A study of the impact of technology in early education

Rafal Wajszczyk
Abstract

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The purpose of this study is to analyse the current state of the use of Information and communication technology (ICT) and its impact on pupils in their early stages of education. The aim is to find out how, when and in what context ICT is used in the work with students. The overall objective is to study teachers views on ICT and their opinion on how ICT does affects pupils - positively or negatively. The results of this study are based on both a literature review and a qualitative study. The use of the qualitative methods in-depth interviews and surveys in strategically chosen primary schools extended the understanding and knowledge of the current state of ICT in early education. The result of this study shows a number of different aspects and issues that introduction of ICT into early education has caused and how it influences both teachers and students. As a result of the interviews and the survey answers, the main factors that have to the highest degree influence on how ICT does affects pupils are the access to technology and the abilities of both students and teachers. Despite all negative effects that ICT may be associated with, it can be concluded that the impact of ICT on students is positive in most cases.
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One of the tasks of the modern school is to prepare students for life in the information society. Teachers should create an environment for students to acquire the ability to search, organize and use information from various sources and learn how to use information technology (IT) in a creative and productive way. This can be achieved by preparing students to use computers and IT as well as by using technology in the classroom with a variety of subjects, at all stages of education. The implementation of this task is a large and long-term project.

Education, like every sphere of human activity in society, undergoes evolution associated with changes in the conditions in which it is conducted. The direction of these modifications are determined by the educational concepts or are natural result of the transformations of the social and technical measures that accompany education. The education system reorganize its settings of the program curriculum and school activities dictated by the central authorities, schools and teachers and slowly evolve into a system that supports individual educational goals of students. The Swedish National Agency for Education, Skolverket, has a specified curriculum for the compulsory schools, preschool and the recreation centre in which the following statement can be found:

“Teaching should be adapted to each pupil’s circumstances and needs. It should promote the pupils’ further learning and acquisition of knowledge based on pupils’ backgrounds, earlier experience, language and knowledge.” [1]

The school shall, above all, help students in developing their own education. The use of modern IT in education is an opportunity to emerge a cognitive resource-based mechanism in students and develop the skills and the importance of lifelong learning and continuous education. It can also facilitate a more individual approach and individualized communication between teachers and students.
As mentioned before the school should prepare for a life in the modern world, which is difficult to imagine without computers and the skills to use them. Changes in the education system should therefore take into account the changes that are taking place around us in society. One of the most important factors, which already has a huge impact on individuals, communities and entire societies is IT, which increases the possibility of active participation of citizens in the functioning of their communities. The national curriculum created by Skolverket acknowledge the importance of technology and requires the use of IT in all sectors of education since IT has become an integral part in many fields. The curriculum should take this into account. According to Skolverket [2] students should have access to the technology that is needed for a modern education. After compulsory primary school\footnote{Primary school (swe: grundskaola) \[3\] is a school in which children receive primary education. In Sweden, pupils start primary school when they are 7 and finish it at the age of 15. Primary school in Sweden is divided into three stages. Elementary school (swe: lagstadiet, years 1-3) is followed by the middle school (swe: mellanstadiet, years 4-6) and then secondary school (swe: hogstadiet, years 7-9).} pupils should be able to use modern technology as a tool for communication, creativity and learning.

1.1 Background

Constant expansion of application of science in society and the increasing role of computers in communication and exchange of information had an impact on the emergence of a new field, Information and Communications Technology (ICT). ICT is a sector of IT which is responsible for technology transfer of information and tools to control the flow of logic and data transmission through different media. ICT is now recognized as one of the most important branches of IT. The term ICT is often used in a particular context, such as ICT's in healthcare or education. The importance of ICT is rather based on its ability to create wider access to information and communication than its technological aspects. The dynamic development of ICT undoubtedly contributed to the development of the knowledge-based society, which basic feature is permanent education, also called lifelong learning. The ICT term has been used by academic researchers since 1980s, but ICT became widely popular when Dennis Stevenson used it in his report \[4\] addressed to the Government of the United Kingdom and propagated by subsequent documents on education in this country in 2000.

Even if the definition of ICT became widespread during the late 1990s, it does not mean that IT was not widely used in schools before that. IT has been used in Swedish schools since the early 1980s and its use has since undergone major changes associated with the development of technology and a society that is increasingly skilled in the use of IT.
Development and the importance of IT in Swedish schools has gone from computer science with a focus on programming to a focus on embracing digital competence. During the 1980s computers were used in teaching primarily to provide an understanding of computers as tools for programming and its role in society. Based on Skolverkets report, during the 1990s, the focus shifted to the use of the computer as an educational tool in schools and focused strongly on the exchange of educational software between the Nordic countries. During the 2000s IT began to be used more generally in schools as a tool for information retrieval, processing, creation and communication. Nowadays IT have become an integral part of the learning environment. Since late 1980s great efforts have been conducted regarding the use of IT in swedish schools. Foundation for Knowledge and Development (swe: KK-stiftelsen) was created in 1994. The Foundation’s primary goal is to promote professional development and to create the conditions for economic growth. The foundation has since then supported IT development in schools, with main focus on training for teachers, in order to increase the skills of teachers in the field of IT. Additionally Skolverket started the ITiS project (ICT in Schools) which was initiated in the late 1990s. ITiS focuses primarily on investments on professional development of teachers and the IT infrastructure of schools. ITiS started with a campaign with a 1.5 billion swedish crowns budget, under the motto ”Tools of Learning.” Even ITiS largely focused on teachers skills. Around 40 percent of primary schools teachers have been offered to participate in self-study in groups that will act as a support for learning at work [5]. As we can see, implementation of ICT in education has come a long way. However, it is still not properly introduced and there is still a lot of research left to do and there are still many questions that can be raised.

1.2 Purpose

The purpose of this study is to analyse the current state of the use of IT and its impact in early education. The aim is to find out how, when and in what context ICT is used in the work with students. Another aim is to study teachers views on ICT. The study will also, to some extent, include observations of the technique used with children. An overall goal of this study is to identify the major impacts regarding the primary school IT environment from a primary school staff perspective where ultimately the new knowledge can form an informed basis for further research in early childhood education.

In order to fulfill the aims and objectives of this study, there is a need to define a number of issues concerning the use of ICT in primary schools and how it is related to the staff and in to some extent also to the children.
The main research question of this study is to look from a teachers perspective on:

- How does ICT help students to achieve their personal goals and how does ICT influence their learning progress - positively or negatively?

### 1.3 Methods

To be able to judge the current state of technology and its impact in early stages of education (elementary and middle school) there was a need of analysis of the available literature, studies and reports in this field. In order to be able to see the whole picture an additional study of a psychological and developmental state of children’s progress and their way of thinking and perception was required. A validation of the gathered data from the literature study has been conducted. The use of qualitative methods [6] such as in-depth interviews and surveys in strategically chosen primary schools could extend the understanding and knowledge of the current state of ICT in early education. To answer the above presented questions, interviews with teachers in primary schools were conducted.

### 1.4 Thesis disposition

This thesis is structured in the following way. First a literature study and analysis of the current state of ICT in education is presented. This provides an overview of the background and the issues that are dealt with in this study. Following this a presentation of the theoretical perspective is provided. In this chapter the reader can get acquainted with two learning theories, namely cognitivism and social-constructivism. The theoretical perspective is followed by the description of the methods used in this study. In this chapter the research strategy, as well as the methods used in order to gather data for the analysis are presented. The main results of this research work are then presented in the analysis chapter, which is followed by a discussion of the results of this study. The discussion chapter includes also reflections upon future research possibilities. The conclusion chapter summarizes the work performed during this thesis.
Chapter 2

Literature study

2.1 ICT in education

According to the commonly accepted concept of mankind - epistemology [7, 8], also referred as a theory of knowledge - humans can be seen as a system that processes informations. His behaviour does not only depend on the current information coming to him from all sides, but also from the so-called cognitive structures, which are encoded in the memory of the knowledge gained in the course of learning and thinking. The human is also being independent and creative. Learning and teaching should enable him to not only process information, but also to create a new cognitive structure based on the basic information and develop skills of continuous learning to cope with new emerging information resources.

Most of the areas of knowledge, and therefore the fields of education, are characterized by the accumulation of vast amounts of information. Teaching can therefore not be focused on the transfer of teachers knowledge and the accumulation of presented facts by the students, but it should offer students primarily the basic knowledge and skills with which they themselves would be able to reach the information they need. This means that schools should move away from an encyclopedic learning approach and instead teach students how to gain knowledge by developing their skills in continuous learning and teach them how to find reliable sources of knowledge and how to decide what information is essential and relevant [9].

There are many theories and perspectives of how teaching should take place [10]. Those theories reflect the diverse courses in which epistemological traditions impact the experiences we have and how we feel they affect teaching. There are four dominant learning theories such as behaviourism, cognitivism, humanism and (social)constructivism. In
this report cognitivism and social-constructivism are the base of the analysis. Cognitivism theory bases its learning process on transferring of information from teacher to learner. In social-constructivism theory an information is subjectively interpreted by the student. The interpretation is based on a personal experience of the learner. [10, 11]

Nowadays, a huge resource of information is stored and transmitted in electronic form such as all possible data storage devices, as well as Internet and Intranets. For this reason, and also because of the size of the resources, the use of the information is sometimes difficult or impossible without the assistance of computers. This applies not only to numerical information normally related to the fields traditionally linked to the use of computers, such as mathematics and physics, but it can be applied to an even greater range of subjects of natural sciences and the humanities, which also contain tremendous amounts of data and the relationships between them are generally more loose than in the exact science.

According to Papert [12] education has two wings which could be called “informational” and “constructional”. This means that one part of education bases itself on widening the set of information which may hail from perusing a book or listening to an instructor. However, Papert claims, that this is only one part of the education process. The other part is based on constructional aspects such as creating, discovering and constructing things and broadening our knowledge. Both wings are equally important, although because of deficiency of suitable technology, the constructional part of education is undervalued for the benefit of the informational wing of education. Papert believes that this unrecognized dichotomy in digital technology and the education system is constantly genuinely holding back the educational reforms.

Computers and IT in schools create new opportunities for almost all school disciplines. Depending on the scope and extent of their use, there are two types of activities in schools at all levels, in which computers, and more generally - IT is used. The first type are dedicated computer classes devoted to computers and IT, and the second type is what defines all the other classes, in which computers play an auxiliary function [13].

There are a number of topics e.g., in mathematics or physics, of which the explanation is not possible without a computer and the execution of numerous learning objectives becomes possible only through the use of a computer. The methods of computer aided learning should be specified in the curriculum. This may apply to both existing programs content of the curriculum and new content and skills which transfer is possible only through the use of a method and the means of IT. Changes in the program should take into account the possibility of using computers to truly outperform and enrich the previously used method [14]. However, the introduction of computer aided learning should not be designed to replace the teacher [15]. According to Eurydice study [16] all
European countries include ICT in their national policies and curriculums in education. Those policies usually cover the complete learning process. The European commission espoused a new Digital Agenda [17] which objectives are to develop and maximise the ICT skills, which include digital and media literacy. This includes strategies that aim to provide the necessary skills for pupils, as well as to provide necessary ICT training for teachers.

Based on Siraj-Blatchfords’ [18] guide to developing the ICT curriculum for early childhood, introduction of ICT in the curriculum should be an emergent one. An emergent curriculum [19, 20] is a curriculum that advances when investigating what is ”socially relevant, intellectually engaging, and personally meaningful to children.” In this model, both grown-ups and childrens take initiative and settle on choices. This possibility of influencing the curriculum implies that an educational program is likewise arranged between what engages childrens and what adults see as vital for pupils’ education and improvement. The curriculum is called emergent since it constantly develops, veering along new ways as decisions and associations are made, and it is dependably open to new conceivable outcomes that were not considered during the introductory arranging process. It incorporates all interests of pupils and reacts to their diversions as opposed to concentrating on tight, individual topics.

In spite of the fact that a positive pattern could be observed in educators’ utilization of IT aids in class, their general motivation to utilize ICT still remains an issue [21]. Education systems need changes to adapt in order to be able to resolve this issue. Educators should be required to stay up with the latest technology changes through...
improvement in programmes and materials. This could result in better understanding of technology and willingness to use IT aids by the teachers. Additionally, there is a demand for a technical support at schools, that can guarantee constant development of the teachers, as well as access to immediate help in various situations [16, 22].

There are many studies which show that the use of ICT in education may lead to a higher and more effective learning (see Appendix A). Analysts uncover that numerous ICT advancement projects fail to establish the completely combined utilization of ICT which these ventures are aimed at which leads to lower understanding of the impacts on learning and advantages that ICT can provide for education purposes [23, 24]. One of Kulik’s reports review [25] classified the reviewed studies into six types that include tutoring, management, simulation, enrichment of the classroom experience, programming in Basic and Algol to solve mathematics problems and the use of LOGO.

<table>
<thead>
<tr>
<th>Type of application</th>
<th>Number of studies</th>
<th>Achievement effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutoring</td>
<td>58</td>
<td>0.38</td>
</tr>
<tr>
<td>Managing</td>
<td>10</td>
<td>0.14</td>
</tr>
<tr>
<td>Simulation</td>
<td>6</td>
<td>0.10</td>
</tr>
<tr>
<td>Enrichment</td>
<td>5</td>
<td>0.14</td>
</tr>
<tr>
<td>Programming</td>
<td>9</td>
<td>0.09</td>
</tr>
<tr>
<td>Logo</td>
<td>9</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Figure 2.2: Achievement effect sizes for six types of computer-based applications, calculated from evaluation studies published before 1990 [25].

The above presented results show that especially tutoring and the use of LOGO greatly increase achievement effects in learning. According to the studies pupils learned more in classes that included computer tutoring. However, results were not that satisfactory for other types of applications such as managing, simulation, enrichment and programming.

Additional studies in those fields show that integrated learning systems are successfully used and greatly improve achievement effects in the basic skill areas of reading and especially mathematics. Lower grades of effects in reading with integrated learning systems are often caused by incomplete implementation of those systems. There is also a significant growth of the effect size shown concerning reading and writing learning. Effects of use of either Writing to Read or Accelerated Reader [25] programs show a growing reading effect size in most of the performed studies. The same conclusions can be drawn from Word Processing and Computer Enrichment studies results in learning to write. Separated from activities that support literacy and numeracy, proof of a positive effect has been also reported in science, modern foreign languages, history, geography, physical training and the creative arts [26]. However, a great part of the evidence of the
positive impact in those fields is the outcome of small-scale studies and further research is needed to figure out the degree to which the successful introduction of ICT might be reproduced somewhere else.

![Figure 2.3: Empirical results of educational effects of ICT use as a result of FY2006 MEXT commissioned project “Research contributing to promote ICT utilization for education”. (number of students who were tested: 2,915) [27]](image_url)

Considering the developments prodded by the popularity and development of the Internet, Wenglinsky [28] infers classifying technologies for educational use in five categories: support for individual learning, group learning, instructional management, communication and administration. Later investigations of the impacts of students extended Internet access have discovered a positive impact on pupils’ writing skills [29]. Wenglinsky [28] points out that physical access or frequency of the use can not be considered as a sufficient measure to evaluate the effect of ICT on pupils achievements. At the same time, Wenglinsky noted, that computers, when used strictly for educational purposes, lead to significant gains in achievements and improves the social environment in the school. According to other studies the level of engagement with ICT can be used instead of physical access and frequency of use to measure the impact of technology, where engagement can refer to a setup where the user pushes a level of control and decision over the technological innovation [30, 31]. Engagement with ICT, subsequently, is about how individuals improve associations with ICT in a manner that its utilization is suitable, productive and significant to them.

According to Boyd “Success within learning is not only measured by number or letter grades, but is also measured by increases in critical thinking, motivation, self-esteem, problem-solving or creativity.” [32] Moreover, the utilization of technology inside studying situations can increase correspondent abilities by empowering pupils to team up and collaborate with companions and educators. Wenglinsky [28] in his studies discovered that the use of technology in early education increased the level of achievement when technology has been utilized as a method of enhancing the lesson, furnishing chances for pupils to attain higher-order thinking. This also has been shown in many studies, that
with technology development and increased possibilities to enrich the student learning, teachers must carefully select aids for learning activities. Boyd claims that if ICT is used to enrich student learning to simplify higher-order thinking and reasoning, ICT tools can affect student’s achievements positively. On the other hand, if such devices are not advancing the present learning environment i.e., by causing distraction or extending the learning process, the pupils studying outcome might be hindered.

Many studies have proved that the use of ICT in education increases the motivation of students [32, 33]. In many studies educators broadly reported motivational effects rising when students were able to make changes and improve the quality of their work, regarding text composition, presence and presentation. The assets that students reported helping them the most were web resources, writing and publishing software, interactive whiteboards and presentational software [33]. Not only the higher motivation of students has been noticed, but also pupils behaviour during the lessons has been reported as improved in most cases when ICT has been used. Only in a minority of cases the behaviour of students has changed to worse. Those cases were mostly noted in situations when ICT was used only in ICT lessons and access to ICT has been limited. The use of ICT increases also the participation of pupils in educational activities, both regarding the attendance as well as the engagement and active participation during the classes. However, the confirmation of the evidence of increased attainment is to some degree conflicting. Although, in some context and disciplines where ICT has been successfully introduced, attainment has been improved.

Lately researches have moved from questioning the propriety of using technologies into studies to understand and determine what sorts of computer-related environment and methods are best for educational purposes [34]. Based on Clements studies not all tools and methods are equally appropriate to use in education and benefits from their use can vary. Clement claims also that the setting, such as interrelation between tools and classroom environment, and teachers actions and their attitude towards technology use are crucial components in advertising effective education with ICT. Studies of effective and adequate methods for utilizing ICT in early education in the first three years of educating has indicated that when proper guidelines are followed, there is an richness of technology based activities and improvement in nearly every curriculum learning area that is accessible to classroom instructors. However, it is a teacher’s role to introduce proper methods and tools that can enrich the learning activities that encourage communication and social abilities, and at the same time follow the curriculum learning objectives.
2.2 Access

Access to an adequate and satisfactory ICT infrastructure is one of the most significant factors that contribute to the successful and effective utilization of IT in all subjects and for all learners. Then again, some base issues persevere and these are prohibiting the mix of new technologies into educating and studying. The presence of ICT in schools is an essential condition for the successful introduction of creative educating methods and techniques. The utilization of interactive tools and on-line materials can enrich the learning activities and motivate students. According to Eurydice [16] - European education systems and policies studies, there are no extraordinary dissimilarity between schools in accessibility of ICT supplies, however an absence of educational software and lack of support for teachers still influences the level of use of ICT in schools.

ICT technologies can not only enrich learning activities and provide innovative methods, but also can be used to improve school management and its tasks. It can be observed that the introduction of ICT into schools has influenced the change in the functioning and activities of schools. Among school-related activities, in which the share of computers and IT should increase and benefit from computerization of school library and school administration, use of ICT for extracurricular activities and improved communication between teacher and parent, as well as improved, individual teacher-student contact can be distinguished.

When it comes to the use of computers, diverse decisions are made as to how ICT equipment should be arranged in schools. According to curriculum plans from most European countries it is recommended to place ICT equipment in a variety of places in school. Workstation labs permit ICT to be seen as a component of the taught educational program in a financially understandable manner. Although, this can lead to that ICT might rather be used to learn about ICT than through ICT. Workstations, that are promptly accessible, either in a variety of places or in the classroom, may be utilized more often through the day and for various purposes and learning activities. ICT available in classrooms might be desired, especially for personalisation of instructions and studying activities. Wide availability of ICT in school can broaden individual interests and might help to respond to special needs of individual students by introducing individualised studying programmes and techniques appropriate to the students level of knowledge.

However, based on Euridice [16] study, free use of ICT by pupils is not that common. In most cases, particularly when computers are placed in computer labs or classrooms, it is shown that the use of ICT is mostly conducted under the supervision of an instructor and during specific hours.
The access to computers in Swedish primary schools is rather high [35]. However, it is mostly shared stations with other instructors. It should be noted that almost 100% of primary level teachers have access to either a personal or shared computer. With regard to teachers’ access to computers during lessons a majority of them claim that they sometimes or always have access to computers during class. Access to ICT does not necessary mean that it is also used for education purposes. Students at secondary schools, such as high schools, have to a greater degree access to computers than students at primary schools, where in average there is one computer available for six students in municipal primary schools and around 4,5 students for one computer in independent compulsory schools.\textsuperscript{1}

Internet is available in almost every primary school. Only 4 of 10 primary schools have platforms for communication between teachers and students. A high percentage of the teachers have a similar problem when it comes to access to a learning management system, which may indicate that the software is not always used actively.

\textsuperscript{1}Independent schools [3] (swe: en fristående skola) are schools that are running independently from those arranged by the municipality or county. However, independent schools must be approved by the Schools Inspectorate and follow the national curricula and syllabuses. Independent schools are available on both primary as well as on secondary level.
It is very common for schools to offer students computer programs for word processing, spreadsheets and creating presentations. It is also common for students in primary and secondary schools to have access to various educational programs, especially in the primary school where three of four primary schools offer students computer software for math and language learning. On primary level access to educational software for students is more common in municipal schools than at charter schools.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Preschool personnel</th>
<th>Elementary school teachers</th>
<th>Secondary school teachers</th>
<th>Teachers for adult education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every day</td>
<td>11.9</td>
<td>29.4</td>
<td>27.5</td>
<td>43.2</td>
</tr>
<tr>
<td>Every week</td>
<td>25.4</td>
<td>36.5</td>
<td>30.1</td>
<td>27.1</td>
</tr>
<tr>
<td>Every month</td>
<td>8.6</td>
<td>11.6</td>
<td>13.7</td>
<td>7.9</td>
</tr>
<tr>
<td>More seldom</td>
<td>24.7</td>
<td>29.2</td>
<td>19.5</td>
<td>15.1</td>
</tr>
<tr>
<td>Never</td>
<td>28.3</td>
<td>19.7</td>
<td>9.1</td>
<td>6.8</td>
</tr>
<tr>
<td>Data not available</td>
<td>1.2</td>
<td>0.7</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

It is important also how often a computer is used during classes. Skolverkets findings show that the frequency of the use during school activities is rather low, but it must be taken into consideration, that not all activities and areas of knowledge which have to be transferred from educators to students, may be carried out by using ICT tools. In addition, the amount and quality of ICT aids in schools may hinder teachers from using them in the desired way.
Chapter 2. Literature study

Figure 2.7: Diagram represents the percentage of how often teachers in Sweden have access to computers during classes [35].

Other IT equipment available in schools are digital and video cameras, data projectors and interactive whiteboards. Most schools report that they have access to digital cameras or camcorders, and a clear majority indicates that the school has at least one data projector. Interactive whiteboards are however rare and a minority of the schools report that the school has an interactive whiteboard at all. Municipal primary and secondary schools indicate a greater extent than independent schools that the school has at least one interactive whiteboard available. IT plans are available in a majority of primary and secondary schools. Most commonly, schools have their own IT plan. The IT plans concern mostly issues such as IT equipment standards and maintenance, staff development, IT as a teaching tool as well as students’ ability to critically look for information on the Internet.

Figure 2.8: The percentage of schools in Sweden that have access to various IT tools [35].
2.3 The teacher’s role

With constantly increasing importance of technology in our lives and with the unavoidable expansion of ICT in classrooms, the role of the educator has to change [36]. The need of changing a teachers role is irreversible and inevitable because together with the introduction of ICT into schools certain educating assets come to be outdated. It is the teacher’s responsibility to adapt both themselves and students, as well as the lessons course to new technologies and possibilities that it offers. It is no longer sufficient for the teachers to be only an educational authority that transfers the knowledge to the students. It is essential for teachers to encourage critical thinking skills, promote information literacy and support collaborative work in order to prepare pupils for living in the 21st century. Additionally, identification, grouping and confirmation of electronic data sources should be one of the main tasks for educators.

The Assessment and Teaching of 21st Century Skills [37] acknowledge the possibility to collaborate with others and the ability to connect through technology as essential skills in the 21st century. ATC21S defined and categorized the 21st century skills into four broad categories:

- **Ways of thinking** - that includes creativity, critical thinking, problem-solving, decision-making and learning.

- **Ways of working** - communication and collaboration as one of the most important assets.

- **Tools for working** - information and communications technology (ICT) and information literacy.

- **Skills for living in the world** - Citizenship, life and career, personal and social responsibilities.

Those categories can be described with the help of two skills that connect all four categories, namely **collaborative problem-solving** and **ICT literacy**. Those skills should be embraced by the teachers learning activities and support students in broadening those skills.

Recent studies [38] show that the teacher is entrusted with a variety of roles, which have not been seen as needed before ICT’s introduction into education. It is clear that, compared with the traditional roles of educators, the ICT-based environment does not solely focus upon the dispersal of learning.
2.4 The teacher’s didactic choice and teaching methods

The variety of technology devices and techniques that can be used in education can be overwhelming. The multiplicity of choices does not always help teachers to find adequate aids. The choice of teaching aids should be carefully thought through and the choice should be appropriate to the planned learning tasks. The use of technology may not always be helpful. In many cases, it can cause quite the opposite result. Inappropriate use of technology can lead to distraction and overuse both from students, as well as from the teacher side.

ICT supported learning might be either individual or collective, as well as student- or teacher-directed [39]. The use of ICT in education can expedite the individualization of studying methods and support learning processes inside a studying group. In order to be able to fully support those types of learning, the successful introduction of ICT in schools should concentrate in general arrangements of occasions, exercises, activities, context and content, as well as all personal correlations occurring in the setting that ICT is utilized. ICT should be carefully adjusted to the context of use and specific environments that are going to be used. ICT accommodates educating and studying in primary schools in order to enhance studying outcomes in literacy, numeracy, science and 21st century skills [40].

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Figure 2.9: Three models of teacher’s role in ICT-based educational environment [38].
Taking into account how ICT tools are utilized within the classroom, ICT tools can be classified [41] into four categories:

- **informative tools** - these are applications that provide informations in various formats such as text, graphics, sound or video. Examples of informative tools can be e.g., digital encyclopedias and Internet resources.

- **situating tools** - these combine systems that place students in an environment in which they can experiment. Those tools include simulations, games and virtual reality.

- **constructive tools** - these tools are general purpose tools, that are used to manipulate information, creates new knowledge or visualizing one’s understanding. Example of such a tools can be mind maps or social networking applications that allows students to organize their knowledge, ideas and reflections.

- **communicative tools** - these tools facilitate communication between students and/or students-teacher. Examples of communicative tools can be e-mails, chats, forums, teleconferences and also interactive whiteboards.

These tools are intended to engage students in higher-order thinking (e.g., reasoning rather than information collection). Some studies show that higher-order thinking skills for structured inquiry were best acquired when students constructed knowledge rather than passively ingest information [41]. According to Lim and Tay, informative tools alone, may not be sufficient to engage students in higher-order thinking. However, with proper help and support from educators, those tools can successfully help students and educators to realize their goals. Hogle [42] has in his study tested the impact of computer games on interest, motivation and retention of students. The outcome of these studies has shown that simulation and games might improve some of the cognitive learning strategies, that include organizational, memory and compensatory strategies. However, also in this situation, it is important to observe that the positive benefits of games highly depend on the purpose of the game and the context of its use. When it comes to constructive tools, studies results [41] show that a constructivist approach for learning develops students literacy and critical thinking, as well as it engages students in a variety of higher-order thinking. Communicative tools can improve students performance in writing. It also engages social participation. According to Lapadat [43] communicative tools can lead to improvements in analysis, synthesis, interpretation, and evaluation.

Hayes and Whitebread [44] classification of areas of learning and ICT use in some extent overlaps with the above presented four categories proposed by Lim and Tay [41]. Hayes and Whitebread believe that in order for ICT to be able to make a contribution in specific
areas, pupils should use ICT tools in ways that support the situation and context of the use, in which students benefit the most. Areas of use of ICT in education proposed by Hayes and Whitebread are:

- ICT and literacy
- ICT and mathematical understanding
- ICT and science
- Creativity, problem solving and playful uses of technology
- Visual literacy and painting
- Media education (digital animation)
- Learning of music

ICT tools can positively influence the education achievements, as well as engage students higher-order thinking. However, it must be noted, that even if ICT is considered as a powerful and adaptable instrument in the educators hand, it requires care, knowledge and experience to utilize it suitably to context and activities. Inappropriate or improperly selected ICT tools can have negative effects on students and teachers. That is why, simultaneously with the introduction of technology into schools, equally important is the teaching and discussion on topics such as ethics and integrity. Those topics can not be undermined and should be concerned as a part of the ICT introduction into education. Additionally, even if positive effects of ICT use in education have been proven in many studies, there are still identified limitations of ICT, that have to be considered.

Computer software might be beneficial for literacy learning, but there still might be programs that are either not as good as others, or might be inappropriate or inadequate for a specific group in a given context. Moreover, especially with informative tools, technology can not substitute teachers and their presence and support is indispensable [40].

According to Lowe [45] studies, students tend to overlook important information, when there are other distracting informations available. There are also legitimate concerns associated with Internet use. Students, that can freely use computers to access the Internet, may be exposed to offensive or inappropriate informations not suited for their age. Educators need to ensure that students contact with Internet and other available information is supervised during most of the in-class activities. The same conclusion can be drawn from the use of all sorts of multimedia. If they are not properly used, suited or
designed, the use of multimedia can lead rather to distraction than improved attention and learning outcome. Furthermore some psychological factors, e.g., enthusiasm, can have a negative impact on students. Based on Merchant [46] studies, pupils may not be willing to exchange what they learned with help of technology into real world knowledge. It is also important for educators to be able to distinguish, whether technology use is wanted by pupils, or if they would rather prefer the use of traditional teaching materials. Concerns with respect to integration of ICT in early childhood education have been thoroughly studied and safety concerns can be classified (see Figure 2.10).

![Figure 2.10: Different areas of concerns about children’s safety and health as identified in literature [13].](image)

Other aspects that must be considered are children’s motivation and focus. Computers provide a wide range of possibilities, which larger part can be considered to be helpful. Nevertheless, technology can offer many temptations and cause distraction as well. While surfing on the Internet and searching for information associated with a given task, the child is exposed to many information and tempting possibilities such as games, social media or other types of entertainment activities. In order to be able to prevent from such a distraction, the school must be properly prepared and desirable limitations shall be assembled. A lack of motivation or it’s decrease may be caused e.g., through the improperly selected tasks, erratically acting or counterintuitive equipment, or insufficient skills and experience of the student.

### 2.5 The teacher competence

Many studies infer that adequate utilization of ICT makes significant requests on educators regarding their information and comprehension of and acclimation with a variety of tools available. This knowledge is required from teachers so that they are able to recognize affordances of ICT, plan suitable activities and react to students’ individual
needs in the classroom. It is very important that teachers make wise choices regarding suitable ICT tools and techniques. However, as mentioned before, there are still many educators that are skeptical when it comes to combination of technology with education. Scepticism and lack of enthusiasm in introducing ICT into education can be caused either by insufficient knowledge in that area, negative impressions and experiences or even plain personal aversion to changes. An alternate factor that impacts incorporation of technology into education is discovered in the separation between the ICT development, the schools environment and the teachers current practice. The shorter the separation is, the better chances for a successful introduction of ICT a school has [47].

According to Eurydice [16] studies, educators ordinarily acquire ICT educating abilities through their initial education, however further expert improvement is not that common. It is crucial that schools have generally well educated instructors that have the ability to introduce ICT into learning activities in a manner that expedites the transformation from the old to the new model of learning. Instructors may and should put effort in improving ICT abilities throughout initial teacher education as well as to continue to develop and deepen those skills during their professional career.

![Source: Eurydice.](image)

**Figure 2.11:** Types of teachers teaching ICT in primary education, 2009/10 [16].
Teachers have a responsibility to help students to acquire and deepen the ICT knowledge. However, it can be a more difficult task for educators on primary level, rather than on secondary level of education. At primary level, ICT is taught mainly by generalist teachers, while on the secondary level teachers are subject specialists. It is also proven, that schools face difficulties in recruiting ICT teachers. In many cases, mathematics and science teachers may also be used as ICT teachers.

When it comes to Sweden [35], generally over half of the preschool staff and primary school teachers claim that they are fairly or very good at IT. A majority of the teachers indicate that they have been trained in basic computer skills and word processing, and many say that they have been trained to create presentations, search for information and communicate using the Internet. The training in the law and source criticism on the Internet, however, is uncommon. Teachers in public schools, especially in primary schools, have been trained in basic computer skills to a greater extent than teachers in independent schools. Many teachers claims that they have the need to improve their skills in one or more areas of ICT. Teachers mostly express their need for skills in working with images, sound and video (about 6 out of 10). Many educators also say that there is a great need for improvement in skills such as presentation creation and understanding of the law on the Internet. IT as a pedagogical tool is also one of the areas that teachers feel they need additional training. Barriers to a professional development, are mostly a lack of time and the opportunity to undergo training and also that the school does not support enough or require additional ICT competence trainings.
Figure 2.12: The percentage of primary school teachers in Sweden who have been trained and teachers that indicates a fairly or very high need of additional training in IT-related areas [35].
Chapter 3

Theoretical perspective

3.1 Developmental state of children’s progress

The development of children’s brains depends on the environment in which they live and on the type of activities they perform. This means that tools with which they are in contact have a great impact on the structure of a neural network. Those tools may be divided into two categories. The first are those which do not impose any activity, so a child very quickly cease to lose interest in them. The second category includes tools that enable diverse activity and trigger creativity. One of the best examples here are the building blocks such as LEGO. It develops at some levels a child’s motor skills, but at the same time it develops the imitative attitude. Choosing the tools for brain stimulation the most desirable are the ones that make the child the creator and allow an infinite number of different applications. It is important to remember, that new neural connections are formed when the child is active and when it is faced with a situation where it has to overcome difficulties and solve problems.

Jean Piaget believed that everything we do for the children, deprives them of the opportunity to do it by themselves. Therefore, the aim of education should not facilitate the children anything, but should be based on the passing off tasks, which will allow them to develop. Any tools that children have interest in, with time will be replaced with other instruments. When a child’s brain is still growing, it constantly needs new, more difficult challenges. Therefore, the optimal tools are those, that can grow with the child and which for a long time will ensure stimulation. The obvious fact here is also that less developed children can use them differently than more developed children.

Piaget’s theory of cognitive development [48] assumes that the essence of development is the transformation of cognitive structures involving assimilation (integrating new experiences into existing mental schemas) and accommodation (modification of existing
schemes in such a way as to fit the new, incoming information). According to J. Piaget child’s activity is related to the continuing challenge of balancing between these processes.

It is difficult to determine the beginning and the end phase of the formation process of human’s operational intelligence. Developmental changes are not rapid and each of them results and is dependent on preceding changes. Human behaviour specific to individual phases of development does not disappear as it moves to the next stage. It’s like a pyramid - the new behaviours are built on the previous ones, they supplement and correct, but do not replace them.

J. Piaget observed that the transition from thinking based on direct manipulation of the objects, through reversible mental operations on representations of specific objects and events, to think abstractly, in the course of thinking is independent of the objects and events. According to Piaget, children at preschool age are at the preoperative stage and children in the early years of primary school are at the stage of concrete operations - training tailored to the child’s stage of development is possible due to the integrated teaching. A young man learns in this way different areas of reality and can bind them together and combine them into a comprehensive knowledge about man and the universe. The preoperational stage is usually defined by intentional experiments on objects, childrens become increasingly aware of planned activities and the gradual internalization of external actions. The main achievements of this stage are symbolic thinking, language development and gradually forming the ability to understand the stability characteristics.

During the early period of the primary school, the child comes into the operational stage, which is characterized by the appropriate use and development of logic thinking. Children in this period begin to solve the problem in a more logical fashioned way. However, an abstract and hypothetical thinking has not yet been developed. Children are able to reason inductively, which consists of the fact, that the child is able to draw conclusions from observations. However, at this stage, children still have problems with deductive reasoning, which makes it possible to predict the outcome of an event. It is important to notice that children develop at different rates - this process can be carried out unevenly - either quickly or slowly. They also have a different pace of work and differently oriented skills and talents. Periods of growth are therefore universal. The age at which a person enters into a specific developmental stage is not the same for everyone. Jean Piaget gives only approximate age, the one in which process takes place for an average child. However, certain is, that the child has to go through all the stages of cognitive development and it has to be done in a particular order at its own pace. It
is extremely important to match the teaching program and materials available to the abilities and interests of the the majority of children.

The issue of age, in which, according to the model of development created by Piaget, children pass from the concrete operational stage into the formal operational stage varies between researchers. According to Piaget this transformation occurs at the beginning of the age of 12. However, according to more recent studies [49] performed by British researchers on a large sample of ten thousand students in middle school. Results have shown that at the age of 14, over 80% of British students still have not reached the level of the early formal operations. The beginnings of formal reasoning rarely occurs in children under 14. That means that students who started studying at middle school with high probability are still at the level of concrete operations. This may last until the end of primary school.

The formal operational stage allows to use a formal logic, not only with respect to the immediate surroundings, but above all to formulate assessments about the outside world. With it, the children can understand the deeper, more abstract rules that govern reality. Child’s reasoning at the level of concrete operations is based on hypothetical reasoning. Abstract concepts such as honesty, fairness, time and laws have a certain impact on children who know what it means, but only at the level of everyday experience. The formal abstract understanding of concepts such as justice, requires the capability of crossing the borders of everyday experience, e.g., the view, that society must meet the same basic needs to survive, constitutes a mental construct and not the perceived phenomenon. A lot of experience in the fields of economics, sociology or physics may be impossible to understand for children at this age.

During the development of the child it is extremely important to create a moral backbone of students. Children are able to produce it by standing up for certain values, deepening their knowledge about them and continuous fixation of these values. This will not be possible if the teacher would not indicate (by example) the relevant moral principles and respect the rules of professional ethics.

Piaget studied numerous aspects of ethical judgement, however the greater part of his discoveries fits into a two-stage hypothesis. Specifically, younger children base their ethical judgements increasingly on outcomes, while more advanced in years childrens build their judgements in light of intentions. Kohlberg [50] believed that this issue is more complicated and defined it into six stages of moral development.

Children learn moral principles at different stages of development. In the first, pre-conventional stage, children are guided by what is pleasant for them, then start to avoid certain activities and perform others in fear of the consequences, or just because they
want to achieve their goal. In another stage, the conventional stage of development, children follow certain rules because they are guided by their relatives or authorities. Later, the children begin to recognize certain norms that are defined by a social group or society. At the end of the process (post-conventional stage) a child is capable to internalise the most widely used norms and rules and is capable to follow its own ethical principles. The teacher should be involved in all stages of shaping the morality. As someone close to the child, as well as the authority, the teacher is entitled to specify standards of conduct, why these standards exist and the benefits that come with them. The teacher should help students to identify with those standards and to adapt them as their own.

In summary, the intelligence, according to J. Piaget’s, is not something that the child has, but it is something that the child creates. The human mental development is based on the balance, the transition from the state of disequilibrium to equilibrium. The imbalance motivates the child to seek a balance, it is the driving force to make changes in the skills and knowledge a child possess. Children are actively building their knowledge - this process is called constructivism [51]. A constructivist approach to teaching is not only connected with Piaget’s theory, but also with the socio-cultural theory of Lev S. Vygotsky.

### 3.2 Socio-Cultural Perspective

The socio-cultural perspective is an exceptional viewpoint in the context where reasoning is based on the knowledge not only of individuals, but also knowledge and interaction that occurs among individuals. In the socio-cultural perspective lies one of the starting points for individuals and groups and how they utilize and absorb resources, both cognitive and physical. The focus here is on the interaction between individuals or as the purpose of the study says - how does teachers perceive ICT help students to achieve their personal goals and how does, based on the teacher’s opinion, ICT influence their learning progress.

Constructivism [52] assumes that the child’s learning is based on the active performance rather than passive knowledge acquisition and clearly emphasizes the importance of working with other people. It is noteworthy to notice the various types of relations between the child and the environment. William Hartup [53] distinguishes two types of relationships: vertical and horizontal. A vertical relationship generally relates to interaction with an adult (parent, teacher, various authorities) in which someone who has more knowledge, ensures the safety and protection of the child. This person helps in the accommodation of knowledge, but also acts as a supervisor. Relations that are
horizontal generally refer to peer interaction, based on the principles of cooperation and complementarity. Such relationships are bilateral - can reverse their direction, as the participants have similar skills. Hartup emphasizes that certain skills, such as cooperation and competition, children can only learn in a peer group, thanks to the horizontal relationships. Adults and peers play a different role in the child’s relationship with the environment and their goal is to satisfy different needs.

The theoretical perspective that has been selected as a framework in this study is Lev Vygotsky’s socio-cultural theory [54, 55]. Vygotsky’s theory concerns both children’s cognitive development as well as how society and culture models affects individuals. Based on the socio-cultural perspective on learning the environment is crucial for individual development. Social communication creates a social interaction between different people, the culture and the knowledge, the surrounding community, as well as the environment itself. Vygotsky claims that it is the social environment and the surrounding culture that plays the greatest role in an individual’s learning and development. Vygotsky’s theory emphasizes the dynamic between the social context and the individual where a dependency exists between social and individual processes. Every environment that an individual is exposed to is not seen as an isolated learning environment, but every single environment is a natural part of a larger socio-cultural community.

Vygotsky believed that learning takes place through interaction with others. If we take into consideration only educational aspects that take place at educational facilities, interaction can be seen as a communication and cooperation with students and a teacher who supports and helps students to acquire the knowledge. Vygotsky believed that true education is not the same as mastering the specific knowledge, but to develop in children continuous learning skills. A child’s ability to clear and creative thinking, planning, implementation and communication of these plans is much more important than knowledge itself. Acquisition of knowledge is in fact easier for the children if they know how to learn. Vygotsky suggests that new knowledge is acquired best in so called “zone of proximal development” [56]. It includes tasks that can not be done by the child alone, but they are able to tackle them with little support from those who are more experienced. As an individual gains new skills, the “zone of proximal development” extends and allows to manage the increasingly more complex tasks than before.

“Zone of proximal development” of the child is a child’s level of functioning, which includes more undeveloped properties and features that are just beginning to take shape. This area describes the possibilities of the child and its future development. The teacher should therefore be a very careful and sensitive observer of the child’s development process and the learning plan shall cover the child’s “zone of proximal development” in order to stimulate its development.
The essence of teaching is that in order to support the development of the child, the teacher shall plan carefully educational activities. The tasks that are not challenging for a child can only perpetuate the already acquired skills. The child will develop when the level of task difficulty is moderate and goes beyond child skills. This is why the role of a teacher is very important. It is a teacher who has to skillfully adapt educational activities to the realm of child development, so as not to give a child such as too simple or too difficult tasks to perform which can discourage the child to further work and research. “Zone of proximal development” does not specify the child’s intelligence, but rather the level of developmental potential. Learn how to perform various tasks and solve problems in cooperation with others is a very important element in e.g., adaptation to life in the community school or preschool, working with the teacher, etc.. Therefore, it is important to focus on what the child can do tomorrow, and not on what the child can easily do today.
Chapter 4

Method

4.1 Research strategy

Since the aim of this research is to find out what perceptions a teacher has towards using ICT and what influence ICT has on the students from a teacher’s perspective and experience, interviews have been chosen as a primary research strategy. So the method used is the qualitative method and interviews play a central role in this research. The main purpose of a qualitative study is not only to analyze but also to interpret and understand obtained results. During the research qualitative semi-structured interviews have been carried out, where interviewees and their own thoughts and views were in focus and could be formulated and develop relatively free [57]. During the research four standardized, semi-structured interviews with open-ended questions have been performed. This amount of interview is sufficient to achieve, given the researches limited extend, a relative high degree of what Esaiasson calls the theoretical saturation point [57], which is the state in which the researcher no longer believes that some distinctive new aspects can be found by conducting more interviews.

Additionally, in order to achieve higher validity coefficient and support reliability of the performed study, a survey has been carried out among teachers at primary schools throughout Sweden. The survey contained both open-ended and closed questions. This combination allows to obtain answers to questions both simple as well as more complex, for which the divergence of opinion and the amount of possible answers is too large. Simultaneously preventing respondents from answering freely to some questions could result in a significant loss of reliability of responses.

If the possibility existed an interview and survey study could be supplemented by an additional observational study of the teacher’s use of ICT during class and observation of
how ICT affects the students. An observational study could create a larger picture of the situation, which includes ICT as an object and students reactions could be investigated from a different perspective than the teacher’s perspective. Since the main interest of this study are the teacher’s thoughts and reflections and considering the studies extent and limitations, an observation as a method has been rejected.

### 4.2 Selection of respondents

The respondents are active teachers at both the elementary and the middle stages of various primary schools around Uppsala. The interview respondents have been selected from both groups. The respondents, who participated in the study, use in different ways actively ICT in their teaching, which made them suitable respondents for the study. Because the information of the technological equipment and possibilities has not been available publicly beforehand, the choice of similarly large primary schools has been the priority in the choice of respondents. This makes the schools and the results of the research comparable by assuring that a chosen facilities are as similar in as many aspects as possible. However, later on during the interviews it got clear that each of the primary schools that respondents were working at, were similar, not only as far as the number of students is concerned but also as far as the technological possibilities of the schools were concerned.

When it comes to the survey study, the choice of the respondents could not fully be controlled. The survey has been distributed over Internet via Facebook groups addressed to teachers interested in ICT, as well as ordinary primary school teachers groups on the Internet. In addition to that, the survey has been distributed to rectors of various primary schools in Uppsala and Stockholm. The survey has been addressed to all teachers at the elementary and middle stages of education of primary schools all over Sweden.

### 4.3 Data collection method

#### 4.3.1 Interview

The data collection method used in this study has been qualitative interviews with four respondents. As the aim of this study is to examine teachers perspective on how ICT influences pupils, interviews seemed suitable as a data collection method. Interviews give the opportunity to gain insight into teachers’ opinion and insight on the asked questions. This method is justified since it allows to obtain the respondent’s thoughts
and perceptions. Esaiasson [57] puts it in a similar way and believes that an interview is one of the best available methods that allow to access the respondent’s perceptions and opinion.

During an interview, the respondent and his thoughts serve as a study object. In carrying out the interviews, an interview guide with pre-planned topics and issues has been used. Based on the Esaiasson knowledge, in the design of the interview guide, it is important to take into account its form and content. This contributes to that the questions included in the interview guide should have a clear connection to the study’s main focus. The questions, which act as an interview guide’s content, should be formulated in a way that helps the respondent to feel inspired to respond. In formulating the questions one should avoid the why-questions and academic formulations and focus mainly on using open and short questions with the hope that those will provide long and informative answers. The Interview guide’s questions used in this study are structured based on various topics. The first topic begins with questions about basic personal data, followed by themes related to the study’s purpose and issues. The goal with the interview guide’s design is that it will lead to a lively, open conversation in which the respondents feel motivated to share their experiences. Questions used during the interviews can be found in the Appendix B.

One of the advantages of qualitative methods in the form of interviews is that it becomes a vibrant conversation that can take different directions. In a larger survey, there is no opportunity to ask follow-up questions in the same way as during an interview. Interviews give great freedom and flexibility, however the survey is a great way to support the interviews results with quantitative data.

4.3.2 Survey

Since the survey was fully anonymous it is not possible to determine the sources of origin of the responses. In order to be able to divide and judge the level of maturity of the students that respondents base their answers on, the survey contained the question of the grade(-s) and the subject(-s) that respondents are responsible for. As mentioned before, the survey contains both open-ended and closed questions. Such a mix of questions allows to create a survey which questions in the highest extent possible, resemble questions and explore topics similar to those in the interview guide. This allows an easier comparison of the result of the survey and the answers of the interviews. The survey has provided also some quantitative data that can be helpful for the validation and analysis of the results of the interviews. During the survey response collection period over 50 respondents (in which 25 respondents are from elementary schools (years 1-3) and 29 teach at middle
schools (years 4-6)) have granted answers to the survey, which seems sufficiently to perform a quantitative analysis of responses. Gathered data has been analysed with division into two groups - one for data from teachers from elementary school and one from teachers from middle schools. Questions used in the survey can be found in the Appendix C.

4.4 Validity and reliability

Reliability is a measure of the extent to which an instrument or approach gives the same results in different occasions under equal circumstances [58]. The individual main factor that can cause reliability problems in this study are the result of conducted interviews. The reason these could have a strong impact on the reliability is that the main part of the obtained results is based on the performed interviews and their results. It is common that people, asked for their opinions and perceptions, have different experience and a range of factors that cannot be excluded during the research, may affect the response.

Recording the interviews helps the interviewer and contributes to make the obtained data more credible, because the researcher is not occupied and distracted with making the transcription of the interview during the conversation, but can make it afterwards, as well as it is possible to listen to answers again and if relevant, examine if leading questions have been asked. Since all of the interviews have been recorded with the respondents permission, the reliability of this study increases.

The validity of a study indicates whether the empirical observations are valid in the reality that researcher wants to highlight. The main problem in this study that can influence the validity of the research are the interviews. An interviewee can easily be affected by external factors as well by the interviewer and the interview location. While internal factors such as misunderstanding of the questions or a desire to appear in an as good light as possible can affect the answers, it is not possible to eliminate the distortion that can occur in interviews, but instead the researcher may be aware of those factors and try to reduce the negative effects they produce [58].

The reliability and validity of the survey results may be lower than those collected during interviews, since all data are obtained via the Internet and all answers are anonymous. Even though the distribution of the survey has been to some extent controlled and no answers should come from not qualified respondents, the collected data of the survey should be taken into consideration as a secondary data source.
4.5 Ethical aspects

The Research Council [59] has developed research ethics which describe the researcher’s actions in a study project. The ethical rules contain two main areas, which can be divided into research requirements and individual protection requirements. The research requirements imply that society and the individuals in the society have the right to demand that the research conducted is of high quality and oriented to substantive issues. The individual protection requirement contains four requirement territories: information, consent, confidentiality, and utilization. These requirements are relevant throughout the whole study time.

This study has taken into consideration the following requirements with as much care as possible:

- **Information Requirements**: The participants of the study are informed that the information they provide will be used only in the research report.

- **Consent Requirements**: The participants are informed that they at any time have the right to cancel their consent and end their participation.

- **Beneficial Requirements**: The study participation is voluntary and at any time the participants can withdraw their participation and the data from the interviews will be destroyed.

- **Confidentiality**: All personal information is treated with great caution so that no one who comes in contact with the study’s results would be able to identify the participants. Informations that could lead to potential recognition of schools and/or teachers that participated in the study are not provided in the report. All quotes are anonymous and not bonded either to the respondents/interviewees sex, name or place of work. All quotes are numbered in order to be able to recognize opinions from the same person.

4.6 Material processing

All interviews were recorded on the voice recorder and then partially transcribed. Additional notes that have been taken during interviews were attached to the transcribed notes from the interviews. The survey data has been deeply analyzed, validated and structured in form of graphs, where possible to apply. The open questions have been analyzed, structured and possible patterns extracted and attached separate into the summary of the interviews. The summary has then been read several times to create
an overall picture of the content and create a prerequisite essential basis to categorize patterns and themes in the collected material.
Chapter 5

Analysis

The degree in which ICT affects students does not depend solely on the amount of time spent by students in front of the computer, but is dependent upon a number of different factors, which together form the complete picture of impact of ICT on students. Factors, which have an impact on the direction of influence, can be divided into several categories, that can be seen from different points of view. One of the base elements that have an impact on the degree of ICT influence is the access to ICT, not only at school, but also at home. Accessibility in turn affects not only the student’s ability and skills, but also limits a teacher’s possibilities to use ICT in the process of learning. Other categories that can affect the impact of ICT are the teachers skills and their attitude towards ICT and their use of technology in learning. In the later part of the analysis the remaining factors which have an effect on the degree of influence of ICT on students and their learning will be presented. In order to be able to fully assess the impacts of ICT, there is a need to divide the analysis into two separate sections - one dedicated to the teachers and the second one with the focus on the students.

5.1 What perceptions do teachers have of ICT in education?

5.1.1 Access

As mentioned before, one of the main factors that restricts teachers from using ICT in education is the access to technology. The interviews paint a rather negative picture of the technology access at the schools at hand. The educational establishments generally have from one to several computer rooms that are equipped with a small number of computers that range between 10 to 20 stations. Typically, they are also not equipped
with high-end products and their amount rarely is enough for students to have the 
opportunity to work independently on a computer by themselves. One example from 
an interview is a class with 27 students that has to work in a 12 stations computer 
room. Another problem with the access is the amount of classes in comparison to 
the number of computer rooms available (e.g., 17 classes for 1 computer room), which 
is disproportionate to the actual needs. In many cases students have one lesson in a 
computer room during a whole week.

The access to computers is limited in the other classrooms, too. Typically, the only room 
in which computers are located are computer rooms. The classrooms are equipped with 
either only one computer or none at all. Very often teachers bring their own computer, 
which in most cases is a laptop provided by the school, with them to the classroom. 
These laptops then are used by the teachers during the lessons.

Such a limited access does not offer the teachers great opportunities to use technology 
in their teaching. Even if there is a possibility of teaching computer science, there are 
no real possibilities to use technology in a larger scale to teach e.g., math, geography or 
other subjects that could benefit from the access to computers.

Interviewees unanimously agree that:

“There is a great desire among staff and as well among us - the teachers, 
to use computers more with the students, but it is an economic issue and 
financial matter to the municipality.”

-Interviewee 1

As can be seen in the result from the survey (see Figure 5.1 and Figure 5.2) there are no 
significant differences between elementary (years 1 to 3) and middle stages (years 4 to 
6) of primary school. Minor differences in form of ICT that teachers use in both stages
can be explained by different access and availabilities of ICT aids at different schools. Such a difference could also be noted during interviews, especially when it comes to less common teaching aids as interactive whiteboards. A computer combined with a data projector is still the leading teaching method when it comes to technology use during classes. More and more popular become tablets that in one interview have been more popular and more available than regular computers. Teachers try to use the technology at hand in every possible aspect of their work with the students, as well as with their colleagues. The only part of teaching where teachers still try to avoid the use of ICT are homeworks. This is dictated by the uneven student access to computers at home compared with their access at school (see Figure 5.6). Assigning mandatory homework to all students, with regard to the knowledge that not all students have the same access to technology can lead to exclusion and segregation of students.

When it comes to the access to materials that can be used during lessons like educational applications, music, movies, as well as other digital materials, it differs between schools, as well as between teachers. The majority of the interviewed educators does not know
any good particular place, where those digital resources can be obtained. Most of their materials must be created or obtained by themselves during Internet research or/and by courtesy of their colleagues. The quality and quantity of the available materials depends then mostly on a teachers skills and experience.

5.1.2 Ability and further training

Despite the fact that the access to technology is usually a decisive aspect in the selection of the method of teaching and use of ICT, the knowledge and experience of the teachers is an equally, if not even more important element that stands in the way of ICT use in education. It is precisely a teachers skills and experience that decide whether or not the ICT is going to be used during a course. If a teacher does not have adequate knowledge of how technology can be used during the class, even full access to ICT materials and teaching aids will not affect the degree of use of ICT during lessons. The opinion of the teachers on their current knowledge and skills, as well as on the availability of further training courses is divided. Most of the teachers however, mutually agree that the younger a teacher is, the better the general knowledge and capabilities, when it comes to the use of technology. The majority of the older generation has greater problems with the introduction, adaptation and use of the technology during the class. One of the reasons for this state is the uneven and selective opportunity to further education of the teaching staff.

Based on the interviews, the possibility of further education is possible and there are special courses available for teachers, that provide them with a better understanding of ICT, as well as they help them with the use and adaptation of ICT. However, there are also a vast pool of different courses thematically diverse that can be chosen in order to train various disciplines available. Preparation courses for teaching with the use of ICT, as well as courses designed for improving the current knowledge in technology, are not mandatory. It depends on the school policy and the teachers themselves what course they choose and in what direction they develop further.
5.1.3 Attitude towards ICT

Lately, there is big pressure on teachers from the national agencies of education (see Chapter 2.1) to use ICT in teaching. However, despite the centrally issued recommendations, still existing barriers like the access to technology or unequal skills of the teaching staff result in a slow adaptation of ICT into the educational segment. Nevertheless, not only the knowledge of the technology is an obstacle in the use of ICT, but also the attitude towards ICT has an effect on the degree of use of ICT at schools. According to the information gained from the interviews, as well as from the literature analysed earlier in this study [16, 35], most of the teaching staff is optimistic and has a positive attitude towards the use of technology in teaching. Regardless, there are still teachers who believe that technology is an unnecessary addition and in some cases even an obstacle in teaching. One of the reasons of such a negative attitude towards ICT can be inexperience or inability to adapt ICT in education. This could be caused by a lack of training and education in the use and understanding of ICT. Another reason may be plain reluctance and aversion to technology and faith in the old-fashioned method of education. According to the interviewed teachers, such instances of educators exists, but they belong to the vast minority.

5.1.4 Changes caused by ICT

The introduction of ICT at schools resulted in changes not only in teaching but also in other sectors associated with the school such as administration or communication. The introduction of technology has facilitated some tasks, but also at the same time
complicated others. Of course, the assessment how much, positive or negative, a school has changed through the introduction of ICT in schools is the subjective opinion of each of the teachers. Impact on the estimation has e.g., access to technology, a teacher’s personal skills, as well as many other independent factors, among others school management or municipalities and national agency of education ordinances.

For some an ease, for others a strain is the transfer of administration and document management to the virtual world. For some teachers the system through which they are updated and new data is added causes problems. Others appreciate the possibility of accessing all documents at any time, because they are available over the Internet, which facilitates their work. Another element, which arises diverse views, is the communication, not only between colleagues, but also with parents and students. Unfortunately, however, the communication type depends on the environment in which the teacher is located. Both the faculty and its attitude, willingness and ability to use technology, as well as the access to technology, both at school level, as well as outside the school, determine the type and degree of ICT use. Also the communication with parents depends on their possibilities and willingness. Not all parents have the option or wish to be contacted over the Internet.

When it comes to teaching, according to the interviewed teachers, the introduction of technology has facilitated much work. It is possible for example to quickly create copies of tasks for all students, whether through the creation of copies of non digitized materials available, or just by printing their own materials. The possibility to create and use presentations, play a movie or music also facilitates the work with students. Again here, the assessment of whether the ICT facilitates or hinders teaching, is associated with a teachers skills and experience.

**Figure 5.5:** Answers to the survey’s question: “Has the role of the teacher changed with the introduction of technology in school?”
5.2 What perceptions do teachers have on how ICT influences students.

5.2.1 Access

Students are not only dependent on the technological possibilities offered by the school, but also the possibilities which they have outside of school. Access to a computer and the Internet has an effect both on the student’s abilities, as well as their development in the field of technology. Due to the different levels of access to technology, the level of knowledge of this topic can vary between students with limited access to computers. In many cases, it is hard for teachers to fully assess the students range of the access to technology outside of school. However, everyone is in agreement that, over the years, this difference has diminished. Of course, this is dependent upon environmental and economical factors. As mentioned before, the differing access to computers between students hinders also teachers from assigning homework solely based on the computer work.

![Figure 5.6: Answers to the survey’s question: “Differs the students access to computers between school and home?”](image)

One of the possible ways for increasing access to technology for students at school is approval to use their own devices as laptops or tablets during classes. However, views on the possibilities of using own equipment at school is divided between teachers and usually depends on the school policy. Allowance to use own laptops or tablets can be also seen as not fair in comparison to other students that do not own such a devices.

During the interviews, the teachers opinion has been subdivided, although the three out of four teachers interviewed claim that the use of students own equipment is not
consented by the school board during classes. The use of own equipment during breaks between classes is also limited depending on the school. One of the examples may be a school in which students, especially in the younger classes, do not have permission to use their mobile phones throughout the entire school day. MP3-players on the other hand can be used as well as tablets. Depending on the school, students that have graduated to year 4, 5 or 6 of primary school receive a laptop from the school until completion of primary education. This increases the access to technology and eliminates differences in access to technology between students.

At all schools at which interviews have been performed, students are not allowed to use the school computers without teachers permission and/or supervision. This is understandable, especially when most computers are located in computer rooms and only single units are situated in the classrooms. Comparing the results of the interviews with the results of the survey however, some differences can be noted. Particularly the younger students (years 1-3) must be supervised in most cases and use of the school computers can not take place without a teacher’s consent. When it comes to the later years (years 4-6) the rules are more diversified and almost half of the respondents spoke in favor of the possibility for students to use school computers without the consent and supervision of teachers.
5.2.2 Ability

The assessment of the students technology operating capabilities from the interviewed teacher perspective is quite high. Of course, the knowledge and skills that are evaluated take also into account the age of the students. Students in most cases do not have notable problems with operating a computer, surf the Internet or use part of the function of graphics applications or word processor.

"Using a computer is not so difficult for a child, but to use all the functions right, then to be self-critical online, knowing which pages are better than other ones, that needs to be taught."

- Interviewee 2

Nonetheless, the students skills are also dependent upon the fact how much access to technology a pupil has outside of school and how often, even if a student has access to a computer, he or she uses it for other activities than games and Internet surfing.
5.2.3 ICT influence on students

Currently, there is quite a lot of pressure on teachers to use technology in teaching. This reflects both a change the curriculum and teaching plans. Additionally, many materials and teaching aids exist more and more often only in a digital form. It is the natural order of things. Student’s contact with technology at school is becoming more frequent, and sometimes it is outright inevitable. As mentioned earlier, one of the biggest obstacles now, is the economic situation of municipalities and schools, that are not able to ensure a technological infrastructure at the level they wish they could. Despite this, teachers strive to use the technological base of schools and fully use all available aids. They try to provide the students the most frequent contact with ICT possible.
Working with computers in schools is becoming more commonplace. If they are not used by teachers to show presentation or work together with students, they are used for various activities supporting both the work of the teacher as well as students, i.e., using the text editor to write along with the students or use Internet to search for information.

**Figure 5.11:** Answers to the survey’s question: “How often do the students use computers in their school work?”

Such common contact with ICT must to some extent affect the students. One of the main concerns associated with ICTs are the students motivation and the fear that ICT affects negatively the concentration of students.

“When you turn on the projector, they always think that - ohh, we’ll watch a movie? - and then they start to drop a little bit, but it shows that they before were not used to it, so they think it will be like some movie all the time when you turn on the projector ... when they understand that there will be no movie, so they get pretty quickly back.”

- Interviewee 1

Most of the interviewed teachers agree that the concentration of students, during use of ICT aids, is partially reduced, however, this could be noted only in some cases and in the early stages of ICT’s aids use.

All respondents emphasize, that if the teaching aids are used correctly, students focus is on quite a high level. Frequently, the concentration of students is even better while using ICT aids, than while using traditional methods. Students are for example more interested and more focused while watching a film or following a presentation in comparison to the students focus level while performing a task from a book or listening to a teacher without the support of e.g., pictures or a presentations.
Figure 5.12: Answers to the survey’s question: “What kind of influence has ICT on the student’s motivation and focus?”

As can be noted in the chart below, according to the teachers who responded to the questionnaire, the use of ICT has a moderately or strongly positive influence on the students motivation and focus. This confirms the data obtained during the interviews. Of course, it still should be mentioned, that there exist cases, where the concentration or motivation of children is lower when using ICT, than when using traditional methods. Although, those cases usually take place when ICT’s teaching aids are used in an inadequate or unsuitable way, or when the used aids are not fully functional. One of the examples is a decrease in motivation, when the disciple can not cope with the reproduction of one of the functions of the program or a program that students use does not respond in the way the student is used to, so the student is unable to cope with the problem independently. A decrease of a student’s concentration can be furthermore caused by inadequate security and limitations, e.g., by blocking access to wrongfully chosen websites, programs and services.

One of the most common problem that students have in connection with the use of ICT is the loss of focus and distraction from the actual problem, which was given by the teacher.

“Using the tools in a working manner. They are really good at surfing, act on social media and play, but to use the computer as just a tool there is a need to teach them from scratch.”

- Survey’s respondent 1 answer to question - “What is the biggest problem students have in relation to ICT?”

Inadequate computer protection that enables students to ”get lost” on the Internet, results often in students getting stuck on Youtube, Facebook or Instagram. Pupils have
Figure 5.13: Answers to the survey’s question: “How do you see the impact of ICT on the students’ learning?”

problems in keeping away from games and social media during classes. Students, in spite of the fact that entering specific pages has been prohibited, whether by the teacher or the school, still ignore the imposed prohibitions and often use computers for other purposes than established. In many situations such rules are only oral and no limitation or parental control software is involved. Along with a better protection against such habits, students would be more focused on assigned tasks if they had known that it is not possible to workaround bans and limits imposed by the school or a teacher.

“The school does not have the digital resources in a good, educational way to not be distracted by the network’s enticements beyond the task of ensuring that the school’s use of IT may differ from the private use.”

- Survey’s respondent 2 general comment

Even if technology is used in the manner recommended by the teacher, there is still no certainty that nothing stands in the students way to distract him/her.

“Students today can use digital tools for social interaction and playing games. It is far less common that they know how to use ICT in an adequate way for learning. When pupils i.e., write in Word, they use way too much time to change the font, the color of the font, Wordart to headlines and look for pictures (which usually are copy protected images). They also have poor knowledge of source criticism and how to use a resource without copying.”

- Survey’s respondent 3 answer to question - “What is the biggest problem students have in relation to ICT?”
One of the most frequent reasons of a reduced motivation of students is the bad access to technology, which generally leads to students having to work in groups on one computer. Then there is the problem with the computers at hand, such as that the old, slow computers are cause for that a lot of time is spend to prepare for classes, as well as work on them during the class is more complicated and more time consuming than it should. Many problems also are caused by the hardware, which often breaks down, or a difficult access to the network. Although most schools have an IT support available locally, the opinion on the access to technical support is divided among the respondents. Their view is rather positive than negative. In contrast to the result of the survey, the interviewed teachers mostly praised the access to and the quality of the technical support.

![Figure 5.14: Answers to the survey’s question: “How would you rate the access to technical support?”](image)

Not only the state of and the access to the technology can cause a decrease in motivation of the students. Another common problem is not properly working software. But it can also be the students themselves who often cause their own decrease in motivation to work. One of the frequent problems is the forgetfulness or lack of knowledge how to save their own work. This problem was one of the most frequently mentioned by respondents to be the biggest problems that students have while using ICT.

ICT affects not only the focus and student’s motivation to learn, but also may influence their level of communication, as well as, what is the most important, their academic result.

Given the opinion of teachers, with whom interviews were carried out, in a few cases it was difficult to determine whether the technology actually affects the students academic results. However, most could tell, that if there is such an influence, it is definitely positive. One of the examples of the positive impact of ICT on pupils academic results is the use of tablets by children with dyslexia.
Figure 5.15: Answers to the survey’s question: “Does ICT affects the student’s academic performance?”

“Children with special needs, who have difficulties absorbing knowledge, children with dyslexia, children with other disorders, where we work a lot with the tools and it is both tablets and smart boards that you write on, and here, we at school believe, that it has given them very much in the recent years. It helps a lot to learn better, more efficient, to find another way when they get stuck at some point with the reading. There are a lot of good programs now to help the little ones.”

- Interviewee 3

Figure 5.16: Answers to the survey’s question: “Does technology help the students to become more communicative?”

In many cases the use of technology leads to situations where students are more communicative in comparison to situations when traditional methods are used. Typically,
while using the computer, or especially during presentations, the students show a bigger interest and communicativeness. The results of the survey, where over 80% of the respondents believe that ICT helps students to become more communicative, reaffirms the above stated hypothesis.

With the increasing popularity of social media and the Internet a very important aspect in the education of children has become ethics, which is currently affiliated not only with the real world, but also with the virtual world, which for younger recipients may be not understandable enough, or even can be considered abstract and not at all connected to the real world. Source criticism, the use of copyrighted material, caution in contact with strangers, cybermobbing, behaviour and attitude on the Internet, and especially respect for others are only some of the topics that children have problems with and need to be confronted with continuously.

“Many young people do not understand that some things they do are wrong, illegal, one might say, it can happen sometimes, and it can have great consequences, now I’m thinking most of social media, where you can type easily behind the computer screen... it must not be full words, but they are much larger in reality, you know.. We work a lot with it, social media and everything regarding this.”

- Interviewee 4
Chapter 6

Discussion

The introduction of ICT in schools does not only aim at changing the pupils perception of technology as created merely to provide entertainment, but also aims at teaching children the proper use of technology. Nowadays, technology plays a very important role in almost every branch of industry and the ability to operate a computer is currently one of the most important fundamental skills which are expected from future employees. Therefore contact with technology, as early as possible, is the most advisable. Although, one of the more important questions that should be posed in this context is whether early contact with technology and the use of ICT in education has really a positive effect on children or not.

One of the possible anchor points that could help answer this question is the analysis of the result received by students that learned with the help of ICT, in comparison with the results of students without the help of ICT in the course of learning. Based on the previously presented data (see Chapter 2.1 and Appendix A) students who had used ICT for learning, mostly achieves better results than students who had not had the ICT support. Due to the limited scale and time at which this report was carried out, it unfortunately was not possible to conduct similar studies. However, according to both, interviewed teachers, as well as survey respondents (see Figure 5.13 and Figure 5.15), clear indications that the use of ICT affects the student’s academic results can be noticed. Based on this assessment of teachers, the impact of ICT on students is mostly positive.

A very important element, which affects the level of impact of ICT on teaching and students is the access to technology. Looking at the data presented by the Skolverket (1 computers for 6 students in municipal primary schools), one may create quite a positive picture of the state of technology of primary schools in Sweden. However, comparing these data to the data collected in this report, both during interviews, as well as among
the respondents of the survey, it is precisely the access and physical condition of the equipment available, that is one of the biggest problems and hinders in the adaptation and development of ICT in education (e.g., 12 station for 380 students in municipal primary school). As it has been mentioned already before, the insufficient access to technology, as well as slow, old computers, have a negative impact on students, both, their learning progress , as well as their attitude towards technology in schools and education. As long as this situation does not improve, it would not be possible to fully use all the advantages offered by the ICT for education and all reasons of negative influences, such as the lack or outdated ICT aids, would not disappear.

According to the socio-cultural perspective a child’s ability to creative thinking and planning is far more important than knowledge itself. This is why it is important that teachers should try to select teaching aids, as well as to create an entire course schedule, with taking into account the current developmental state and current knowledge state of the children. The tasks with which a child should be confronted, should be challenging, but not discouraging, or too long oscillating at the same level. Aids should be selected according to the level at which the child is situated at the moment. In certain stages of development some aids are considered better suited for children of a certain developmental stage than others. It means that educational aids should be selected in accordance to age and developmental stage of a child. However, it should be taken into consideration that environmental and individual aspects influence the developmental growth.

Vygotsky believed that learning takes place through interaction with others. As it may be noted, the vast majority of teachers is convinced that ICT improves students communicative skills, as well as that, the cooperative work leads to such an improvement. Group work is partially forced by the school situation and children are found in situations where group interaction with one computer is the only possible way to interact with the computers at school. This state helps however to improve communication and cooperation is one of the keys to success. This cooperation and interaction that is so important, as Vygotsky said is, at a time when social media are so popular, carried out on a daily basis not only at school, but also after school hours. It is worth to try to integrate the behaviour and needs of people outside of the school for educational purposes through the adaptation of game and social integration in the education. One of the best examples of a successful connection of these elements with the education is gamification\(^1\). Services such as ClassDojo \[61\] or The World Peace Game \[62\], are very popular both among teachers and pupils, and seem to have a positive impact on pupils, their motivation to learn and their results.

\(^1\)Gamification \[60\] typically involves applying game design thinking into non-game applications in order to make them more fun and engaging. Gamification is used widely through industries, as well in education. Gamification can lead to increased interactivity, awareness and motivation.
Piaget’s theory of the intellectual development shows that at the elementary stage of the primary school, a child has two basic objectives [63]. One is the ability to learn basic skills such as reading, writing and understanding arithmetic problems. The second one is the acceptance and acknowledgement of child inclination for school. At this stage, the child transforms from the egocentric into the socialized speech manner. Those, and many more changes the child is experiencing during the concrete operational stage development, are very important and the child should not undergo this stage without contact with technology. Since the child is learning the most fundamental skills, and as such one could perceive an ability to use a computer, the child should be exposed to ITC as early as possible.

This study tries to introduce and present the most important aspects, which have influence on the impact of ICT on students. However, as can be seen in the previous chapters, some factors have a greater impact than others on the final result. As it has been said, the access and abilities of both students and teachers, have the greatest importance. Of course, the remaining factors can not be ignored and must also be taken into account when assessing the impact of ICT on students. These factors, however, do not have as high affect on the degree of the impact of ICT on students. These aspects also occur less frequently and are dependent upon the access to technology, as well as the ability of subsequent teachers and students. Furthermore, it should be noted, that the data contained in this report, even though analyzed with the utmost care, unfortunately, can not be taken as a main benchmark in assessing the impact of ICT on pupils. All data presented in the above analysis, are teachers subjective assessments and respondents come from different schools, thus, their students have a different background and access to technology e.g., computers or tablets. The level of access to technology, as well as skills, both teachers and their pupils have, may differ to a significant degree, which definitely affects the responses and evaluation of the actual situation. Nevertheless, I believe, that amount of schools and teachers who responded both during the interviews, as well as through the questionnaires, is sufficiently high enough to be able to stretch out the conclusions about the impact of ICT on students. Also the scale of divergence of answers to questions is not large between the respondents, which could mean that the presented data and the conclusions pulled out may be considered as trustworthy.

6.1 Further research

As mentioned previously, this study is based solely on teachers subjective opinions and perceptions of the ICT influence on students. One of the possible ways to continue research and achieve a higher degree of reliability, a study of practical use of ICT in
teaching would be interesting. Moreover, one could examine the impact of ICT on students and their study results with and without use of ICT. This could result in a large amount of quantitative data, which could be analyzed together with an empiric study of the practical use of ICT. An additional study concerning the student’s perspective and their favours and opinions on ICT could yield enthralling results. The students opinion could uncover many new questions and limitations, which we, as adults perceive differently than children.
Chapter 7

Conclusion

Based on the information gained during the research, as well as based on wide range of studies carried out on a much larger scale, despite all negative effects that ICT may be associated with, I can subjectively conclude, that the impact of ICT on students is positive in most cases. However, it is important that the introduction of ICT into the curriculum shall be carried out reasonably and with moderation. As it may be noted, a huge impact on how ICT affects the students has not only ICT itself, but also factors associated with it such as the access to technology, the attitude towards it, as well as the level of knowledge teachers possess. If the above elements are chosen in an appropriate manner, with a suitable technological base, as well as adequately educated staff, I consider that the influence of technology on students could be more positive than it is today.

ICT opens tremendous possibilities for teachers. Both the choice of the type of teaching aids and materials, as well as their availability has increased incalculably even compared only to the previous decade. However, with increasing possibilities of choice, it is more and more important that teachers not only teach, but also dedicate themselves to training. Along with better knowledge and experience, it shall become easier for teachers to use ICT and the use of technology would become more common and with the time ICT may slowly displace part of the classical methods of teaching. Important is, however, that teachers shall find the perfect balance between those ”two worlds” and shall manage to get the most out of both.

Consistent with Vygotsky’s beliefs, each environment that a distinctive individual is exposed to is not isolated from other environments, but each and every environment is a part of a bigger socio-cultural learning area. Taking this into account, it is important that the technology shall not be seen only as a tool for fun and entertainment, but technology shall also be seen as a tool that is fit for work and a great aid for learning.
Even if a school, to which the child is attending, for economical or other reasons, is not fully adapted to teach a child all aspects of ICT and its benefits, there is nothing that stops parents from teaching a child those values at home. Even before the era of the technology boom and the introduction of ICT into schools, it was imprudent to leave the upbringing, education and development of a child fully in the school’s hands. The child spends at most half of its day at school. How the child is going to spend the other half depends largely on his legal guardians. The earlier a child learns how to use technology, not simply in order to find entertainment, but also to be able to use it, to learn and maybe even craves to use the computer and other available technology for educational and developmental purposes, both the child’s motivation and its knowledge may grow with time. It may not be only a benefit for the child, but with time and a changed attitude towards technology’s purpose in a child’s early ages, it may benefit the image of ICT in education.
Appendix A

The effects of ICT in education

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration</th>
<th>Grade Level</th>
<th>Location</th>
<th>Source of ILS</th>
<th>Sample size</th>
<th>Achievement effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clariana (1996)</td>
<td>1 school year</td>
<td>5</td>
<td>Western U.S.</td>
<td>Jostens Learning Corporation</td>
<td>873 students</td>
<td>0.40</td>
</tr>
<tr>
<td>Fletcher, Howley, &amp; Pete (1990)</td>
<td>71 school days</td>
<td>3, 5</td>
<td>Canada</td>
<td>Milliken Math Sequences</td>
<td>79 students</td>
<td>0.40</td>
</tr>
<tr>
<td>Howell (1995)</td>
<td>1 school year</td>
<td>6 - 8</td>
<td>Georgia</td>
<td>Jostens Learning Corporation</td>
<td>131 students</td>
<td>0.14</td>
</tr>
<tr>
<td>Laub (1985)</td>
<td>7 months</td>
<td>4 - 5</td>
<td>Pennsylvania</td>
<td>CCC Success Maker</td>
<td>900 students</td>
<td>0.58</td>
</tr>
<tr>
<td>McCartney (1996)</td>
<td>6 months</td>
<td>8</td>
<td>New Jersey</td>
<td>WCAT Systems</td>
<td>52 students</td>
<td>1.05</td>
</tr>
<tr>
<td>Spencer (1996)</td>
<td>5 years</td>
<td>2 - 3</td>
<td>Michigan</td>
<td>Jostens Learning Corporation</td>
<td>92 students</td>
<td>0.37</td>
</tr>
<tr>
<td>Stevens (1997)</td>
<td>1 year</td>
<td>3 - 5</td>
<td>Texas</td>
<td>Jostens Learning Corporation</td>
<td>150 students</td>
<td>0.54</td>
</tr>
</tbody>
</table>

**Figure A.1:** Study features and effect sizes in 7 evaluation reports on integrated learning systems in mathematics. [25]

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration</th>
<th>Grade Level</th>
<th>Location</th>
<th>Source of ILS</th>
<th>Sample size</th>
<th>Math</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becher (2004)</td>
<td>1 school year</td>
<td>2 - 5</td>
<td>Inner-city school</td>
<td>Computer Networking Specialists &amp; Jostens Learning Corporation</td>
<td>NA</td>
<td>0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>Clariana (1994)</td>
<td>1 school year</td>
<td>3</td>
<td>Rural school</td>
<td>Jostens Learning Corporation</td>
<td>85 students</td>
<td>0.49</td>
<td>0.05</td>
</tr>
<tr>
<td>Leiker (1990)</td>
<td>1 school year</td>
<td>3</td>
<td>Texas</td>
<td>Jostens Learning Corporation</td>
<td>331 students</td>
<td>0.58</td>
<td>0.29</td>
</tr>
<tr>
<td>Miller (1994)</td>
<td>1 to 3 years</td>
<td>3 - 5</td>
<td>New York City</td>
<td>Waterford</td>
<td>30 schools</td>
<td>0.20</td>
<td>0.05</td>
</tr>
<tr>
<td>Roy (1993)</td>
<td>1 school year</td>
<td>3 - 8</td>
<td>Texas</td>
<td>Jostens Learning Corporation</td>
<td>956 students</td>
<td>0.15</td>
<td>0.44</td>
</tr>
<tr>
<td>Schmidt (1991)</td>
<td>8 months</td>
<td>2 - 8</td>
<td>California</td>
<td>Wasatch</td>
<td>1224 students</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Sinks (1999)</td>
<td>1 school year</td>
<td>2 - 6</td>
<td>Northeast U.S.</td>
<td>Jostens Learning Corporation</td>
<td>729 students</td>
<td>0.17</td>
<td>0.22</td>
</tr>
<tr>
<td>Underwood et al. (1996)</td>
<td>6 months</td>
<td>Elementary</td>
<td>United Kingdom</td>
<td>CCC Success Maker</td>
<td>173 students</td>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td>VanDusen &amp; Worthen (1995)</td>
<td>1 school year</td>
<td>Elementary</td>
<td>Several areas of U.S.</td>
<td>Unspecified</td>
<td>93 classes</td>
<td>0.09</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Note: NA = Not Available.

**Figure A.2:** Study features and effect sizes in 9 evaluation reports on integrated learning systems in mathematics and reading. [25]
### Appendix A.

<table>
<thead>
<tr>
<th>Study</th>
<th>Grade level</th>
<th>Duration</th>
<th>Location</th>
<th>Sample size</th>
<th>Reading effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kindergarten effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christopher (1991)</td>
<td>Kindergarten &amp; Special Ed</td>
<td>2 months</td>
<td>NA</td>
<td>209 students</td>
<td>1.06</td>
</tr>
<tr>
<td>Shaver &amp; Wise (1990)</td>
<td>Kindergarten</td>
<td>1 year</td>
<td>Louisiana</td>
<td>NA</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Grade 1 effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collins, Olla, &amp; Oliba (1990)</td>
<td>Grade 1</td>
<td>1 year</td>
<td>Canada</td>
<td>97 students</td>
<td>0.41</td>
</tr>
<tr>
<td>H. Jones (1991)</td>
<td>Kindergarten &amp; Grade 1</td>
<td>2 years</td>
<td>Texas</td>
<td>40 students</td>
<td>0.55</td>
</tr>
<tr>
<td>Rogier, Owens, &amp; Patty (1995)</td>
<td>Grade 1</td>
<td>1 year</td>
<td>Missouri</td>
<td>40 students</td>
<td>0.78</td>
</tr>
<tr>
<td>Sarangesam (1990)</td>
<td>Grade 1</td>
<td>1 year</td>
<td>New Mexico</td>
<td>121 students</td>
<td>0.21</td>
</tr>
<tr>
<td>Shaver &amp; Wise (1990)</td>
<td>Grade 1</td>
<td>1 year</td>
<td>Louisiana</td>
<td>NA</td>
<td>0.40</td>
</tr>
<tr>
<td>Velcher (1990)</td>
<td>Grade 1</td>
<td>1 year</td>
<td>California</td>
<td>179 students</td>
<td>-0.18</td>
</tr>
<tr>
<td><strong>Effects after Grade 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Howard &amp; Persaud (1992)</td>
<td>Grade 2</td>
<td>1 year</td>
<td>Georgia</td>
<td>12 schools</td>
<td>-0.01</td>
</tr>
<tr>
<td>Z. Jones (1993)</td>
<td>Grade 3</td>
<td>1 year</td>
<td>Chicago, Illinois</td>
<td>30 students</td>
<td>0.70</td>
</tr>
<tr>
<td>Leahy (1991)</td>
<td>Grade 1</td>
<td>2 years</td>
<td>NA</td>
<td>548 students</td>
<td>0.24</td>
</tr>
<tr>
<td>New York City Public Schools (1996)</td>
<td>Grade 2</td>
<td>2 years</td>
<td>New York City</td>
<td>1976 students</td>
<td>0.03</td>
</tr>
<tr>
<td>Varner-Quick (1994)</td>
<td>Grades 2 through 4</td>
<td>3 years</td>
<td>Detroit, Michigan</td>
<td>60 students</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note. Shaver & Wise (1990) examined both kindergarten and Grade 1 effects.

**Figure A.3:** Study features and effect sizes in 12 evaluation reports on Writing to Read. [25]

<table>
<thead>
<tr>
<th>Study</th>
<th>Grade level</th>
<th>Duration</th>
<th>Location</th>
<th>Sample size</th>
<th>Reading effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlational studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kunz (1999)</td>
<td>3, 6</td>
<td>NA</td>
<td>Illinois state-wide</td>
<td>500 schools</td>
<td>0.47</td>
</tr>
<tr>
<td>Paul, Swanson, Zhang, &amp; Hehenberger (1997)</td>
<td>3 - 8</td>
<td>NA</td>
<td>Tennessee state-wide</td>
<td>740 schools</td>
<td>0.33</td>
</tr>
<tr>
<td>Paul, VanderZee, Rue, &amp; Swanson (1996)</td>
<td>3 - 8, 10</td>
<td>NA</td>
<td>Texas state-wide</td>
<td>6000 schools</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Experimental &amp; quasi-experimental studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McMillan (1996)</td>
<td>4</td>
<td>1 year</td>
<td>Texas</td>
<td>214 students</td>
<td>-0.02</td>
</tr>
<tr>
<td>Peak &amp; Dewalt (1993)</td>
<td>3 - 8</td>
<td>5 or 6 years</td>
<td>North Carolina</td>
<td>50 students</td>
<td>1.12</td>
</tr>
<tr>
<td>Volland, Topping, &amp; Evans (1996)</td>
<td>Elementary</td>
<td>1 year</td>
<td>Aberdeen, Scotland</td>
<td>39 students</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Note: NA = Not Available.

**Figure A.4:** Study features and effect sizes in 6 evaluation reports on the Accelerated Reader reading management program. [25]
## Appendix A.

### Figure A.5: Study features and effect sizes in 10 reports on word processing and computer enrichment effects on student writing. [25]

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration</th>
<th>Grade level</th>
<th>Location</th>
<th>Sample size</th>
<th>Writing quality effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beyer (1962)</td>
<td>1 school year</td>
<td>Middle school</td>
<td>Delaware</td>
<td>16 schools</td>
<td>0.15</td>
</tr>
<tr>
<td>Dyckahl, Shaw, &amp; Bilasows (1997)</td>
<td>7 months</td>
<td>5</td>
<td>Northern U.S.</td>
<td>41 students</td>
<td>-0.42</td>
</tr>
<tr>
<td>Greyst &amp; Hannafin (1992)</td>
<td>3 weeks</td>
<td>6</td>
<td>NA</td>
<td>66 students</td>
<td>0.54</td>
</tr>
<tr>
<td>Li (1990)</td>
<td>5 months</td>
<td>8</td>
<td>Hong Kong</td>
<td>40 students</td>
<td>0.46</td>
</tr>
<tr>
<td>Follansbee et al. (1997)</td>
<td>6 to 8 weeks</td>
<td>4 - 6</td>
<td>Urban U.S.</td>
<td>104 students</td>
<td>0.36</td>
</tr>
<tr>
<td>Gardner, Morrison, &amp; Jarman (1990)</td>
<td>1 year</td>
<td>Elementary &amp; secondary schools</td>
<td>Northern Ireland</td>
<td>275 students</td>
<td>0.46</td>
</tr>
<tr>
<td>Nix (1998)</td>
<td>3 months</td>
<td>4</td>
<td>Texas</td>
<td>196 students</td>
<td>0.35</td>
</tr>
<tr>
<td>Owenon &amp; Wideman (1997)</td>
<td>3 years</td>
<td>3 - 5</td>
<td>Canada</td>
<td>110 students</td>
<td>0.33</td>
</tr>
<tr>
<td>Schiefer (1999)</td>
<td>2 years</td>
<td>5 - 6</td>
<td>Washington</td>
<td>477 students</td>
<td>-0.10</td>
</tr>
<tr>
<td>Stone (1995)</td>
<td>8 weeks</td>
<td>2</td>
<td>Massachusetts</td>
<td>56 students</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Note: NA = Not Available
Appendix B

Interview questions

Interview questions:

1. I teach the following subjects:

2. I am a teacher for the class(-es):

3. How do you use technology in your work?

4. Has the role of the teacher changed with the introduction of technology in school?

5. Curriculum - What goals and visions does school have and how does it work in reality?

6. What are your thoughts about rules that should apply?

7. How does technology and ICT aids work and in what situation is it used?

8. What kind of further education did you get when ICT was introduced into schools? What additional courses and further education possibilities do you believe is needed?

9. How well do you feel you are trained for the challenges that ICT brings?

10. How good is the access to ICT materials?

11. Is it easy to create your own material?

12. What form of ICT is best suited to support student learning?

13. Does ICT changed the way you teach?

14. Has ICT caused any problems or does it make your work easier?
15. How do you use ICT? (in the classroom, to preparations, during lessons, at presentations, communication with students, communication with colleagues, homework)

16. What forms of ICT do you use? (Computer, Tablet, Interactive board, GPS, Data projector, Camcorder, Voice Recorder ...)

17. Differs the students access to computers between school and home?

18. Are students allowed to use their personal computers/tablets during classes?

19. How do students use computers in their school work?

20. What is the impact of ICT on pupil’s motivation and focus?

21. What types of materials/ICT aids children consider as most exciting?

22. How is technology used in the communicative context? Does it help the children to become more active?

23. How do you assess the students’ computer skills? Are they curious or do they prefer the usual “old” methods?

24. Do you believe that ICT helps or hinders the learning? Does it affect the students negatively or positively?

25. If you look at your role as a teacher today - is it different from 5 years ago, 10 years ago?

26. Is it easier with ICT?

27. What do the students think about working with computers?

28. How do you and your students prefer to work?

29. What abilities do the students already have (chat, surfing, etc.)? What do they have the biggest problem with? Is it the knowledge or the access (too few computers, etc.)?

30. Do students learn faster, more, differently with the use of ICT?

31. Does ICT influence the students negatively according to you?

32. General advantages/disadvantages of ICT?

33. If something does not work or you do not understand something, is there any support available?

34. To what extent is ethics in relation to the use of ICT subject of your teaching?
Appendix C

Survey questions

Survey questions:

1. I teach the following subjects: (Open question)

2. I am a teacher for the class(-es): (Open question)

3. Differs the students access to computers between school and home?
   Possible answers: Yes, No, Do not know

4. Are students allowed to use their personal computers/tablets during classes?
   Possible answers: Yes, No

5. May the students use the computers etc. only with a teacher’s supervision?
   Possible answers: Yes, No, Other

6. What forms of ICT do you use?
   Possible answers: Computer, Data projector, Tablet, Interactive whiteboard, Video-camera, GPS, Smartphone, Dictaphone, Other

7. How do you use ICT as a teacher?
   Possible answers: In the classroom, The preparations, During lessons, At presentations, Communication with students, Communication with colleagues, Homework, Other

8. How good is the access to ICT materials?
   Possible answers: Very bad, pretty bad, neither good or bad, pretty good, very good, do not know/not applicable

9. How well do you feel you are trained for the challenges that ICT brings?
   Possible answers: Very bad, pretty bad, neither good or bad, pretty good, very good, do not know/not applicable
10. How would you rate the access to technical support?
   Possible answers: Very bad, pretty bad, neither good or bad, pretty good, very
good, do not know/not applicable

11. Has the role of the teacher changed with the introduction of technology in school?
   Possible answers: not at all, partially, much, very much, do not know/not appli-
cable

12. What is the extend of the use of ICT in the students’ school lives?
   Possible answers: very low, relatively low, neither low nor high, pretty high, very
high, do not know/not applicable

13. How often do the students use computers in their school work?
   Possible answers: not at all, rarely, often, very often, do not know/not applicable

14. How do you assess the students’ computer skills?
   Possible answers: Very bad, pretty bad, neither good or bad, pretty good, very
good, do not know/not applicable

15. What is the biggest problem students have in relation to ICT? (Open question)

16. What types of materials/ICT aids children consider as most exciting? (Open
question)

17. What kind of influence has ICT on the student’s motivation and focus?
   Possible answers: strongly negative, slightly negative, neither negative nor positive,
moderate positive, strong positive, do not know/not applicable

18. Does technology help the students to become more communicative?
   Possible answers: Yes, no, do not know/not applicable

19. How do you see the impact of ICT on the students’ learning?
   Possible answers: No effects, slight effect, neither small nor great, quite large effect,
very large effect, do not know/not applicable

20. What form of ICT is best suited to support student learning? (Open question)

21. Does ICT affects the student’s academic performance?
   Possible answers: Yes, Partially, No, do not know/not applicable

22. General comments. (Open question)
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