Digitalization of schools in Sweden

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Abstract

This thesis will be focusing on how digitalization has been implemented in elementary and middle school. It will also be studied which tools can be used to help future generations succeed in society. This will be researched through a systematic literature study done from the databases JSTOR and ACM. A semi structured interview will also be made to get a real time perspective of how implementation of digitalization can be made following the different findings. The result showed that elementary and middle schools are entering a new era where the way of teaching is changing based on how digital society has become. It also shows that schools are in need of good digital tools to help students succeed, and that it can be difficult to find the right tools, but that it is up to every principal to constantly search and implement new things.
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1.0 Introduction

It has always been in the school's interests to attempt to ensure the students of a well equipped education entering the working life, but also to navigate in the complex world as an independent individual. As a researcher is it interesting to read articles written in 2000 since that was the beginning of that hugemendous digitalization. Reading about the predictions concerning of how computer technology can help support learning and how useful it may be developing higher skills like critical thinking, analysis, and scientific inquiry [1]. For me as the author to know that this actually was the case is super interesting. It could already be predicted that not all programs and strategies would be efficient in a classroom environment. But also that research can show which factors will be highlighted and which ones will not. Focusing on this article from 2000, it is about the different ways computer technology can be used to improve what and how children learn in a school environment. The result of this shows that the use of technology as an effective learning tool is more likely to take place in embedded broades education forms that includes improvement in the curriculums, student evaluations, and the school’s capacity for change. However, the article ends with it mentioning that further research is necessary to identify the uses that most effectively support learning and conditions required to succeed with implementations.

Moving forward 19 years a lot have changed and as predicted in the last article, technology has made changes in how school is taught and made it easier for both teachers and students [2]. The digitalization has now reached a level where second-grade students have designed a puppy playground by using computational thinking. Computational thinking, CT for shortage is a fundamental skill not just only for computer scientists, but for all. CT can be used to provide a basis for problem solving, making evidence-based decisions, and to learn code or create programs. This is why it is important for early graders to have the opportunities to begin developing that type of problem solving and CT skills. In this article, teachers have designed an engineering design activity trying to introduce and engage children in kindergarten to second-graders in computational thinking. Through this exact activity the children had a 30-minute play-based activity where they could create a safe play space for Eva’s puppy. The implementation of this activity was placed in an informal learning setting in the safe presence of adults. For this to work the adults applied strategies to aid the children throughout the experience. As a conclusion of this activity, it is important in the 21st century to advance computational thinking in young children, which is why exposure like this activity
is important to promote and support childrens CT engagement. It can also be seen in the Next Generation Science Standards that this type of integration of engineering and CT is promoted.

Another example of how digitalization has progressed in Sweden is a study that has been made on 28 Swedish third-grade school children at the age of 9-10 [3]. This empirical study is based on the participation of these students in a creative workshop where they were challenged to design a digital game using stop-motion film technique by working in groups. This is another way of introducing CT at an early age just like the article presented above. The aim of the study is to investigate what aspects of computational skills can be identified participating in this activity. To collect data video observation, casual conversation, and stop-motion videos were presented. The result showed three aspects of CT strategies while children participated, step-by-step procedural skills, design and arrangement skills, and computational perspectives.

The research questions to be studied in this paper is:
Q1: How has digitalisation been integrated into elementary and middle schools?
Q2: Which digital tools could help future children to succeed in elementary and middle schools?

1.1 Aim and purpose

Through this article it will be studied how digitalization has been integrated into the schools, but also which digital tools could be implemented into teaching to help future children succeed. As understood, education is an important part in the future of development, which is why a functioning school system is necessary giving the future generation preparation for the future. The aim is to present ideas of tools to implement into the teaching to help students learn more and be prepared for the future adulthood, but also where the digitalization of teaching lies in this developmental society. The purpose of this research is to better understand how big of an impact digitalization has on teaching and how to improve it for future children. By trying to find different digital tools to help education, teaching and studying enter a new era and increase the quality of schools.
2.0 Background

2.1 CT

Computational thinking or for short CT is a combined word for an interrelated set of skills and practices for solving complex problems, disciplines, and a necessary skill to fully participate in the computational world [8].

To put a term on talking about computing many different terms are being used, computer science, computational thinking, and programming [8]. The word computing is encompasses the skills and practices in both of the terms computer science and computational thinking. However, computer science is an individual discipline, CT is problem-solving that integrates across different activities. programming is the practice of developing sets of instructions to a computer to make it understand and execute, but also to debug, organize, and apply the code to appropriate problem-solving contexts.

Focusing on computational thinking which is the broader, a more leveraging concept and skill for computer science and to apply them to other contacts, like core academic disciplines like art, English, and math, but also everyday problem-solving [8]. As for classroom educating, CT can be best understood as a series of interrelated skills and competencies. An example of how computational thinking can be implemented into the classroom is the pedagogies divided into three categories to emphasize the different pedagogical approaches. The first one, designing accessible instruction, refers to strategies teachers should use to engage all learning about computing. The second one, connecting students' interests, home, and communication, is about drawing on the experiences of students to design learning experiences that are connected with their homes, communities, interests and experiences to the relevance of computing. And lastly, acknowledging and combating inequity, which is that the teachers support students to recognize and take a stand against the oppression of marginalized groups in society broadly and specifically in computing. Together these three pedagogical approaches can promote a more inclusive CT classroom environment, but also life-relevant learning, and opportunities to critique and counter inequalities.
2.2 Skolinspektionen

2010 Sweden implemented a new unique law that requires the education of the schools to be based on scientific basis and proven experiences. Even though this comes with many positive effects as it shows a perspective of how important research is for the development of education, can problems be seen with the expectation and evolvement about the subject need to proceed. Schools need to receive plans and strategies for how research and scientific basis can be implemented into the teaching. Nevertheless, the principals and teachers have been alarmed about the difficulty in finding relevant research, studies, and knowledge overviews [9].

In the freedom of teachers deciding by themself the content and methods for their education, is the requirement of them finding scientific provement of them crucial [9]. This is why it is important for principals and those involved to create a structured plan to give teachers the presumptions needed to make education research based. Today there is an international contribution in giving the schools access to research and proven experience, with several Swedish institutions trying to spread, strengthen, and initiate research.

3.0 Method

The method chosen for this study is a literature study where scientific articles have been read, interpreted and analyzed within the chosen subject in order to deepen the knowledge and find an answer to the research questions [4]. However, a semi structured interview will also be made to get an example of how a school can interpret the content of “Skolverket”. The results in this article are based on a number of scientific articles to find positive effects of digitalization, but also examples of tools that could be used in Swedish teaching.

3.1 Method Discussion

For this paper a literature research will be made in the quest of answering the research questions. An interview will also be made to get the perspective of how a school can use “Skolverket” to teach the next generation of children, but also to get an example of digital tools that can be used to help students and teachers. Then thinking about which method to use it was decided that a literature study was the most suitable, however interviews and observations were discussed. Interviews would have given a good perspective of how schools
digitize their teaching right now, however it could be difficult to find enough material to answer Q2 in a futuristic perspective of development. An observation would have been a good method of testing the different tools in a school environment and observing teaching to see how digitalization influences schools. However it would be too big to test so many different tools and would take too much time observing schools when the answer already exists on the internet.

3.1.1 Literature study

A literature study was chosen since articles already have tested the different tools and that the information about digitalization in Swedish schools also exists on the internet. However, the combination of the two still needs to be done to present where the school is right now, which tools can be used to develop and how to proceed in the future.

When doing research it is often that quantitative and qualitative methods are separated. Qualitative research which is used here is based on the endless amount of subjective realities that is consumed by individuals [5]. Here the focus lies on words and not numbers, and to generate a theory from the empire instead of the theory testing. In this research paper a qualitative perspective will be taken and aims to illustrate where the research subject is at a standpoint rather than to make statistical conclusions, which leads to a deeper understanding of the subject.

A literature study is the information taken from other literature to gather information and make conclusions [5]. A systematic literature study can be described as a transparent and replicated research process whose purpose is to gather the best possible knowledge within the subject to answer one or more questions. By following guidelines can the best literature be found which increases the credibility. One guideline is the importance of having a critical approach on the research process, both against the literature researcher takes a part of, but also about the researchers limits to interpret the literature.

It can be seen as an disadvantage to use a systematic literature study, due to the guidelines less articles can be found which can lead to the risk of a different result [5]. However, by following the guidelines, the result shown is directly addressed to the subject. Nevertheless, if this becomes a risk this research will be more about enlightening how far the subject has come and for what use it can be used, rather than to make a statistical conclusion. Another risk with a literature study is that the researcher needs to trust that the literature used is
correct and that they have made the right conclusion of the reality. By studying more research papers the researcher is trying to find the most accurate information needed to get the right answer. To get all the information necessary some gray literature has been used to be able to better understand the guidelines and laws that schools are using. Since it is important to use first hand information it is important to use this gray literature instead of gathering it from research articles.

3.1.2 Interview

In this research a semistructured interview was also made, this to get a perspective of how schools can implement digitization, thoughts about the future and worries [6]. By having a semistructured interview premade questions were made, but during the interview other questions were also asked to get deeper into the subject and to get the proper answer. In the choosing of questions they were created to get as much information as possible and possibilities of discussing deeper, see appendix A. The main aim with the interview is to confirm the answer from the literature study and to mainly answer Q1, however one of the questions is to get a perspective of the digital tools used right now and the image of change to implement digital tools in the future. The interview was with a principal of an elementary and middle school in Sweden.

3.2 Data collection and selection

Research words for search are to be acknowledged and afterwards should the searching begin. The result of those searches should be analyzed and integrated to be used however the researchers like, to be finalized and written down in the result. Through this project two different databases have been used, JSTOR, and ACM. These databases were selected based on the theme of the research and research questions and the width of different articles published in the databases to be able to get a wide view of solutions to the different problems. To be sure that the right articles are shown the function to sort out peer reviews is used, however it is important to control the articles before using them as research. Peer review is used to only show scientific reviewed articles.

To get the most relevant research the time episodes are between 2018 to 2023. The reason for only showing articles during 5 years is that technology changes quickly and to be certain that articles with already addressed challenges are shown and that only the most accurate articles
with challenges and solutions. Of course there can be challenges that have not been addressed from time episodes earlier and good ideas of solutions as well, however to not make this research too big and time consuming the researchers have chosen to only work with newer articles.

The research words used in this thesis were:
- digitalization in + school
- digitalization of + schools
- digitalization of + school systems

Through these searches over a thousand searches were shown since the subject is so big, to narrow it down the word “Sweden” was added first to get a perspective on what articles about digitalization in Sweden have been produced. However it is also important to get the perspective from around the world as a more global perspective, especially since this research is about finding out if Sweden could and should digitize more. By searching with these 2 articles on ACM and 51 on JSTOR was found, based on this the most accurate articles were chosen to help answer the questions. In the second search Sweden was removed and the focus was laid on digitalization and school to find the global perspective. The result was thousands on JSTOR, which is why it was narrowed down by only searching for research articles on both of the databases. This gave a search result of 67 on JSTOR and 38 on ACM. However, it was decided to manually select the most accurate ones from here.

The manual search was made by reading the articles, the articles with titles which were found to not be accurate to answer the research question were removed. Moving on with the articles whose title fitted where the abstract of those articles read to quickly get a view if that article would be useful or not. The abstract should give the reader a short summary of the article's content. From here more articles were removed that were not relevant for this research. From this stage every article was read and eventually removed if the content was not usable. The result was the 14 research articles presented in the appendix that are the ground to the data analysis as a result.

However, to be able to answer the research questions whether the Swedish curriculum is up to date when it comes to digitalization and preparing generations for the future is also the
curriculum from [7] used. Here the 19 subjects in elementary school are taken under consideration and analyzed to find the answers to this article.

3.3 Data analysis

To understand the chosen articles and to not miss anything a matrix was done to get a better view of the content, all the information has been gathered to a table in the result. This also makes it easier to go back and confirm that the right result was presented. This made the process easier to go back to remember what the article was about and where to go in for more detailed information. The matrix was used as a tool not having to search through all of the articles, however all of the articles were read multiple times to make sure that everything was objective and no misunderstandings were made.

4.0 Result

4.1 Digital content from the central content on “Skolverket”

This is an extract from the central content presented on the website of “Skolverket”. It shows the points of what schools are supposed to teach students about digitalisation. It shows in which subject and in what year the student should be able to prove knowledge of digitalization.

4.1.1 Art

4.1.1.1 Year 1–3

The student should be able to take photos and to transfer and work with pictures with the aid of digital tools [19]. Some tools and materials the student should have worked with are painting, drawing, modeling and constructions for photographing and other digital working with images.

4.1.1.2 Year 4–6

The student should be able to reuse and work with pictures, like collages and picture montage. The student should also be able to work with pictures, movies and other digital creations and also editing pictures and moving images [19]. The student should have understanding of the commercial image, for example commercial and news images.
4.1.2 Biology

4.1.2.1 Year 1–3
The student should be able to work with simple field studies, observation and experiment should be able to be done with words, images and digital tools [19].

4.1.2.2 Year 4–6
The student should be able to work with field studies and experiments through analog and through digital tools should be able to be feasible by planning, performance and analyzing the result with words, images and tables [19].

4.1.3 English

4.1.3.1 Year 1–3
The student should be able to speak English clearly from simple texts that are instructive, contact-making and descriptive from the media, and combined with illustrations. Be able to understand movies and dramatized stories. And know words and phrases from the environments, like on signs, advertising and other simple texts.

4.1.3.2 Year 4–6
The student knows strategies and that within to reformulate, question and support questions, to contribute and ease the conversation and written conversation, even digital ones [19].

4.1.4 Physics

4.1.4.1 Year 1–3
The student should be able to make simple field studies, observations and experiments. Performance and documenting with words, images and digital tools [19].

4.1.4.2 Year 4–6
The student should be able to make observations and experiments with both analog and digital tools. Planning, performance, and analysis of the result should be done with documentation with words, images and tables [19].
4.1.5 Geography

4.1.5.1 Year 1–3
The student should be able to talk and make reflections about norms and rules in the student's living environment, that within school and digital environments [19].

4.1.5.2 Year 4–6
The student should be able to make digital and analog maps and how it is built with grad grid, colors, symbols, and size, but also Topographic and thematic maps [19].

4.1.6 History

4.1.6.1 Year 1–3
The student should be able to reflect and have conversations about norms and rules in the student’s environment, that within school and digital environments. But also know about the globe, analog and digital maps and its size relationships and directions [19].

4.1.6.2 Year 4–6
The student should know what historical sources are, examples of which are archaeological findings, letters, story tellings and digital material, and how they can be used to give knowledge about the past [19].

4.1.7 Chemistry

4.1.7.1 Year 1-3
The student should be able to make simple field studies, observations and experiments. Performance and documenting with words, images and digital tools [19].

4.1.7.2 Year 4–6
The student should be able to make observations and experiments with both analog and digital tools. Planning, performance, and analysis of the result should be done with documentation with words, images and tables [19].
4.1.8 Mathematics

4.1.8.1 Year 1–3
The student should be able to make simple tables and charts, and know how to use them to sort data and to describe the result from investigations, with and without digital tools [19].

4.1.8.2 Year 4–6
The student should know the methods for calculations with natural numbers and simple numbers in fractional and decimal form for rough calculation, main calculation and written calculation. Use of digital tools in calculations [19]. Programming in visual programming environments. How algorithms are created and used in programming. Tables and charts to describe survey results, both with and without digital tools. Interpretation of data in tables and charts.

4.1.9 Music

4.1.9.1 Year 1–3
The student should know the percussion instruments, string instruments, keyboard instruments and digital tools for making music and creating music [19].

4.1.9.2 Year 4–6
The student should know the chord, melody, bass and percussion instruments as well as digital tools for making music and creating music [19].

4.1.10 Religion

4.1.10.1 Year 1–3
The student should be able to reflect and have conversations about norms and rules in the student’s environment, that within school and digital environments [19].
4.1.11 Civics

4.1.11.1 Year 1–3
The student should be able to reflect and have conversations about norms and rules in the student’s environment, that within school and digital environments [19].

4.1.11.2 Year 4–6
The student should know how digital and other media can be used responsibly based on social, ethical and legal aspects [19].

4.1.12 Swedish

4.1.12.1 Year 1–3
The student should know joint and individual writing. Strategies for writing words, sentences and different types of texts with adaptation to their structure and linguistic features [19]. Creation of texts where words and images interact, both with and without digital tools. Handwriting and writing with digital tools. Oral presentations and oral narration. Objects, images, digital media and tools and other aids that can support presentations. Texts that combine words and images as well as texts in digital environments for children. How words and utterances are perceived by the environment depends on body language, tone of voice and nuances of words. Language use and opportunities and risks in own communication in digital media. Information search in books, magazines and websites for children as well as in internet search services.

4.1.12.2 Year 4–6
The student should know joint and individual writing. Strategies for writing different types of texts with adaptation to their structure and linguistic features [19]. Creation of texts where words, images and sounds interact, both with and without digital tools. Handwriting and writing with digital tools. Dictionaries and digital tools for spelling and word comprehension. Oral presentations and oral narration for different recipients. Outline with introduction, content and conclusion. Supporting words, images, digital media and tools as well as other aids for planning and carrying out an oral presentation. How gestures and body movements can affect a presentation. Texts that combine words, images and sounds as well as texts in digital environments. The content, structure and typical linguistic features of the texts.
Formal and informal language. Differences in language use depending on recipient, purpose and context. Responsible behavior when communicating in digital and other media. Information search in a few different media and sources, for example in reference books, through interviews and in internet search services.

4.1.13 Technology

4.1.13.1 Year 1–3

The student should know some objects and some technical systems in the students' everyday life, how they are adapted to human needs and how they have changed over time [19]. Safety in students' use of technology, for example electricity and various services via the internet. What computers are used for and their parts for inputting, outputting and storing information. Objects in students' everyday life that are controlled using programming, for example household appliances and smartphones. Control of objects with programming.

Documentation of technical solutions: sketches, images, words and simple physical and digital models.

4.1.13.2 Year 4–6

The student should know opportunities, risks and safety when using technology in everyday life, for example when using electricity and when transferring information in digital environments [19]. Some of the computer's parts and their functions, for example processor and working memory. How computers are controlled by programs and can be linked together in networks. Technical solutions that use electrical components and simple electronics to produce sound, light or movement, for example alarms and lighting. Terms used in connection with this. The different phases of technology development work: identification of needs, investigation, proposals for solutions, construction and testing. Control of own constructions or other objects with programming. Documentation of technical solutions: sketches with views and measurements, words and physical and digital models.

4.1.14 Religion

4.1.14.1 Year 1–3

The student should be able to reflect and have conversations about norms and rules in the student’s environment, that within school and digital environments.
4.2 Change of curriculum and syllabus 2022, Skolverket

In the autumn of 2022 was the changes of the curriculum and syllabus presented for elementary school and others [7]. With a focus on the syllabus three major changes were done, first was the central content and the rating criteria changes by making the central content more adapted about scope, degree of concreteness and progression. The rating criteria is less detailed now to make the teachers’ conditions of setting a more fair grade and reduce the risk of the rating criterias to control the teaching. The aim of changing the curriculum is to make it a better tool for the teachers.

However it is up to the teacher to decide how the central content should be used in teaching depending on the students and their knowledge [7]. In grading is the teachers using the rating criteria which should be read and interpreted from the central content and the teaching from the teacher.

4.3 Systematic literature study

In the table below can the result from the literature study be seen, it has been chosen to separate the table into five categories to easily get an understanding of what the study is about, the first section simply gives the source a number to easily find an article, the next one contain the title and the link to where the article have been found to be able to read more about the paper, the third one presents the aim of the paper to easy get an understanding and knowledge about the paper. The forth one is presenting the method, and the last one presents the result and findings.

<table>
<thead>
<tr>
<th>Nr</th>
<th>Title</th>
<th>Aim</th>
<th>Method</th>
<th>Result</th>
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<tbody>
<tr>
<td>1.</td>
<td>A designerly approach as a foundation for school children's computational thinking skills while developing digital games</td>
<td>The study shows a designerly approach to game design activities to investigate the aspects of computational skills that can be identified when children employ stop motion filmmaking as a</td>
<td>The method included video observations, casual conversations, and stop-motion videos representing the children’s game</td>
<td>The analysis showed three aspects of computational thinking strategies while children produced stop-motion films: step-by-step procedural skills; design and arrangement skills; and</td>
</tr>
</tbody>
</table>
2. **Programming in primary education: towards a research based assessment framework**

   In March 2017, the Swedish government decided to introduce digital competence, within programming, in primary school [10].

   a longitudinal research project investigating how students programme in primary school [10].

   presenting the main findings related to the suitability of the instrument based on a pilot study done in spring 2019, collecting data from 310 students [10].

3. **Creative Situated Augmented Reality Learning for Astronomy Curricula**

   This study proposes a creative situated learning through (AR) and develops an AR-based Cosmos Planet Go App to show the motion of planets in the universe [18].

   A quasi-experimental method was used and a qualitative analysis. The control group were using “normal” classroom narrative teaching, and the experimental group students were using the AR-based Cosmos Planet Go App [18].

   results showed that students who learned with the use of the AR-based Cosmos Planet Go App performed much better than the control students on measures of learning effectiveness, learning motivation, and flow experience [18].
<p>| 4. | <strong>Playgrounds in the digitally mediated city: An approach from augmented reality</strong> | A child-friendly city can be a place to engage children using contemporary tools such as AR, this helps children communicate better and get abilities such as spatial cognition, and physical and social skills in the physical and digital world [17]. | This method explores various examples and analyzes the child-friendly city features of each [17]. | This result shows AR and its capabilities as a potential tool to be used in the city to pave the way toward a child-friendly mediated city, an inclusive social urban environment where children play or spend their leisure time and effectively mature into adulthood [17]. |
| 5. | <strong>Assessment of Satisfaction Levels of Learning Foreign Languages in a Digital Format for Students / Course Attendees</strong> | The aim of this study is to identify ways to optimize the organization of the educational process, its didactic and methodological support [16]. | The method in considering this problem is a double sample questionnaire and regular conversations with students [16]. | The results are presented and some ideas for reorganizing the educational process in the context of the ever-increasing digitalization of education are considered [16]. |
| 6. | <strong>An Integration of Computational Thinking and Language Arts: The Contribution of Digital Storytelling to Students’ Learning</strong> | The study focuses on language arts, English as a second language. It investigates digital storytelling as a way to integrate CT, analyzing its impact on students’ learning both of English and of CT, and on students’ attitudes toward the CT integrated English lesson [11]. | A class of 8th grade students participated in the study. The method was investigating the students’ final products, surveys, rubrics, exit tickets and focus group interviews[11]. | The results showed that the digital storytelling approach may improve students’ learning of English and of CT, and that it helped improve students’ creativity and collaboration, thus promoting their digital participation [11]. |</p>
<table>
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<tr>
<th>7.</th>
<th><strong>Creation and Development of the Digital Learning Environment in Educational Institutions</strong></th>
<th>The educational process takes place regardless of time and place. It evolves and requires quick and easy access to information and educational resources [15].</th>
<th>The approach of creating and using the digital learning environment of the educational institutions involves the use of all its elements [15].</th>
<th>This approach will create and develop the digital learning environment of the educational institutions that can be adapted to innovation in education and ICT [15].</th>
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<tr>
<td>8.</td>
<td><strong>Using the digital platform in personalized student learning</strong></td>
<td>The article presents the issues of preparing students in digital personalized learning. The main priorities of digital transformation is the framework models, the main stages of changing the culture of an educational organization from analog to digital are given [13].</td>
<td>A digital platform where students can participate in the development of educational programs and create their own learning schedule [13].</td>
<td>The results showed the success of the digital platform, as well as a high level of digital literacy of employees, that contributes to the introduction of modern approaches to the implementation of university activities and readiness for new challenges [13].</td>
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<td>9.</td>
<td><strong>SpARklingPaper: Enhancing Common Pen-And Paper-Based Handwriting Training for Children by Digitally Augmenting Papers Using a Tablet Screen</strong></td>
<td>With SpARklingPaper, are the first to combine the genuine haptic feedback of analog pen and paper with the digital support of apps. It enables children to write with any pen on a standard paper placed on a tablet’s screen, showing animated letters</td>
<td>Two online surveys with overall 29 parents and teachers of elementary school pupils and a user study with 13 children and 13 parents for evaluation were used [12].</td>
<td>Results show the importance of a genuine analog haptic feedback, with the augmentation of SpARklingPaper [12].</td>
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<td></td>
<td><strong>Title</strong></td>
<td><strong>Description</strong></td>
<td><strong>Findings</strong></td>
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<td>10.</td>
<td><strong>Game-Based Teaching of Basic Hardware Components With an Educational Virtual Reality at Different Levels of Immersion</strong></td>
<td>In the VR &quot;Bill’s Computer Workshop&quot;, students explore the inside of a computer and other products while searching for hardware components [14].</td>
<td>A study with 71 middle school students compared three different devices, laptop, Mobile VR, Head-Mounted-Display, studying levels of presence and resulting learning outcomes [14]. The findings show first, a strong effect of the virtual environment for the intended learning objectives, secondly, a higher level of technological immersion does not automatically lead to higher learning outcomes, and third, a positive correlation between presence and learning outcomes [14].</td>
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<td>11.</td>
<td><strong>Comic-based Digital Storytelling with Primary School Children</strong></td>
<td>The aim of the study is to investigate how comic-based storytelling supported by a digital tool, named Communics, can facilitate primary school children in creating stories and in reflecting on situations involving discrimination within the classroom context [20].</td>
<td>In the first stage, two teachers were involved to negotiate the intervention, but also to define graphical and textual content, In the second stage, a piloted intervention with 12 children investigated the scaffolding opportunities offered by The result discussed preliminary insights and suggestions for future studies [20].</td>
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<td>12.</td>
<td>Developing a Mobile-based Digital Math Game for Learning Number and Calculation in Elementary School</td>
<td>The aim of the study was to develop a mobile game-based math learning APP for students in elementary school [21].</td>
<td>The users had to solve math problems to finish the challenging mission in the process of the digital game. When they encounter difficulties in the game playing, the APP offered real-time intervention gradually for assisting them to break through the challenge [21].</td>
<td>The result of the study was an expert evaluation and learning experiment. The evaluation results showed that the experts proved high appraisal toward this APP and the learners expressed their high interest and willingness to use it [21].</td>
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<td>13.</td>
<td>Introducing Coding through Tabletop Board Games and Their Digital Instantiations across Elementary Classrooms and</td>
<td>This paper presents an approach for helping elementary schools integrate computational thinking and coding by leveraging existing resources and</td>
<td>The model presented emphasizes instructional linkages being made between one domain (the</td>
<td>The result presents the experiences of three elementary school teachers as they implemented the unit in their classrooms with the help of their school librarian. Also</td>
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<td>School Libraries</td>
<td>Infrastructure that do not rely on 1-1 computing. Through tabletop board games, students can use their prior knowledge and ease with tabletop gaming mechanics to cue relevant ideas for core computational concepts [22].</td>
<td>Tabletop board game) and another (specially designed Scratch project shells with partially complete code blocks) [22].</td>
<td>Showing initial findings on the impact of the unit on student interest, as measured by pre- and post-surveys [22].</td>
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<td><strong>14. Computer Science Unplugged</strong></td>
<td>The digitalization has now reached a level where second-grade students have designed a puppy playground by using computational thinking. In this article, teachers have designed an engineering design activity trying to introduce and engage children in kindergarten to second-graders in computational thinking [2].</td>
<td>Through the activity the children had a 30-minute play-based activity where they could create a safe play space for Eva’s puppy. The implementation of this activity was placed in an informal learning setting in the safe presence of adults [2].</td>
<td>The result showed that it is important in the 21st century to advance computational thinking in young children, like in this activity [2].</td>
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### 4.4 Interview

The principal informed that “Skolverket” were used as a plan for the teachers to use and that there has been a change in how digitalization has made its way into the teaching. Before
teachers and principals felt that they had to work directly with digitalization and implementing it into the teaching like how to use an ipad or having the children take license for computers. However, with difficulties regarding children distracting themselves with digital tools and the effects of social media, the teaching has entered a new era. The principal felt that the schools have moved on and are now focusing more on how digital tools can improve the teaching, the principal said the following. "It's not the digital technology they have to learn, like it was before. Okay, you're going to get a computer driver's license and you're going to learn these programs. But we have passed that, now we rather think like this, the students should learn about climate types, in what way can the digital transformation support learning, to take learning to the next level, we can use VR glasses, green screen." which has been translated from Swedish. 

At this school are two specific digital tools used, Glerups and Classroom. These two were selected because they work well together and Glerups can be used with most of the subjects and can be adapted to children with specific needs like the text to be read to them or certain words/senticent underlined.

For this specific era the principals of the schools are trying to put together a profile for the school that can match what will happen in society within the coming 15 years to prepare students properly. To do this, the principal means that the profile has to be at the line of technology and innovative enough to match what is to come, with VR glasses and other digital tools and programs. However, for this to work the principal means that it is important to give the teachers the right education, some of the teachers went to school 30 years ago which gave them a very different education to prepare students then what is needed now. That is why it is important for the teachers to have the right knowledge to teach students the right way.

4.5 Q1: How has digitalisation integrated into the elementary and middle schools?

As understood by the school system based on different standpoints, there is the law to follow and also the requirements from “Skolverket”. All of these requirements and guidelines create a system for the schools to follow. Even though they are free to put up their own way of teaching, they are following those requirements. Which is why the importance of a good
central content that is up to date to prepare the students the right way for the future. As seen in the cutout of information of the central content can digitalization be seen in most of the subjects taught in school, it doesn't say how to implement the digital tools or which to use, that leaves the schools with wider possibilities. For example, should a student in year 1-3 in Biology be able to make simple field studies, observations and experiments with words, images and digital tools [19].

From the interview could a perspective of how the central content and digitalization is handled in that school to give an idea of examples of integration. By reflecting over the central content and the way this principal integrates digitalization a shift in teaching appeared. No longer are the teachers teaching the student how a computer or an ipad works, now it is important through different subjects to teach the students how to use digital tools to improve their teaching. It can through this shift be seen that the school system is developing right now, schools have to find new tools to improve the teaching.

From both of these methods used, and all the information gathered can six major findings be shown as proof of how digitalization has been integrated into the teaching industry, all listed beneath.

1. In March 2017, the Swedish government introduced digital competence, including programming into the primary school [10]
2. English Year 4–6.
3. Mathematics Year 4–6
4. Swedish Year 1–3
5. Technology Year 4–6
6. Digital frameworks that work together to inform and let the children work with, like Gleerup

Below will it be presented why these six are proof of how digitalization has integrated the elementary and middle schools. To begin with the first one has since 2017 been law to teach students about programming in primary schools [10], this is a major example of how digitalization has integrated itself into the schools.

Moving along with number two and how digitalization has entered teaching in the subject English, can it be seen in the central content that it is important for the students to show
knowledge about strategies and that within to reformulate, questions and support questions, to contribute and ease the conversation and written conversation, even digital ones [19]. This gives the schools the option in how to teach their students these requirements. Nevertheless, it shows the importance of the schools evolving the students into developing the right characteristics.

Another example of how digitalization has been integrated into schools is in the subject mathematics and year 4-6 where the student should know the methods for calculations with natural numbers and simple numbers in fractional and decimal form for rough calculation, main calculation and written calculation. Be able to use digital tools in different calculations, program in visual programming environments, and know how algorithms are created and used in programming. Tables and charts to describe survey results, both with and without digital tools. Interpretation of data in tables and charts[19]. Here digitalization has entered into many different parts of the subject, which shows the importance of integrating digitalization into the subject to prepare the students for the future. Here it can be seen to be used for many different parts of the teaching, calculation, algorithms, and surveys with tables and charts are some examples of where digitalization has been integrated.

In the subject Swedish has digitalization been majorly integrated into many different categories, in the year 1-3 can it be seen in the central content as, creation of texts where words and images interact, both with and without digital tools. Handwriting and writing with digital tools. Objects, images, digital media and tools and other aids that can support presentations. Texts that combine words and images as well as texts in digital environments for children. Language use and opportunities and risks in own communication in digital media. Information search in books, magazines and websites for children as well as in internet search services[19]. Digitalization can be seen in many different parts of this subject as well, it can be seen in image work, writing, digital media, presentation, and digital environments. All of these parts are proof of how digitalization has been integrated.

Technology which contains the most integration of digitalization and technology can there be seen a diversity of different types of digitalizations and characteristics that is necessary to prepare future generations for this high-tech society. The central content contains the following about digitalization in the year 4-6. The student should know opportunities, risks and safety when using technology in everyday life, for example when using electricity and
when transferring information in digital environments. Some of the computer's parts and their functions, for example processor and working memory. How computers are controlled by programs and can be linked together in networks. The different phases of technology development work: identification of needs, investigation, proposals for solutions, construction and testing. Control of own constructions or other objects with programming. Documentation of technical solutions: sketches with views and measurements, words and physical and digital models[19].

Lastly, from the interview done with a principal in Sweden was told the importance of a good digital framework where the students can get information and work with their homeworks. This shows a way that digitalization also has entered schools, not only for the subjects taught in school, but also the way it is structured, where the students grades are published and all information for the students, teachers and parents to get important information, that also will help improve students chances of succeeding. A study was made in this area and the results from the analysis of scientific and pedagogical works of foreign and domestic researchers, international documents of the Council of Europe, OECD, and legislation [15]. It is clarified that the digital educational environment is an effective tool to educational processes and in the process of professional self-improvements. To create and maintain a digital learning environment as a part of the digital ecosystem is an important task of the system. It is noted the importance of aspects in the development of modern digital educational environment are compliance with the principles of continuity and consistency, equal access to education, anti-discrimination, gender equality, information security, mobility; interactivity; involvement in the professional development of teachers and professional interaction of various actors and stakeholders; unity of purpose, content and focus on results; innovation and content with digital means; the ability to create their own digital resources and interaction of participants in the learning process in an unlimited open educational information space [15].

4.6 Q2: Which digital tools could help future children to succeed in elementary and middle schools?

There are many different tools that can be used to help children succeed in school, and it is important that schools continue to search for new articles that are published. Below is listed several articles with different digital tools that can be implemented into teaching.
1. SpaRKling Paper [12]
2. Cosmos Planet Go App [18]
3. Bill’s Computer workshop [14]
4. A designerly approach as a foundation for school children's computational thinking skills while developing digital games [3]
5. Playgrounds in the digitally mediated city: An approach from augmented reality [17]
7. Using the digital platform in personalized student learning [13]
8. Comic-based Digital Storytelling with Primary School Children [20]
9. Developing a Mobile-based Digital Math Game for Learning Number and Calculation in Elementary School [21]
10. Introducing Coding through Tabletop Board Games and Their Digital Instantiations across Elementary Classrooms and School Libraries [22]

It can be hard for schools to find the right digital tools to teach students about technology and at the same time make them learn something else and to not make them lose any abilities. However, in the list above are eleven examples of well tested activities schools could implement to fulfill the central content and help students succeed in the future. SpaRKlingPaper, is one example of this. At this stage there are many digital devices that are omnipresent and educational apps to improve learning, however they are seldom used to train handwriting where pen and paper still is the standard due to the genuine haptic feedback [12]. Which is where SpaRKlingPaper comes in as an augmented handwriting system that combines a pen, a standard paper, and a tablet and with that gives the specific benefits of the genuine haptic feedback and the individual digital learning of students. The focus lies on a comfortable pen writing and a high accessibility for a vast population by using already available smartphones and tablets, to be used in class as well as in homes.

Another example is the Cosmos Planet Go App that showed that students who learned with the app performed better than the control students on measures of learning effectiveness, learning motivation, and flow experience [19]. The learning engagements that occur when
students can use multiple perspectives to solve problems, is the most important element to evaluate AR-learning in creative situations. AR can effectively enable students to observe and understand the course content. Materials designed via ARCS teaching strategies can also help students improve either learning effectiveness [19]. By proposing a creative situated AR environment combines situated learning theory, the characteristics of AR with the ARCS motivation theory and creative learning environment model to develop the AR-based App, such as Cosmos Planet Go App.

Bill’s Computer Workshop could be used in the subject, Technology to help students learn some of the central content requirements. This research shows that there is no need for expensive equipment to engage students in first-hand, perceived-as-real learning experiences [14]. Nevertheless, other subjective factors are crucial to proceed any further research on how to integrate immersive technology into the classroom. As an outcome when linking the virtually supported and the physical classroom learning activities, VR has shown as a promising tool for computer science teaching and learning.

However, to implement characteristics in students, very little digital equipment be used, in this activity important characteristics are taught [3]. The workstation was built with a table in the center, chairs, the workshop material, and a fixed camera facing the table center to record the activities at the workshop. To help there were three assistants to assist the university teacher by helping the children needing help, keeping eyes on the cameras, and supplying the children with fruit and water. Even though CT was introduced based on the children’s previous experiences and knowledge of playing digital games, which can be varied based on your background, by applying the designing approach, the author argues that the children have extended possibilities to develop CT skills as well as developing confidence and pride in work [3]. However to make sure CT is implemented the right way, there needs to be further exploration to find strategies to develop the students design interaction anc CT skills for personal development and to raise new design and digital skills necessary in their future.

Another example of an activity that can help teaching the subjects in school is this study which explores different examples and analyzes the child-friendly cities features of each one [17]. It presented AR and its capabilities as a potential tool utilized in the city to make a way towards child-friendly cities, where children can play or spend their leisure time and
effectively mature into adulthood. AR facilitates the development of skills among children. It develops inquiry-based learning, spatial ability, and practical skills, and can further create hybrid learning environments that combine digital and physical objects [17]. By utilizing AR to be more present in the city and perform physical activities to develop various skills. With the results from the methodology can AR provide the urban environment with more features of a child-friendly city to inspire children to more active presence.

5.0 Discussion

Based on the study made of “Skolinspektionen” there is a positive possibility that there is a corroboration between the teaching and principals through the education of teachers (VFU) and the research facilities of teachers [9]. However, there is also the regional development center (RUC) that is working with just the collaboration of schools, universities and colleges. Nevertheless the government tried to help schools in 2017 to find a way to develop models to find more research based content for teaching. However, by the study done, research shows that there is still a need for development to help teachers and principals find more research based content.

As seen in the result, can digitalization and knowledge about important tools be seen in many of the subjects studied in schools [9]. It can also be seen that even at an early age the government is trying to implement this knowledge to the students. Seeing that it has been updated recently indicated that the content is accurate and adopted for the right time of being.

An example of how the government have given the teachers an opportunity to implement the digital characteristics and the skills of digitalization at an early age is the central content year 1-3 geography where the student should be able to talk and make reflections about norms and rules in the student's living environment, that within school and digital environments [7]. However this is only a guideline and the teacher can interpret it however they like. The teacher could use a strategy like “A designerly approach as a foundation for school children's computational thinking skills while developing digital games” where the students develop several different characteristics and learn both about digital tools and the subject taught [3]. However, this is only one way to interpret the central content and it can also be taught in a way that does not challenge the minds of the students.
Even though the central content is just guidelines for schools to follow, could the interview interpret that at least this school is using it as the major influence while planning the education, and are doing their best to implement everything into the schedule. This school and the entire principal area are working together to implement digitization and evolve teaching as much as possible and hold a positive image of it. This principal even implemented that even though some teachers were against the fast forwarding of technology and digitalization, teachers would not know how to educate anymore without technology.

Nevertheless, there are two research questions in this paper, to be able to answer the second question, an understanding of how digitalization has been integrated into schools is necessary, which is why Q1 is existing. Since the implementation of digitalization has evolved and is now entering a new era it is important to gather information about tools for schools to use to succeed in following the central content, the law, and preparing the students the right way. With all of the digital tools presented in the literature study it is impossible to know the outcome in 20 years, however, it is important to do research about it, like it has been done in the presented research to have the right information before implementing it into teaching.

As presented in the result, there are numerous activities that can be implemented into teaching and different frameworks that would help structure the teaching which would benefit students, teachers and parents. However, it can be difficult for schools to verify which articles are studied enough and it is also impossible for schools to know how it will affect students in the long run, especially since new activities and research are published frequently. Which is why it is important for schools to put time to verify that the research is well tested by reading them thoroughly and putting up guidelines for the school to follow before implementing the activity into teaching.

Focusing more on research question one, and how digitalization has entered teaching can it be seen in numerous parts of the central content how important digitalization is for teaching. Many examples have been given of where technology and digitization has been implemented. However, as discussed above and found in the gray literature are there obstacles that can make it difficult for schools to know how to implement new parts into teaching. To help schools with this obstacle are VFU and RUC as written above to help, but also the statement from the interview, that it is up to them to support the teachers in this change, and handle the
consequences from it. Which is why there is a need for guidelines and further help for schools around the country to know how and what to implement.

If summarizing the information gathered from the central content that contains digitalization can it be seen in subjects where the student should be able to do different types of observation and field studies with the help of different tools such as digital ones. This can be seen in different subjects such as biology, civics and chemistry. Seeing the pattern of the central content containing similar content for different subjects would one digital tool that could be used for the different subjects be at best interest for the schools, and is where the focus might be at for schools in the search for tools that could help teach this.

As for the systematic literature study could many different activities be found that implements how much digitalization has entered teaching, given that there are constantly different researchers and activities taking place, trying to find new and innovative ideas of how to integrate new digital teaching methods. There can be seen activities like “Computer Science Unplugged” [2] where the importance of characteristics of a digital mindset is shown. But also different digital frameworks that can help students succeed better like “Programming in primary education: towards a research based assessment framework”, who is presenting research done to create a framework for students. By that being sad is it not only by guidelines and laws that digitalization is entering teaching and schools, it is also frameworks that can help students, teachers, and parents to get better information and communicate better.

Digitalization is entering teaching not only because it is decided by upper hands. In the interview with the principal, it was discussed the motivation of digitalization among teachers, and the response could probably be put in the context of not only teachers, but also researchers, parents, students, etc. The principal ment that even though some might claim to not want to implement more digital tools, most of us would be lost if we went back to no technology at all tomorrow. Digitalization has slowly been integrated and adjusted, making us comfortable with it.
6.0 Conclusions

To conclude this paper is teaching on the virtue of changing and developing into a new era of teaching to prepare students for the future. It is important for the school systems to use the right digital tools and to focus more on evolving abilities like CT. However, there is a lot of research out there that can help school systems to succeed and help students during their years of studying. In future work it should explore more about how schools in the entire country are using the central content and if this big freedom can be given or if there should be more guidelines and help for schools to choose the right tools. In the future it would also be interesting to see what is important for schools in 30 years to teach, is it digitalization like now and are there some characteristics removed and not taught anymore.

7.0 References


[17] E. Roig and Y. Nekoui, “Playgrounds in the digitally mediated city: An approach from augmented reality.” https://www-jstor-org.proxy.mau.se/stable/27184921?searchText=%28%28digitalization%29+AND+%28school%29%29+AND+la%3A%28eng+OR+en%29&searchUri=%2Faction%2FdoAdvancedSearch%3Fgroup%3Dnone%26q0%3Ddigitalization%26q1%3Dschool%26q2%3D%26q3%3D%26q4%3D%26q5%3D%26q6%3D%26sd%3D2022%26pt%3D%26isbn%3D
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8.0 Appendix

A.

Interview questions translated from Swedish:

- How do you choose to lay out the teaching in relation to the central content? Which parts do you choose to remove and what do you focus more on?

- Based on the grading criteria at the school board, you don't have to teach the students in digitization or CT at all, how does that feel?

- In a preparatory perspective, how important do you think it is to teach the students about digitization and the characteristics from CT to prepare them for working life?

- How do you prepare students for the ever-evolving future, are teachers good at looking for research and implementing it in teaching early?

- Are you afraid that digitization will cause students to lose out on certain skills, e.g. writing style or being able to write properly with paper and pen, e.g. i can't type and my handwriting is nowhere near as nice as my parents who used paper and pencil during their studies?.