbooks that the children work with. Technology also functions as an extra tool which makes some parts of teaching a lot easier, for example reviewing tests. When children can make a test online, the computer calculates their score and can indicate the most suitable exercises per child. But I think it is still very important that teachers keep their role so that they can form the way in which children are able to use technology.'

Finally, the teachers had to describe their ideal image of using digital technology for education in the future. All teachers indicated that they would definitely let children use digital devices more often. The overall idea is that children should come together with a teacher for instructions about content they have to learn. The teachers could for example give more context, more in-depth information, feedback and personal instructions. After these

lessons, children should go practice with the content on their own device, on their own pace and their own level. In this way teachers want to give children the opportunity to work on their individual development at their own level. Unfortunately, money is still the main problem in realizing this type of teaching, which is the reason why teaching at this elementary school remains a little old-fashioned. The management of this school agrees on the fact that implementing more digital technology is needed, but the financial resources are limited.

[Teacher 3] 'In my opinion it is important to be more responsive to individual development. I do not know how to design this idea, but I think that there should be a lot more devices available for each child to work on. Children should always have digital devices available, on which they can work individually. In this way, we can make sure that each child is working on its' own level. I do not have preference for tablets, laptops or computers, I just think that there should be enough of them.'

[Teacher 4] 'In the end, I think that there should be a combination of central instruction and individual development. First, children should receive their first introduction to a subject via a teacher. This adjusts to the team spirit, children should still be able to function in a group. It is risky that with the use of individual technology, the children get too involved in their own world and forget how it is like to behave in group context. I see education as a mix between group context and general instruction and practicing and interacting a lot with digital devices.'

5. Conclusion and Discussion

This section will first present the conclusion of this study, based on the results from the previous section. Subsequently, all results will be discussed in detail. Both the implications and limitations of this study and recommendations for future research are presented in the end.

5.1 Conclusion

This thesis' study aimed to investigate if children's learning outcomes are better when they are learning with an interactive tablet-based learning method or when they are learning with a traditional method. The results showed that learning outcomes were significantly better in the traditional learning condition in comparison to the tablet condition. Furthermore, this thesis aimed to test the attitudes of children and teachers towards the use of interactive technology

for educational purposes. With the help of three different evaluation methods, it was found that children hold more positive attitudes towards the tablet-based learning method than towards the traditional learning method. Teachers that were interviewed also held positive attitudes towards the use of technology for education, but only if the central role of teachers remains the same.

5.2 Discussion

5.2.1 Knowledge tests

This thesis' first research question was: 'Do learning outcomes of children between 6 and 8 years old differ when comparing a tablet-based learning method to a traditional learning method?' The results of the experiment showed that children gave more correct answers while they were in the traditional condition than while they were in the tablet condition. This means that the learning outcomes of children between 6 and 8 years were better when they learned with the help of the traditional method than when they learned with the help of the tablet method.

The findings of this study are not in line with findings of previous studies. Risconscente (2013), Fernandez-Lopez et al., (2013) and Furio et al., (2013) for example, found that children's knowledge about learning concepts improved after intensively learning with a tablet application. However, these studies did not compare the learning outcomes of the tablet condition to the learning outcomes of a control group: children who intensively learned particular concepts with the help of a traditional method. The present study also found that children's knowledge improved after learning English with the tablet, but knowledge of children improved more when they learned English in a more traditional way. It makes sense that knowledge increases when children learn something with the help of a tablet, but it does not directly indicate that this learning method is also appropriate for educational purposes. This thesis therefore shows the importance of comparing one learning method to another, when making decisions about which method is most suitable and efficient for education.

One important reason for the difference between learning outcomes in this study could be the involvement of the researcher. During the experiments, the researcher fulfilled the role of the teacher. In case of the traditional method, the researcher was able to anticipate to each child and adjust the level of difficulty when needed. The tablet game has a fixed order and pace of providing stimuli and therefore, the tablet does not allow for individual needs. Furthermore, children in the traditional condition were interacting with the researcher during

the entire learning time. Children received feedback and assistance while being in the traditional condition, children in the tablet condition were expected to work independent. It is possible that young students, around the age of 6 to 8 years old, benefit from interacting with teachers and depend on their guidance while learning new information. However, in the present study, the researcher possibly paid individual attention to each child more intensively than a teacher pays attention to all children in a classroom setting. This research setting may not be fully representative for a realistic classroom setting, but this method was chosen to show the important difference between traditional learning methods with assisting teachers, and tablet-based methods with less assistance and more individual decisions. More research is needed to investigate if it was the researcher's guidance and feedback which leads to better learning outcomes, for example by making two traditional control groups. One group will receive a lot of personal assistance and feedback from a teacher, the other group will receive as much feedback as in a real classroom setting. Future research should also investigate if older children benefit as well from the help of a teacher, or that they perform better than younger children when they have work independently. Children around the age of 10 to 12 years old might achieve better learning outcomes in the tablet condition in comparison to the younger age group, for example because they might be better in working autonomously with a tablet or because they need less instruction from a teacher.

Another reason that could explain why children in the traditional method achieved better results is that participants in this study were not used to working with the tablet in a school environment. Children who participated in this study never interacted with a tablet for educational purposes before. Even though learning English, as well as the custom made traditional learning method, was new to all participants, working with the tablet might need more instruction and practice to achieve successful learning outcomes. Further research is needed to investigate if more practice with tablets leads to better learning outcomes in the tablet condition, for example by giving each child a short instruction and practice time before the start of the experiment.

5.2.2 Children's attitudes

The second research question of this thesis was: 'What are the attitudes of children between the age of 6 and 8 years old towards using interactive technology for education?' Three different evaluation methods were used to measure children's method preference and learning experiences.

Method preference

With the help of the survey, the interview and the *This or That* method, this study found that children prefer learning with the tablet over learning with the traditional method. This result is interesting, since children achieved better learning outcomes in the traditional condition. First, two reasons will be given why children possibly had a preference for the tablet based method. Furthermore, the discrepancy between the findings of the knowledge tests and the children's attitudes will be clarified.

One reason why children prefer the tablet-method could be that they are used to play with the tablet during their leisure activities. All children who participated in this study were asked if they, or their parents, own a tablet at home and if they are allowed to play games on this tablet. All children indicated that they own a tablet at home, and they were all allowed to play games on their device. Since most children from 6 to 8 years old usually use their tablet for social- and entertainment activities (Holloway, Green, & Livingstone, 2013), the participants in this study might reviewed the tablet-based method as more fun than the traditional method because they related the tablet-method to their leisure activities at home. The traditional method possibly related to more familiar school activities, which might be less attractive than activities with focus on entertainment. The results of this thesis' survey seem to supports this view. Participants were asked which method they would like to use again when they would learn English at home. The majority of all children responded that they would prefer to use the tablet-based method again in their home environment, which could indicate that they see playing the tablet game as a more suitable activity in their leisure time. However, more extensive research is needed to decide whether children prefer the tablet-based method because they see it as entertainment, or because they actually rate the use of a tablet as a more successful learning method.

The second reason for the tablet-method preference could be that children liked the tablet game, Pili Pop, more than the cards that were designed for the traditional method. During the interview, the majority of the children indicated that they preferred the tablet-based method because it is a game and it has interactive features. The traditional method was less interactive than the tablet game: the tablet game has sound features, moving images and it gives rewards after any achievement. Furthermore, the tablet game asks children to use their voice to talk and to use their hands to swipe and click, which makes the game even more interactive. In contrast to the tablet-based method, the traditional method was a lot more static, which could be less attractive to young children. The researcher tried to make the traditional condition similar to the tablet game and also added interactive features or rewards,

but it was unlikely to match the interactivity of the tablet game. For example, in the animal game children could hear the background sounds that animals make and they were asked to feed the animals to make them feel better. After giving the right animal its food, the animal makes a happy sound and the game gives the child a reward. For the researcher it was impossible to copy all those interactive features to the traditional method.

The last reason, about the interactivity of the tablet-based method, opens doors to the explanation why children performed better in the traditional condition, but preferred learning with the tablet-method. In the study of Plowman and McPake (2013), it was found that some of the educational products that are available to young children use the concept of interactivity as a cover to claim they can accelerate the process of learning. Their interactivity might provide more motivation for learning, but it rarely improves actual learning and educational potential. The interactive aspects of for example tablet applications can actually be an impediment to learning if children do not completely understand what they are supposed to do. Moreover, technological interactivity is not comparable to human interaction (Plowman & McPake, 2013). For example, existing technology cannot adapt itself to a young student in the same way as a well-educated teacher who has a lot of experience. When looking at the Pili Pop game, the electronic person in the game that gives instructions to the child cannot simulate the experience of adult-child conversations (Plowman, McPake & Stephen, 2012). In conclusion, technological interactivity might motivate children to engage in learning activities, but it does never guarantee an educational encounter. This means that children could prefer the more interactive tablet-based method, but perform better in the traditional method.

Based on this study's findings on learning method preference, one could say that children hold positive attitudes towards the use of interactive technology for educational purposes. Future research should therefore attempt to determine why exactly children prefer one method over another, and how to implement this in current education systems in order to develop more attractive and efficient learning methods for young students.

Learning experiences

Several questions were asked in the interview, survey and *This or That* method to examine how children experienced the learning activity during the three experiment weeks. With the help of an interview question, children were asked if they learned something during the experiment weeks. Since the goal of this study was not to entertain children but to teach them English words and to check their learning outcomes, this question was asked to find out how

children experienced the learning activity. All children responded that they had learned new things during the experiment, such as new words or a new language. This finding indicates that the goal of the learning project was achieved. Furthermore, two survey items were used to examine if children found one learning method more difficulty than the other learning method. The results reveal that children did not perceive one learning method as more difficulty than the other learning method. Therefore, it can be concluded that even though children performed better in the traditional condition, they did not experience any problems or difficulties in the tablet condition.

One could say that children were not aware of their learning outcomes in both conditions, since they indicated that they did not experience more obstacles while learning English in the tablet condition. However, in one *This or That method* item, children were asked to indicate in which condition they performed best. Since the vast majority of all participants responded that they performed better in the traditional condition, these findings show that children are aware of their performances and that they do know in which condition they achieved better learning outcomes. It is surprising to see how children are aware of their performances and know which learning method would lead to better outcomes, but still enjoy the other learning method the most. This interesting finding needs to be taken into account for the development of new educational learning methods. Ideally, developers of learning methods should combine the entertaining aspects of the fun method with the procedure of the most successful learning method to create the most efficient learning method. In this way, interactive technology could contribute to successful and suitable education systems.

5.2.3 Teachers' attitudes

The last research question of this thesis was: 'What are teachers' attitudes towards using interactive technology for educational support?' The goal of this research question is to examine if teachers' attitudes towards technology influence the use of technology in the classroom. With the help of a profound interview, elementary school teachers and the principal were asked to give their view on the use of interactive technology for educational purposes.

The main trend in the extensive results of the interview shows that both the teachers and the principal are strongly in favor of the implication of interactive technology in education. If it is up to the teachers, interactive technology would be used a lot more often. The only thing that stops the school management from implementing more technology in the education system is the lack of resources, like money or a fast network. One important remark

that should be made according to these findings is that teachers are only in favor of implementing more technology in the classrooms, if the central role of the teacher remains the same. All teachers indicate that technology is a great outcome for educational practices like reviewing tests, showing content as background information and making lessons more interactive. Moreover, it gives children the opportunity to practice learning matters at their own pace and their own level. In this way, children are able to work individually and their development is not restricted by the level of their fellow classmates. However, according to the teachers, technology can never replace the role of the teacher. Technology is a great solution for some educational implications, but it is the teacher who monitors the children, who involves them in the actual learning activity and who gives them the personal assistance and feedback they need. Furthermore, other important matters like children's socioemotional development or their learning- and behavioral disorders can only be monitored by teachers, not by digital devices such as interactive whiteboards or tablets.

This study's findings on teachers attitudes are also supported by the Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989). When looking at the Technology Acceptance Model (Figure 1), teachers who participated in this study would probably integrate more technology in their daily teaching activities, if the schools' lack of resources was not a problem. Teachers in this study held mostly positive attitudes towards the use of interactive technology for educational purposes, and therefore they would have a large behavioral intention to use technology if they had access to it.

5.3 Implications for using interactive technology for education

This thesis provided eye-opening insights to the existing literature on the use of interactive technology for educational purposes. Three important implications can therefore be derived from this study's findings. First of all, the interactivity of technology does not guarantee better learning outcomes. This study revealed that an interactive learning application motivated children to learn, but not led to better learning outcomes than less interactive learning methods. Secondly, successful integration of technology in classrooms nowadays is not hindered by attitudes of children or teachers. However, digital learning methods will only be added to existing education systems if they have an added value for both the teachers and the students. And last but not least, the role of teachers in achieving desirable learning outcomes continuous to be a central factor in when more technology is implemented to existing education. Children in this study achieved worse learning outcomes during the tablet

learning sessions, because they did not receive any guidance or feedback from a teacher. Furthermore, teachers supported this finding by indicating that young students will be helpless without a teacher monitoring their learning activities.

5.4 Limitations and recommendations

Some aspects of this thesis' study need extra attention when conducting further research. One of these aspects was the sample size. There were no problems with the sample size to gather reliable data for qualitative research. However, even though the sample size was large enough to find significant results in the quantitative data, a larger sample size would provide more reliable results. Another considerable aspect is the survey that was conducted to test children's attitudes towards interactive technology. A lot of children lost their concentration because of the level of difficulty of the survey, and the youngest children had troubles with reading and understanding the questions. Therefore, questions were read out loud by the researcher and children were given help filling in the intended answer.

Due to the delineation of this study, some interesting aspects remained open for future research. Firstly, this study's target audience were children around the age of 6 to 8 years old, which means that no insights have been acquired in the learning performances of children from other age groups. However, it is very likely that, according to the development stages (Markopoulos & Bekker, 2003), children from other age categories respond differently to interactive technology than the participants in this study. Future research could therefore also focus on other age groups, like teenagers. Another aspect that should be examined in future research are extra learning conditions. This study only focused on the use of a tablet-based learning method, but other digital learning methods, such as methods developed for laptops or desktop computers, need to be investigated to see if there are any differences between all these digital learning methods. In this way, better conclusions can be drawn about the effect of using interactive technology for educational purposes.

Regardless of these limitations, the present study showed that continuous research and improvements will always be required to provide the most qualitative and effective education for young children.

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Appendix I
Consent letter to parents, in Dutch

Beste ouder(s)/verzorger(s),

Mijn naam is Danielle Hendriks, ik ben 22 jaar oud en studeer Communicatie aan de Universiteit van Tilburg. Ik ben opgegroeid in (plaats) en ik heb vroeger ook (naam basisschool) gezeten. Ik zal deze zomer afstuderen voor mijn master en ik heb er voor gekozen om mijn afstudeerproject op mijn oude basisschool uit te voeren. De reden waarom ik dit project doe is omdat ik me al vanaf de middelbare school heel graag wil verdiepen in de ontwikkeling van kinderen. Daarnaast heb ik voor de universiteit al eerder een project gedaan met kinderen en dat is toen heel goed bevallen.

Mijn afstudeerproject zal plaatsvinden van 11 tot en met 28 april. In deze periode ga ik met een aantal kinderen aan de slag om ze in contact te brengen met de Engelse taal via een educatief spel op de iPad. Met behulp van deze app zullen kinderen spelenderwijs een aantal makkelijke Engelse woorden leren. Na dit project met de iPad wil ik graag kijken of kinderen de Engelse woorden sneller kunnen leren via een tablet dan wanneer ze de woorden op traditionele wijze zouden leren. Wanneer ik merk dat de kinderen niet mee willen doen of eerder willen stoppen mag dit natuurlijk altijd. Alle gegevens worden gedurende het project anoniem verwerkt.

Wanneer u **geen** toestemming geeft om uw kind mee te laten doen aan dit project, wilt u dan zo vriendelijk zijn om de bijgevoegde strook uiterlijk 5 april bij de leerkracht in te leveren? Wanneer u nog vragen heeft of wanneer u graag de uitkomsten van ons project ontvangt neemt u dan gerust contact op door te mailen naar (emailadres) of te bellen naar (telefoonnummer).

Met vriendelijke groet,

Danielle Hendriks

De ouder(s)/verzorger(s) van ……(voor- en achternaam) uit groep … geven **geen** toestemming voor deelname aan het project van de Universiteit van Tilburg.

Appendix II
Knowledge test score sheet

Animals

Participant number:

Parrot	Cat
Mouse	Bird
Dog	Rabbit
Guinea Pig	Turtle
Fish	Hamster
Total correct:	*Total correct*:

Colors

Participant number:

Blue	Grey
Green	Yellow
Pink	Red
Black	Purple
Orange	White
Total correct:	*Total correct*:

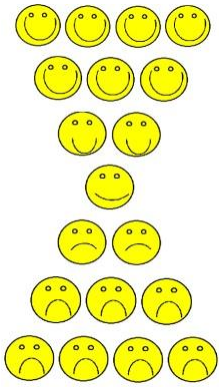
Appendix III

Survey – child evaluation

7-point scale items:

1. Ik vond het leuk om Engels te leren met de tablet
2. Ik vond het leuk om Engels te leren met de kaartjes

Smiley-o-meter:



5-point scale items:

3. Ik vind Engels leren makkelijker op de tablet dan met de plaatjes
4. Ik vind Engels leren makkelijker met de plaatjes dan op de tablet
5. Ik zou thuis het liefste Engels leren met de tablet
6. Ik zou thuis het liefste Engels leren met de plaatjes

Smiley-o-meter

Deleted items

- Leren met de tablet was net zo leuk als ik dacht
- Ik vond het moeilijk om te leren met de tablet
- Ik vond de spelletjes op de tablet spannend
- Engels leren met de tablet was saaier dan ik dacht
- Ik vind het jammer dat het leren met de tablet afgelopen is
- Ik heb heel goed opgelet tijdens het spelen op de tablet
- Ik zou het spel liever helemaal alleen spelen
- Ik wil vaker Engelse woordjes leren
- Ik vond het makkelijk om te leren met de tablet

Appendix IV

Interview questions – child evaluation

1. Did you like learning English words?

   Why did/didn't you like it?

2. Do you think one method was more fun than the other method?

   Why was that method more fun?

3. Do you think learning about colors or animals was more fun?

   Why was that subject more fun?

4. Did you learn something?

   What did you learn?

5. Which method did you learn most from?

Appendix V
Coding interview questions

1. Did you enjoy learning English words?
    (1) Yes
    (2) No
2. Do you think one method was more fun than the other method?
    (3) Tablet
    (4) Traditional
    (5) Both / no preference
3. Do you think learning about colors or animals was more fun?
    (6) Colors
    (7) Animals
    (8) Both / no preference
4. Did you learn something?
    (9) Yes
    (10) No
5. Which method did you learn most from?
    (11) Tablet
    (12) Traditional
    (13) Both / no preference

Appendix VI

This or That method – child evaluation

1. Which method was most fun?
2. Which method made you learn most?
3. Which method was most difficult?
4. Which method do you want to use again?
5. Which method was most stupid?
6. Which method would you like to use at home?
7. Which method was most boring?
8. In which method you performed best?

Appendix VII

Interview – teacher evaluation

1. What do you think about the results I found?
   In which scenario tablet could have worked better? Why?
2. What do you think of using digital technology in classrooms (like smartboards/computers/tablets)?
   What are your experiences on using digital technology in classrooms?
   What are specific contents which are being taught using these technologies?
3. What do you think of digital learning methods (like applications/software)?
4. How do you see using digital methods the future?
   How do you think school management reacts to these new methods?
   How do you parents would react to these new methods?
   Does these methods improve the quality of learning in the home environment?