Bachelor Computer Science

Enhancing Computational Learning and Enthusiasm in Scouts through Unplugged Activities

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BACHELOR THESIS

Leiden Institute of Advanced Computer Science (LIACS)
www.liacs.leidenuniv.nl
August 11, 2024

Abstract

Computers and technology are becoming a big part of our daily lives, it is crucial that kids learn computational thinking and skill sets. These abilities can be taught through unplugged activities. These activities teach these skills without the use of computers and technology. This presents a viable method for involving kids and improving their comprehension of computational ideas. In this thesis, the effectiveness of unplugged activities in enhancing enthusiasm and understanding of computational concepts among scouts will be examined. Thirteen scouts, aged 8 to 11 called cubs, participated in a two-hour unplugged activity that included three smaller unplugged tasks. The results were measured with a pre- and post-activity questionnaire. No significant improvement in algorithm knowledge was measured. The participants did, however, report that they had fun with the activities. They expressed interest in future activities that were similar to the enjoyable and educational unplugged session. Furthermore, given the low cost of unplugged and the ability to be integrated outside, it seems that unplugged activities are a good fit for the scouting setting. Future studies could look into how a combination of unplugged and plugged-in activities can lead to better learning outcomes and how to modify the activities to maximize engagement and knowledge transfer.

Contents

1 Introduction

Our society has become increasingly dependent on computers and technology. As the world becomes more and more digitized, computational thinking skills have become more crucial. Computational thinking is a problem-solving approach drawing on concepts fundamental to computer science [LY20]. Children must develop the foundational skills necessary for navigating modern-day challenges.

In recent years, integrating computational thinking into education has become more of a priority. Digital literacy is now mandatory in school curricula [SLO23]. Digital literacy is the set of skills necessary to navigate around digital technologies, including basic ICT skills, information literacy, media literacy, and computational thinking [SLO24b]. Children are taught about computational concepts in schools. However, there are still challenges faced when teaching them. An important question is, how can we best help these children navigate in a world surrounded by computers?

One promising approach for teaching computational thinking is through *unplugged activities*. Unplugged activities are activities that teach computational concepts without the use of computers [Cor15]. These activities are interesting as they provide a simple teaching method to teach children fundamental computational concepts in a different context. Many studies underwrite that unplugged activities are beneficial for developing computational thinking skills [Che23].

Much research has been done on unplugged activities, showing promising results in enhancing children's understanding and enjoyment of computational thinking [JdOM20]. However, their effectiveness outside of school environments is explored less. Scouting, where children participate in various activities to develop personally [Nedd], could benefit from unplugged activities. These activities can be adapted to fit the SCOUTS game vision [Nedc], since no technology is needed. Exploring these activities in scouting could implement new digital literacy teaching methods.

The goal of this research is to explore the effectiveness of unplugged activities in enhancing children's understanding and enthusiasm for learning computational concepts. With the focus on the extracurricular setting of scouting. Investigating how these activities can be integrated into out-of-school environments can give more insights into better teaching methods. This gives us to the following research question: "To what extent can the use of unplugged activities enhance enthusiasm and understanding of computational concepts among scouts?"

To answer the research question, an unplugged activity was carried out by a group of scouts, called *cubs*. Cubs are scouts aged seven to eleven. The activity consisted of three unplugged tasks. Two questionnaires were used to collect data. The first questionnaire was administered a week before the activity and the second one right after the activity. With this method, their enthusiasm and knowledge before and after the activities can be measured.

In this thesis, these different components of the study are discussed. First, the related work will be discussed in Section 2. Additionally, the methodology will be explained in Section 3 and Section 4 will examine the results that were obtained from the performed study. Finally, the discussion and conclusion will be presented in Section 5.

2 Background

Computers have become a very important part of our day-to-day life, thus researchers want to know more about how to help children learn computational thinking and computational skills. In an essay by Jeannette M. Wing [Win06] computational thinking is explained as a fundamental skill that builds on the power and limits of computer processing, performed by both humans and machines. Computational thinking allows us to solve problems and design systems that would be difficult to achieve individually. In Dutch education computational thinking is explained as having the knowledge and being skilled in various thought processes that are essential for solving problems that need a lot of information, variables, and computing power [SLO23].

2.1 Computation Thinking in Education

At schools, children are taught computational thinking skills, though improvements could be made. Currently, the government has made a new curriculum on digital literacy mandatory. No exact core objectives have been formulated in the digital literacy curriculum [SLO23]. However, recent developments show progress in this area. In March 2024, Curriculum Development Foundation SLO delivered a draft of core objectives for digital literacy to the Ministry of Education, Culture and Science [SLO24a]. Prior to this, SLO has stated that someone is digitally literate when they meet the following four core objectives: basic ICT skills, Media literacy, Computational thinking, and Digital information literacy [SLO22].

While schools use various teaching materials to teach these objectives, schools did state they face challenges in designing their lessons. Schools that want to integrate digital literacy into their lessons are faced with questions about the content, time management, and the skills of teachers. Therefore, these schools ask for more guidance and expertise on the subject [vR12]. With more guidance schools could be doing more to help students in their participation in the digital society [vR12]. Unplugged lessons could be beneficial for teachers in teaching computational thinking. As computer science has become more common, especially in elementary schools, many teachers have embraced Unplugged [BV18]. Teachers find that unplugged activities help them with teaching subjects they are not familiar with, which helps them give more enthusiastic lessons. A more enthusiastic teacher can help students understand and motivate for subjects.

The digitally literate lessons taught in classrooms often place technology at their core. Primary and secondary schools do employ some teaching methods to introduce computer concepts without the use of computers. However, the majority of these lesson materials heavily rely on software and computers [SLO24b] [SLO24c]. While learning with computers is undeniably important for children, especially in a world where digital skills are increasingly vital, it is also beneficial to offer a diverse range of teaching approaches. Utilizing alternative methods, such as unplugged activities or a combination of plugged-in and unplugged lessons, can be highly beneficial for a student's overall skill development as well as their motivation [JdOM20]. By engaging students with multiple learning styles, teachers can provide different learning styles so that each student has an appropriate learning experience [BV18].

2.2 Unplugged Activities

Unplugged activities are a teaching method for teaching computational thinking and skills without the use of computers. These types of activities offer a straightforward method for teaching computational skills to a broad audience [Cor15]. With these activities, students learn about computational concepts without the use of technology. Instead, the children will learn by participating in physical activities to help them understand certain concepts.

The *CS Unplugged* website contains a collection of unplugged activities that teach computer science through fun games and puzzles. They state CS Unplugged is heavily based on the approach that students are given challenges based on a few simple rules. As the children solve those challenges they discover powerful ideas for themselves [Unp]. One example of an unplugged activity is teaching a group of children about sorting networks by an interactive game [Unp]. The children are organized into groups and are given a card with a number. The children need to sort the cards by following the lines of the network drawn on the ground in chalk. When the children meet at an intersection, they have to compare the cards. The children have to choose the correct direction based on the numbers on their cards. One direction is for the bigger number and the other direction is for the smaller number. The end goal of the game is that the cards will be sorted in order from smallest to largest at the end of the network. This unplugged activity helps the children understand sorting systems and better their computational thinking skills. These types of unplugged activities open up the possibility for many ways to help children become enthusiastic about computational concepts

Previous insight shows that unplugged activities are beneficial in an academic setting. Students in the early years of Primary Education respond better to lessons with the use of unplugged or a combination of unplugged and plugged-in activities instead of using only plugged-in activities [JdOM20]. Instruction in computational thinking, starting with unplugged activities and followed by plugged-in activities, not only benefits the skills acquisition of the children but is also beneficial for their motivation. More studies have shown that using both unplugged and plugged-in can be beneficial for student's motivation and knowledge since it can meet the needs of all students [Erü20]. Furthermore, Hermans and Aivaloglou [FH17] have compared plugged-in and unplugged ways of teaching children Scratch showing that although both ways of teaching did not make a difference in performance on the understanding of programming concepts, the unplugged group showed more self-efficacy and used a wider vocabulary of Scratch blocks. These findings underscore the potential benefit of integrating unplugged activities into computational thinking lessons.

Another benefit of unplugged activities is their flexibility to the target group [ALR19]. Complex concepts can be simplified and made more accessible for younger students, making these activities beneficial not only for school-age children but also for preschoolers learning basic computational thinking skills [VC22]. With the use of guided games, younger children may learn some essential computational thinking skills related to logic, sequencing, algorithms, and debugging [VC22]. By engaging in unplugged activities, students are encouraged to reflect on their own thinking and actions and relate them to how computers operate [ALR19]. They can observe similarities between their thought processes and the decision-making of the current working of computers.

Additionally, there are other advantages to unplugged activities beyond motivation and understanding. First, unplugged activities do not require expensive equipment such as computers and software, making these activities a low-cost way of leaching computational thinking skills [PC23]. This makes these activities accessible to children from different socioeconomic backgrounds. Furthermore, as many unplugged activities add an element of enjoyment and excitement to the learning process, children may have more enthusiasm about studying computational concepts. Moreover, unplugged activities can be adapted to suit different situations [Cor15]. This ensures they can fit different age groups and educational settings, making them versatile. When computers further evolve and the working of computers changes in the future, unplugged activities can change with them. All these benefits show the potential for unplugged activities now and in the future to be an effective and inclusive approach to teaching children computational thinking skills.

Though unplugged activities have shown much potential, there are some points of criticism. One of the concerns is that unplugged activities are more accessible for teachers with less computing background. Thus, a class might never move on to using a computer and stay in the theoretical phase [BMR23]. This can lead to students having no experience working with real computers. Therefore, it is important to not only use unplugged lessons [BV18]. These unplugged activities need to be connected to current technology and programming practices. This means that after learning the basic concepts through unplugged activities, students should also be given the opportunity to apply these concepts with real computers and programming tools. In addition, unplugged activities compared to technology-based lessons can be perceived as less exciting for children. It is suggested that working with technology has its own excitement for students [WPC15][FH17]. Furthermore, unplugged activities explain computational concepts in another context without computers [Unp]. Students may interpret the information differently than intended. This can cause students to misinterpret the material. Despite these criticisms, unplugged activities have shown that they can be beneficial for education [PC23], but these criticisms should be considered when making use of unplugged.

2.3 Embodied Cognition

The effectiveness of unplugged activities in conveying computational concepts can be explained by the framework of embodied cognition. Embodied cognition states that it is not the mind that works on abstract problems, but the body that needs the mind to function [Wil02]. The brain does not learn independently but also uses the body as a guide through the world, helping the brain in our understanding [DG13]. When children are participating in an unplugged activity they are not only mentally learning, but are also integrating sensory and motor experiences into their cognitive processes. This framework is already being used in STEM (science, technology, engineering en mathematics) to help children understand abstract concepts such as mathematics [AM20].

There are two levels of body involvement in cognition. The first is the “online” aspect. This online aspect means that there is direct involvement. The physical interaction of the body and the environment directly influences cognitive processes [FW13], [Wil02]. The “offline” aspect means that there is indirect involvement. This aspect states that the body is not used directly, but the internal representations and simulations of physical experiences in the brain still influence cognitive processes [FW13], [Wil02]. For example, solving a puzzle involves physically moving the puzzle pieces, which represents the online aspect. However, solving the puzzle also requires thinking about a tactic to solve the puzzle, which represents the offline aspect. Performing unplugged activities involves both direct and indirect involvement since children will perform both physical tasks and mental tasks.

One of the claims made about embodied cognition states that offline cognition is body-based [Wil02]. This can be explained as that even when the mind is not directly connected to the environment, it still relies on mechanisms that are developed to interact with the environment. The body not only serves as a means of converting perceptual input into cognition and later behavior, but it plays an integral role in the control of cognitive processes [FW13]. Offline thinking involves mental thinking simulations of perception and action [AM20]. This framework highlights the effectiveness of unplugged activities. For instance, in activities like the sorting network game explained before, students engage in physical movement and interaction to understand abstract concepts. They physically move through a network of lines, compare cards, and make decisions based on numbers, which helps them grasp sorting and network structures. This hands-on experience supports and reinforces cognitive processes by engaging both the body and mind, illustrating how offline cognition benefits from the body-based mechanisms developed through physical interaction.

Embodied cognition is evident in other unplugged activities as well like a search game with numbered cards. In this lesson, students learn about the efficiency of searching a sorted list versus a random list [Unp]. This unplugged activity includes cards containing the numbers one to one hundred. Fifteen of these cards are placed in front of the class faced down and have been organized in ascending order. The teacher chooses a number from the cards. The students have to find the card that the teacher chose, but they can only look at one card at a time. The students have to choose a card to look at. The chosen card is turned over to reveal the number underneath. If it's the correct one, the game stops, otherwise that card is removed, and any other cards that can't be the number (depending on the chosen number are the cards right or left of the chosen card). This process is repeated until a student chooses the card with the teacher's number on it. The best strategy is to keep choosing the card in the middle. The lesson emphasizes the importance of the divide-and-conquer strategy and helps the students understand it. In this activity, children are required to physically move through a network of lines, compare cards, and make choices based on numbers, which helps them better understand the concept of sorting and network structures. The movement in a physical space together with the mental thinking supports and reinforces the cognitive learning process, which is characteristic of embodied cognition.

Embodied cognition has shown benefits in combination with learning computational concepts. Students can learn about computational techniques in combination with their sensory and motor skills [SBD14]. Furthermore, engaging in unplugged activities boosts motivation and may influence how youngsters develop their cognitive thinking. [WH23]. During activities without the use of technology, children's thinking processes are also connected to what they observe and do. These insights show us that students profit from using their sensory and motor skills when learning computational concepts.

2.4 Teaching Computational Thinking Outside of the Classroom

Lessons about computational thinking and programming mostly take place in an academic setting. However, there are some extracurricular places where programming is taught. These places help children gain experience with computation concepts without the environment of the classroom.

2.4.1 Code Clubs

Well-known out-of-school places where children are taught about computational concepts are called Code Clubs [AH19]. Code Clubs are after-school clubs where children are introduced to computers and computational concepts in a simple and fun way. These Code Clubs aim to motivate students to engage in computer science [SSS14]. Code Clubs have shown that students involved in these clubs have a high motivation for learning computational concepts [AH19]. This is most likely because the students chose to do the course, unlike with a mandatory school curriculum.

Out-of-school activities could be a promising way to help motivate students to partake in more computer science, as shown with Code Clubs [AH19]. Children who participate in out-of-school activities are shown to be more motivated to subjects and have better academic adjustment [Fre21]. Out-of-school activities can motivate students to continue participating in those subjects [ER02]. Furthermore, out-of-school activities are associated with positive socio-emotional and academic outcomes in young people [GFK14]. All these findings show that out-of-school activities are a perfect place for motivating students to be more interested in topics such as computer science.

Code clubs often make use of plugged-in activities [pfa]. During a Code club lesson, children are guided and provided support to help them with various projects such as creating games, animations, and web pages using Scratch, Python, or HTML/CSS [pfb]. Plugged-in lessons are a successful way of teaching children programming and computational thinking. However, since a combination of plugged-in and unplugged lessons has shown promising results, it could be beneficial to also make use of unplugged activities [FH17].

2.4.2 Scouting

An Out-of-school environment where unplugged activities could be beneficial is scouting. Scouting is a place where children aged five to eighteen take part in a two-hour activity once a week. They aim to be an environment where children are challenged with fun and exciting activities and the goal is to inspire children and young people to develop personally [Nedd]. Scouting has a long history dating back more than a hundred years [Nedb]. The founder of scouting, Lord Baden-Powell organized the first summer camp in 1907 and scouting grew rapidly. Scouting Nederland, the largest youth organization in the Netherlands [Neda], was founded in 1973. Since then numerous children have participated in scouting activities.

There are three types of scouting with different main themes. The three types are land, water, and air scouting [Nedd]. These types have their own smaller groups categorized by age, such as beavers, cubs, and scouts, with their own emphasis on land, water, or air but all three groups use the same base activities. These activities are based on the SCOUTS game vision [Nedc]. The vision includes six essential elements that stand for cooperation, norms and values, outdoor activities, personal challenge, teamwork, and creative play. The activities that are established for the scouts are all based on these elements. Since unplugged activities are adaptable, all these elements of the SCOUTS game vision can be implemented.

One of the elements of the SCOUTS game vision is outdoor activities [Nedc]. However, children today are more digitized, thus they tend to play less outside. Many parents mention the competition between computers and television as the biggest reason why their children play less outside [DvB15]. As mentioned before, scouting is a place where children are guided in their development. Nowadays with personal development comes digital development. Scouting already integrates technological developments in the scouting program for example through treasure hunts with GPS or outdoor activities via mobile phone [DvB15]. However, activities without the use of computers that still teach computational skills could be a significant addition. These types of activities could make children enthusiastic about learning computation concepts while still enjoying outside play.

Additionally, scouting has shown science learning opportunities [Jar05]. Scouts enjoy engaging in scientific lessons, which benefits the students' motivation on the subjects [Jar05]. The hope is that when children are motivated and enthusiastic about certain concepts, enjoyment positively affects their understanding and learning [HJ18]. When unplugged activities are implemented in scouting activities this might help motivate scouts and thus enhance their understanding. Given the findings and the aims of the organization, it is interesting to see how these unplugged activities fit into a scouting environment.

3 Methodology

This section describes the design and implementation of the study. It includes detailed descriptions of the procedure, ethical considerations, and measurements. Additionally, the analytic methods used in the study are outlined below.

3.1 Participants

The participants included a group of thirteen children. These children were members of scouting and are called *cubs*. Cubs are scouts aged seven to eleven. The group included seven boys and six girls. The age range was between eight to eleven with the average being 9.5. Ten of the participants (seven girls and four boys) participated in the pre-activity questionnaire as well as the unplugged activity and the post-activity questionnaire. One of the participants has only filled in the pre-activity questionnaire. Two participants only participated in the unplugged activity and filled in the post-activity questionnaire.

3.2 Procedure

The participants took part in an unplugged activity. This activity consisted of three smaller unplugged exercises inspired by the activities from *CSUnplugged* [Unp]. Around the activity, a story was incorporated. The results of this study were obtained using two questionnaires. A pre-activity questionnaire, including a section on the participant's habits around computers and knowledge of algorithms, and a post-activity questionnaire, including a section on the participant's opinion on the activity and knowledge of algorithms. The unplugged activity was conducted during a scouting activity, lasting two hours.

Since this study involves children, it is essential to take ethical considerations into account. The study has been reviewed by the ethics committee of the Faculty of Science of Leiden University. Before the activity, informed consent was obtained from all participant's parents or legal guardians by a survey. The parents or legal guardians were given information on what the activity entailed and how the children's results were measured. They were asked if they agreed to let their child participate in the activity or not. The participants themselves gave assent before the pre-activity questionnaire and before the activity. Both parents or legal guardians as well as the participants were aware that the study included a two-hour activity and two questionnaires about their computer habits and opinion of the activity. Additionally, they were encouraged to ask questions. Furthermore, parents were assured their child's participation was voluntary and free of risk. Finally, the privacy of the participants was taken into account and the collected information was treated confidentially. The data are kept for ten years following standard guidelines and will then be destroyed.

A week before the activity the children filled in a questionnaire about their usage of computers. This questionnaire also included three questions about their knowledge of algorithms. During the activity, the children engaged in three different tasks with the concept of algorithms. During these tasks, children received guidance and support to help them complete the tasks. The guidance was intended solely to guide and encourage them, without providing direct answers. After the activity, the children were asked to fill in the second questionnaire. In this questionnaire, the children were asked about their enjoyment of the activity and again three questions were asked about their knowledge of algorithms.

3.3 Measurement

This section provided further elaboration on the different aspects of this study. The children participated in a two-hour unplugged activity. For the measurement of the children's enthusiasm and knowledge of algorithms, the participants were asked to fill in two questionnaires.

3.3.1 Unplugged Activity

The unplugged activity was designed for this research and inspired by the activities from *CSUnplugged* [Unp], with the aim to let children engage with the concept of algorithms through an interactive and story-based activity. The activity involved three tasks where children worked together with the concept of algorithms. Several guidance's were present to help guide the children in the activity. These guides were original guides from this scouting group. Each of the tasks was designed to emphasize different aspects of algorithmic thinking, including following precise instructions, problem-solving thinking, and understanding symbolic representations of algorithms.

The activity starts with the visit of a professor. This professor is one of the guides who is playing the professor. The professor asked the group of children for their help. Hackers had taken over his computer. On this computer, important data was stored that he needed back. The hackers had stated that the professor needed to complete three tasks to get access to his computer again. However, the professor could not do the three tasks on his own, thus the children were asked to help the professor complete these tasks.

The tasks the children needed to solve were all based on following precise algorithmic instructions. To work on these tasks, the children needed to understand the concepts of an algorithm. The professor asked the children if they were familiar with algorithms. He then asked the children to explain what they thought an algorithm was and if they could give some examples. After assessing their knowledge of algorithms, the professor explained the concept of an algorithm. He explained it as following a series of step-by-step instructions, similar to a recipe. The professor asked if the children could think of other examples of algorithms. He then proceeded to explain the important parts of an algorithm. These parts consisted of very precise and clear instructions.

After the children learned about the concept of algorithms, they could work on the tasks. The group of participants was split into three smaller groups. All the smaller groups had to participate in all three tasks. The first group started with the first task, the second group with the second task, and the third group with the third task. The three groups worked on their task simultaneously. When all the groups had finished their tasks, they moved on to the next tasks until all the groups had done all the tasks. The tasks consisted of:

1 The children were given a series of puzzles that guided them across a plaza. The puzzles included questions about computers and simple math problems. Each correct answer provided a specific route for the children to follow to find the next puzzle, leading them step-by-step until they reached the final puzzle with the final answer. For these tasks, the children needed to use a problem-solving way of thinking and algorithmic reasoning.

2 One of the children was blindfolded and acted as a “robot”. On the ground, obstacles were placed and the robot needed to move around the obstacles. The other children needed to give clear instructions to the “robot” so that it passed the obstacles safely and quickly. This taught the children the concept of algorithms and the need for precise instructions.

3 The children stood in front of a maze and received several cards with symbols on them. Each symbol corresponds to a movement.

   circle: one step to the left

   triangle: one step to the right

   square: one step forward

   The children had to use the cards to create a code that guided them through the maze. The symbols needed to be placed in order so that, by following the symbols, they could get through the maze. They also had to test this code by walking through the maze themselves following their code. With this exercise, the children created a type of algorithm to get through a maze. This further familiarized them with the concept of an algorithm and gave them a small insight into making their own code and testing the code.

Throughout the tasks, the children were helped if needed to correctly complete the tasks, but the emphasis was on the children solving as much as possible themselves. After all the tasks were completed, the professor asked the children about the tasks. He asked them what they were tasked to do and how this related to algorithms. After the children and the professor discussed about the activities, he filled in the answers on the computer. With the help of the children, the answers were correct and the professor had access to his computer again.

3.3.2 Questionnaire

A week before the activity, the participants were asked to fill in a questionnaire. They first had to fill in their name, gender, and age. The first set of questions was about their knowledge of the topic of algorithms. The questions consisted of three multiple-choice questions about algorithms shown in Table 1. The correct answer in Table 1 is displayed in bold.

Question	**Answers**
What is an algorithm?	1. A game 2. **A series of step-by-step instructions** 3. A computer 4. Random instructions
What is the most important thing in an algorithm?	1. Have as many steps as possible 2. Using symbols 3. Be as quick as possible 4. **Following precise instructions**
What is not an algorithm?	1. Making a sandwich 2. Following a recipe 3. Following a route 4. **Making a drawing**

Table 1: Multiple-Choice Questions about Algorithms

The last part of the questionnaire focused on the participant's daily use of and interest in computers. Five questions were asked related to their computer habits. To make it easier for the children to express their feelings, a smiley scale was used. They could answer these questions by selecting the smiley that best represented their feelings about each statement, ranging from 'disagree' to 'totally agree'. The range is more on the positive side since children tend to have more positive attitudes compared to teenagers and adults [HHT16].

After the unplugged activity, which was a week after the first questionnaire, the participants were asked to fill in another questionnaire. The participants were again asked about their knowledge of algorithms, using the same questions as on the first questionnaire shown in Table 1. In the second part of the questionnaire, the participants were asked ten questions about their enjoyment and whether they felt like they had learned about algorithms. The last part of the questionnaire included three open questions. These questions were:

- What did you like most about the activity?
- What did you like less about the activity?

- Would you like to say anything else about the activity?

3.3.3 Additional Measurements

In addition to the formal results of the questionnaires, observations during the activity were also included in the analysis. Although these observations were not considered hard results and did not constitute a detailed instrument, they provided valuable additional insights. Examples of such conspicuousness were the level of participation in certain assignments or whether a particular child was away for a long time and therefore missed part of the activity. These informal observations could provide context and help interpret the formal results.

3.4 Analysis

To answer the research question, the collected data was analyzed using both quantitative and qualitative analyses. The two questionnaires' responses were quantitatively analyzed to assess changes in participant's knowledge of algorithms, their computer usage, and opinions on the activity.

First, the questionnaires on paper were digitized using Excel. The data was then pseudonymized. The results were cleaned up by handling missing data and standardizing answers where it was necessary. Some participants only filled in one of the two questionnaires. Only the answers from the questionnaire the participants filled in were considered. Finally, the questions related to each other were grouped.

The next step was to process the questions about knowledge of algorithms. Ten participants had filled in both questionnaires. Since the goal is to analyze the differences in knowledge for both participants, only the participants who filled in both questionnaires were considered. The correct answers from the first questionnaire were counted and this was the score given to the participants. The maximum score that could be obtained was three. The same steps are done for the second questionnaire, thus giving two grades for the same participant. Additionally, the mean and standard deviation were calculated. To see if there was a statistical difference between the mean scores obtained before and after the activity, the answers from the two questionnaires were compared using the Wilcoxon Signed-Rank Test. Furthermore, the difference between boys and girls was considered. With the use of the Mann-Whitney U test the significance of the different scores for the two genders was measured.

Next, the section on the participant's computer habits was handled. First, the questions related to each other were grouped. Additionally, descriptive statistics, including mean and standard deviation were calculated for each category of questions. These results were tabulated. With these calculations, the results could be examined. A reliability analysis, using Cronbach's alpha, was conducted to ensure the internal consistency of the questionnaire items within each category. This ensured that the results could be examined as one construct. For these results, the differences between gender and age were also considered and placed in separate tables. The Mann-Whitney U test was used to measure the significance of the results.

Additionally, the section on the participant's opinion of the activity was processed. Similar steps were taken to analyze these results as for the first questionnaire. First, the related questions were grouped. Descriptive statistics, including mean and standard deviation, were then calculated for each category of questions. Next, these results were placed in a table. Additionally, a reliability analysis was done using Cronbach's alpha to ensure internal consistency of the questionnaire items within each category. The internal consistency of the statements was found valid and the responses were analyzed as a single construct. The differences between gender and age were considered as well and placed in separate tables. The Mann-Whitney U test was used to measure the significance of the results. These calculations can be used to examine the results.

Qualitative analysis was used to examine the open questions. These questions provided deeper insights into the participant's perceptions of the activity. Some answers to the open questions were unrelated to the activity. For example, an answer to the question of what the participants liked less was "that I had to drink water". These answers were not comments on the activity itself, but rather on what happened in between tasks. These answers were filtered, and thus not considered. The related answers to the open questions were tabulated using Excel. Next frequency distribution tables were made for the categories of answers.

4 Results

In this section, the results of the two questionnaires will be discussed. The pre-activity questionnaire included the first test on algorithms knowledge and a section of five statements on the participant's current habits and opinions on computer usage. The post-activity questionnaire included a second test on the knowledge of algorithms and ten statements where the participants could evaluate the activity. On the habits and evaluation questions, the participants were asked to rate statements on a scale from one to five, where one indicates 'strongly disagree,' two 'neutral,' three 'somewhat agree,' four 'agree,' and five 'strongly agree.' Additionally, the post-activity questionnaire asked the children three more questions regarding the enjoyment of the activity and whether they wanted to add anything else to the answers they had given. Eleven children participated in the first questionnaire and twelve children participated in the second questionnaire. Ten children filled in both questionnaires.

4.1 Understanding Algorithms

First, the results of the tests on the participant's knowledge of algorithms before and after participating in the unplugged lesson will be examined. The aim is to study the effect of the unplugged lesson on the knowledge of algorithms. Only the ten participants who completed both questionnaires were considered. For every correctly answered question the participant was given a point, with the maximum being three points. The average scores on the algorithm knowledge questions are presented in Table 2.

As shown in Table 2, the average score on the second test was lower compared to the first test. On the first test, participants had an average score of 2.1 (SD = 1.10). On the second test, the average score was 1.8 (SD = 1.14). The standard deviation on both tests is above 1.0, meaning there was a spread in the participant's scores, indicating variability in the performance of the participants.

	Mean	**SD**
Points first questionnaire	2.10	1.21
Points second questionnaire	1.80	1.14

Table 2: Scores for questions about knowledge of algorithms for the first and second questionnaire

The appropriate statistical test to compare the findings from the before and after tests was considered. First, a paired t-test was reviewed. One of the assumptions of a paired t-test is that the data should be approximately normally distributed. With the use of a Q-Q plot it was checked if the score was normally distributed. For the first questionnaire, the Q-Q plot shows significant deviations from the straight line. This indicates that the data is not normally distributed. For the second questionnaire, the Q-Q plot shows that the points have some deviation from the straight line, suggesting that the data may not be perfectly normally distributed, but is not extremely deviated. Since not all data is normally distributed, it is less suitable to use a t-test. Instead, a Wilcoxon Signed-Rank test was considered. The Wilcoxon test has the following assumptions: The dependent variable is measured at the ordinal level. The independent variable consists of two related groups. The distribution of the differences between the two related groups is approximately symmetrical [Stab]. These assumptions were met, thus the Wilcoxon Signed-Rank Test was used. The test results are shown in Table 3. Table 3 shows the results W = 0.0, z = −1.732, p = .083. This suggests that there is no statistically significant difference in scores between the two questionnaires.

Test	**Comparison**	**Result**
Wilcoxon Signed-Rank test		
	w-statistic	.0
	p-value	.083

Table 3: Comparison of Statistical Tests for Knowledge of Algorithms

Next, the influence of age and gender on the scores of the tests is examined. For the different ages, the average scores and standard deviation were calculated and placed in Table 4. Table 4 shows that the 9-year-old participants got a consistent score on both tests, with an average of M = 1. All other ages show a slight decrease in scores obtained on the second test.

Looking at the two genders in table 5, the girls scored an average of 2.00 on the test before the activity, while the boys scored an average of 2.20. After the activity, the average score of the boys remained the same at 2.20. The girls showed a decrease in their average score, which fell to 1.40. Thus, all the boys obtained the same score on both tests, while the girls answered more questions incorrectly on the second test. Interestingly, the incorrectly answered question on the second test was the question “What is not an algorithm?”.

To see if the difference in score for the two genders was significant a Wilcoxon Signed-Rank test was used. The assumptions: the dependent variable is measured at the ordinal level, the independent variable consists of two related groups, and the distribution of the differences between the two related groups is approximately symmetrical, were met. The average of the results of the two tests

Age	**8**	**9**	**10**	**11**
First test	2.00	1.00	3.00	2.67
Second test	1.50	1.00	2.50	2.33

Table 4: Average score per age

Gender	**Boys**	**Girls**
First test	2.20	2.00
Second test	2.20	1.40

Table 5: Average score per gender

for both boys and girls was calculated and then the Wilcoxon Signed-Rank test was performed on these average results. The Wilcoxon Signed-Rank test showed the difference was not statistically significant, W = 5.0, z = -,680, 0.496.

4.2 Habits Computers

Next, the section on the insight into the participant's opinions on computers and their usage prior to the activity was examined. The group of participants that answered the first questionnaire consisted of six boys and five girls. The average age of the participants was 9.46 years.

Statement	**Mean**	**SD**
I use the computer often	3.55	1.29
I find using the computer easy	3.91	1.22
I find computers fun	3.86	1.00
I use the computer for school	4.18	1.21

Table 6: Answers to the first questionnaire with ratings going from 1 to 5, including mean and standard deviation (SD)

The results from the first questionnaire are summarized in Table 6. The table shows that the participants generally agreed with the statements about computer use, with all mean scores being above 3.5. However, the standard deviation for all statements is above one. This means there are some variations in the answers. The statement "I use the computer for school" received the highest average score of 4.18 (SD = 1.21), suggesting that most participants use computers in school. The lowest score was obtained by the statement "I use the computer often" (M = 3.55 and SD = 1.29). This statement is still rated relatively high. The results indicate a positive overall perception and usage habit of computers among the participants. The data suggests that computers are an integral and enjoyable part of the participant's daily activities.

Initially, Cronbach's alpha was calculated to determine the internal consistency of the statements in the questionnaire. This calculation resulted in a Cronbach's alpha of -0.572, indicating a negative relationship with almost all other statements. The statement "I use the computer for school" may be measuring a different construct. Based on this, it was decided to remove the statement "I use the computer for school" After removing this statement, Cronbach's alpha was recalculated, yielding a result of 0.569. Although this is below the acceptable threshold of 0.7, it indicates a slightly good alignment between the statements about the enjoyment of computers, showing that the internal consistency of the statements is valid. Therefore, the results of these statements can be considered as measuring a single construct regarding participants' enjoyment of computer use.

Gender	Mean
Boys	3.90
Girls	3.40

Table 7: Average ratings on computer habits across all statements

To further analyze the effects of gender on computer usage habits, the difference in rating per gender was examined. Since the internal consistency of the statements is relatively valid, the responses will be analyzed as a single construct. The average ratings for all the statements for boys and girls are summarized in Table 7. Note that the statement "I use the computer for school" was not considered. Overall, the results show that boys and girls differ slightly in their attitudes towards and usage of computers. Boys, on average, indicated that they enjoy using the computer more (M = 3.90). Girls on average also enjoy using the computer (M = 3.40), though less compared to boys.

Test	Comparison	Result
Mann-Whitney U test		
	u-statistic	.0
	p-value	.317

Table 8: Comparison of boys and girls enjoyment of computers using the Mann-Whitney U test

To see if the differences between the boys and girls are significant a statistical test has been considered. First, the data is examined to find out if the data is normally distributed with the use of Q-Q plot. The Q-Q plot shows that the points deviate from the line, suggesting that the data is not a normal distribution. The Mann-Whitney U test has the following assumptions: The dependent variable should be measured at the ordinal or continuous level. The independent variable should consist of two categorical, independent groups. In this case, the independent variable is gender, with two groups: boys and girls. There should be independence of observations, meaning there is no relationship between the observations in each group or between the groups themselves [Staa]. These assumptions are met, thus the Mann-Whitney U test is used. In table 8 the results for the Mann-Whitney U test for the different statements are placed. The table shows a p-value of .317. This p-value is higher than the threshold value of .05. Thus suggesting there is no significant differences between the ratings of the boys and girls.

4.3 Evaluation Activity

In the second questionnaire, the aim is to assess the impact of the unplugged activity on the participant's understanding and enthusiasm for algorithms and computers. The group answering the second questionnaire consisted of six boys and six girls with an average age of 8.77 years. The questionnaire included ten statements related to the participant's opinion on the activity.

Table 9 shows the results from the second questionnaire. These results show that the participants generally agreed they enjoyed the activity. They found the activity educational and would enjoy more similar activities. The table further shows that most of the participants stated they enjoyed the activity (M = 3.75). For this statement there further is a low variety in answers shown by the deviation (SD = 0.65). The average score for whether the participants were more enthusiastic about learning algorithms was lower at 2.25 (SD = 1.00). This means many participants were neutral about the statement or disagreed.

Statement	**Mean**	**SD**
Enjoyment activity	3.75	0.65
Learnability activity	3.00	1.08
Understanding algorithms	3.08	1.41
Enthusiasm learning algorithms	2.25	1.00
Interest computers	3.63	0.83

Table 9: Answers to the second questionnaire with ratings going from 1 to 5, including mean and standard deviation (SD)

Next, Cronbach's alpha was used to determine the internal consistency of the statements of this questionnaire. Calculating the Cronbach's alpha yields a result of 0,577. Although this is below the acceptable threshold of 0.7, it indicates a slightly good alignment between the statements. Showing that the internal consistency of the statements is valid. Thus, the results of these statements can be considered as measuring a single construct regarding participants' enjoyment of the activity.

Following, the influence of genders will be analyzed. With the internal consistency of the statements being relatively valid, the responses will be analyzed as a single construct. In Table 10 the ratings for the two genders and their average rating are shown. Overall the boys rated almost all the statements higher compared to the girls. Interesting results are that both genders rated the enjoyment of the activity the same (M = 3.75). However, all other statements were rated lower by the girls. The boys rated their enjoyment of the activity high (M = 3.42), compared to the girls with a lower average (M = 2.87).

Gender	**Mean**
Boys	3.42
Girls	2.87

Table 10: Average rating post-activity questionnaire per gender

Age	**Mean**
8	3.07
9	3.55
10	2.53
11	3.42

Table 11: Average rating post-activity questionnaire per age

When examining the significant differences between boys and girls a statistical test has been considered. First, the data was examined on being normally distributed with the use of Q-Q plot. The points on the Q-Q plot deviate from the line, suggesting the data to be not a normal distribution. Since the data is not normally distributed, the Mann-Whitney U test is used. The assumptions for this test are met [Staa]. The dependent variable is measured at the ordinal or continuous level. The independent variable consists of two categorical, independent groups. The observations were independent. The results of the Mann-Whitney U test for the different statements are placed in Table 12. In the table it can be seen that the p-value of all the statements is higher than the threshold value of .05. This suggests that the differences between the answers from the boys and girls are not significant.

Test	**Comparison**	**Result**
Mann-Whitney U test		
	U-statistic	21.500
	p-value	0.222

Table 12: Comparison of boys and girls enjoyment of the activity using the Mann-Whitney U test

Next, the answers for the ages were considered and placed in Table 11. There exist some differences in the enjoyment and understanding of the activities rated by the participants. Interestingly the children aged ten have the lowest average rating for the enjoyment of the activity (M = 2.53). The highest rating was given by the children aged nine. However, it is important to note that for every age, there were only three participants.

4.4 Final Feedback

The final part of the survey focused on children's experiences during the activity. The participants were asked questions about their favorite and less favorite aspects of the activity, as well as if they had any other comments. The answers obtained from the participants are categorized and placed in the figures below. Some answers were unrelated to the unplugged activity. These answers are placed under the category "other".

Figure 1: Open answers to the questions: What did you like the most about the activity?

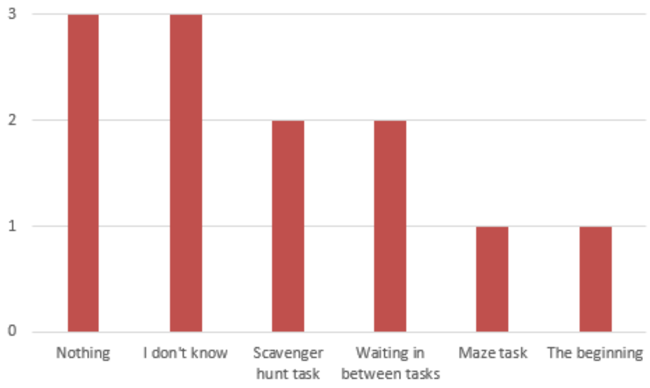

Figure 2: Open answers to the questions: What did you like less about the activity?

Figure 1 shows the frequency of the answers on what the participants found the most enjoyable of the activity. Most children stated that they enjoyed the blindfold task and the maze task the most. The scavenger hunt task was less popular among the participating children. One participant stated they enjoyed none of the elements of the activity. Two participants enjoyed all the tasks.

When asked what the participants liked less about the activity, shown in Figure 2, half of the

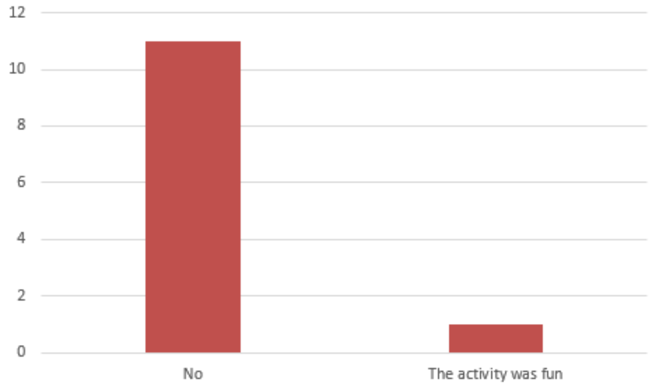

Figure 3: Open answers to the questions: Do you want to say anything more about the activity?

children did not provide any input. They either answered “nothing” or stated that they did not know. The task that did get named as less likable was the scavenger hunt. The maze task was mentioned once. There was one participant who did not enjoy waiting in between tasks. This was also observed during the activity. Some tasks were finished faster than other tasks. Thus, when the children were done with their tasks, they needed to wait until all the tasks were finished. This is consistent with the comment given by the participant.

The last question asked the participants whether they wanted to state anything else about the activity. The answers obtained from this question are shown in Figure 3. When answering this question, almost all of the participants wrote down “no”. Only one participant answered something else, the participant stated she found the activity fun.

Question	**Boys**		**Girls**	
What did you like the most about the activity?	Maze task Scavenger hunt task All the tasks Other No opinion	2 1 1 1 1	Blindfold task All the tasks Nothing Maze taks	3 1 1 1
What did you like less about the activity?	Do not know Nothing Scavenger hunt Other	1 2 1 2	Do not know Nothing Scavenger hunt Maze tasks The beginning	2 1 1 1 1
Do you want to say anything more about the activity?	No	6	No that it was fun	5 1

Table 13: Answers to open question and their frequency, divided by gender

Finally, the data for the two genders were examined. In Table 13 the answers for the genders are shown. The table shows that the activity was generally positively received by both boys and girls.

The boys however answered less enthusiastically to the question of what they enjoyed the most. One of the boys answered that he had no opinion on the question and another boy's answer was unrelated. Of the total of six girls, three mentioned the blindfold task as the most enjoyable, while the boys did not name the blindfold task at all. Both genders had minimal complaints when asked what they did not enjoy. The answers "do not know" and "nothing" were in total equally common among both genders, with a total of three.

5 Discussion and Conclusion

This study aimed to examine the extent to which unplugged activities can improve the enthusiasm and understanding of computational concepts, such as algorithms, in scouts. To answer this question a group of scouts aged 7 to 11 were included in an unplugged activity. The activity included three tasks related to the concept of algorithms. These tasks had the goal to teach the participants about algorithms and enhance their enthusiasm for computation concepts. Before and after the activity the participants were asked to fill in a questionnaire. The pre-activity questionnaire included a small test and questions on the computer habits of the participants. The post-test included the same small test and a section with questions about the participant's opinion on the activity. To answer the provided research question, the analyses of the results of these questionnaires were used. The limitations and difficulties of this study will be discussed and a conclusion will be drawn from the results.

5.1 Algorithmic Knowledge

When looking at the results, it shows that the unplugged activities did not lead to a significant change in knowledge of algorithms. However, there is a downward trend in the obtained scores on the knowledge questions. There are several possible causes for this downward trend.

First, it could have been that the children got more confused about the concept of algorithms because of the activities. Since the activity explains the concept of algorithms in a different context, scouts may have interpreted the information differently than intended. In this study, algorithms are explained through a game, children may have confused the rules or steps of the game with the technical definition of an algorithm. It is important to consider that although unplugged activities can increase engagement and enthusiasm, clear explanations and clarification are needed to ensure that children understand the concepts correctly.

Furthermore, the way in which the activities were set up or presented can also contribute to the lack of clarity. If the tasks were not sufficiently focused on explicitly explaining and repeating the essence of algorithms, this can hinder the learning process. Activities should be carefully designed to ensure that they clearly and effectively convey the core concepts of algorithms and that children are given the opportunity to practice and understand these concepts.

Additionally, Several studies have demonstrated that a combination of unplugged and plugged-in yields the best results for students [JdOM20], [Erü20]. The activity of this study focused exclusively on unplugged programming. The connection with technology was lacking. When unplugged activities are not followed up with or integrated into plugged-in activities, students may struggle to make the necessary connections between the abstract concepts they learned and their practical application in digital environments. This may have contributed to difficulties in understanding how algorithms work.

For this study, it was decided not to integrate technologies into the unplugged activity. This choice was made to emphasize the unplugged aspect of scouting, which focuses on outdoor play, and to investigate how participants experienced this type of activity. However, this does not mean that the combination of plugged-in and unplugged activities is not fitting within a scouting environment. In fact, scouting organizations already have experience with combining these approaches [DvB15]. This demonstrates that the use of technology does not undermine the core values and visions of Scouting.

An interesting insight from the study is the incorrect responses to the question, "What is not an algorithm?" on the second test. The expected answer was "a drawing." However, since it can be argued that a drawing might represent an algorithm, it's understandable that this question could be misinterpreted. However, the other possible answers were "Making a sandwich", "Following a recipe", and "Following a route", which are more clearly algorithms. This is one of the questions that could have been easily misinterpreted. Since the answer is not as clear as for the other questions the children need to get this explained clearly. This further underlines the necessity for clear explanations and the risk of misconceptions.

Moreover, the confusion surrounding this question raises the question of whether the multiple-choice questions on the questionnaire were the right ones. It's possible that the questions, or their answer choices, may have contributed to participant misunderstandings. It might have been better to exclude this question from the questionnaire or switch it to a more straightforward question. That might have given more clear results on the knowledge of the participants.

Finally, unlike educators who may have specific training or resources to support teaching computational thinking, the guides at scouting are not educated on computational concepts. This means that these guides might have trouble correctly explaining certain concepts. It could be possible that their knowledge of some concepts is not enough to clearly convey the knowledge to the scouts. While unplugged activities are recognized by teachers seem useful to engage with topics that they are otherwise unfamiliar with [BV18], the lack of specialized knowledge among scouting guides further underlines the possibility of the misinterpretation of the participants on the concept algorithms.

Still, it could be possible that because of the unplugged activity, the children who at first thought this was a straightforward answer are now thinking more critically. This could also be a reason for answering this question wrong the second time. This increased critical thinking might have led them to over-analyze the question, considering more nuanced interpretations of what is an algorithm. For instance, they may have started to see the potential for a drawing to be part of an algorithmic process, thereby leading them to question their initial understanding. This shift in perspective, although it resulted in an incorrect answer, indicates there might be a deeper engagement with the material.

5.2 Enthusiasm

The participants in this study demonstrated a high level of enjoyment during the activities. Initially, many participants already found computers fun, as indicated in the first questionnaire. While this pre-existing enthusiasm for computers means we can't attribute the positive feedback solely to the activity, it's clear that the children enjoyed the unplugged activities and found them educational. They expressed a desire for more such activities in the future, suggesting that unplugged activities in settings like scouting can successfully combine education with enjoyment.

When asked about their favorite parts of the activity, participants mentioned all tasks, though some were cited more frequently than others. Notably, half of the participants could not identify any part they disliked or stated they did not know. The blindfold task and the maze task were generally the most enjoyed, while the scavenger hunt task was less popular. The varied responses to these tasks underscore the importance of carefully selecting and designing unplugged activities to cater to the diverse interests and engagement levels of children. This information is valuable for future research, which could explore a wider variety of tasks to determine what scouts enjoy most.

When the participants were asked if they found computers and algorithms interesting, they stated they did find computers interesting. However, they did state that they were not as enthusiastic about the subject algorithm. This could mean that even though the participants did enjoy the activity and learning about computers, the specific topic of algorithms was not as interesting to them. It might be interesting to find out what subjects the participants might enjoy more. Other topics might give better results on enthusiasm, but also on knowledge.

An interesting observation from the study was the difference in enthusiasm and knowledge between genders. Though there is not much difference, some interesting findings could be noted. Girls generally rated their enjoyment of computers as well as the enjoyment of the activities lower compared to boys. Given the importance of increasing female participation in STEM fields [JS19], this finding underlines the need for further investigation into the difference between girls and boys when participating in unplugged activities in a scouting setting.

Enjoyment of an activity is an important factor in learning. When participating in fun lessons, children remember more information [HJ18]. There is a connection between experiencing positive emotions, such as pleasure and joy, and successful learning [Luc14]. When children are engaged and having fun, they are more likely to be motivated and attentive, which can lead to a better and deeper understanding of the material. When children state they enjoy activities there are possibilities for teaching various concepts.

5.3 Unplugged and Scouting

The unplugged activities conducted in this study, demonstrate how unplugged activities can be effectively integrated into the scouting context. Scouting offers a unique learning environment that utilizes the principles of embodied cognition. The study that has been conducted fits into the SCOUTS game vision [Nedd]. The unplugged activities in this study engaged children's sensory and motor skills alongside their cognitive processes, effectively leveraging the concept of embodied cognition

[Wil02]. The alignment of these activities with the embodied cognition framework highlights their potential to enhance learning outcomes in informal educational settings like scouting. By integrating unplugged activities that are grounded in physical action, scouting can provide a dynamic learning environment where children develop computational thinking skills in a natural and engaging manner.

Additionally, scouting does not have many funds for expensive equipment for activities. When the activities are implemented, low cost is important. The tasks of this study just as many other unplugged activities have a low cost [PC23]. Thus making them low effort to be implemented. This aspect makes it applicable in scouting settings.

Furthermore, the outdoor environment, which is one of the elements of the SCOUTS game vision [Nedd] enhances the learning experience. Contact with nature has proven benefits, including longer attention spans and improved mental well-being [DvB15]. The tasks for this study all took place outside and thus fit perfectly into this vision. By placing the activities outdoors, they not only increase the fun but also promote learning in a natural environment.

Finally, participants indicated that they enjoyed all parts of the activity. Studies have shown that experiencing positive emotions, like enjoyment and happiness, is closely linked to effective learning [Luc14]. The children voluntarily come to scouting. This might cause the children to participate in the assignments with a more enthusiastic mindset compared to lessons at school that can feel forced [AH19]. Teaching the children in a fun and educational setting has been met with much enthusiasm by the participants, showing that a scouting setting is fitting for unplugged activities just like the one from this study. With the right adjustments in the future, these unplugged activities can be used regularly to get scouts more enthusiastic and knowledgeable about computational concepts.

5.4 Limitations

There are several limitations to this study. The first limitation is the duration of the study. The activity was conducted one time for two hours. When the study takes place over a longer period the participants will take part in more unplugged activities, possibly making a larger impact on the participants learning. It could be that the participants will learn more about computer concepts when they participate in more activities.

Furthermore, there was no control group present. Without a comparison group, it is more difficult to fully determine whether the observed changes in enthusiasm and interest in computers were directly caused by the activities or were influenced by other external factors. Additionally, it is uncertain whether the same results would be obtained with other groups of children, such as school classes, other youth organizations, or other groups of cubs.

Finally, the sample size was limited. Since scouting groups are generally small, the testing group was also small. This could affect the significance of the results, making it harder to draw generalized conclusions.

5.5 Future work

For future studies, some other questions could be answered. First, it could be beneficial to perform a study on a larger sample size. A larger sample gives a more complete and generalized picture of the experiences of the participants. Differences in gender and age can then be better investigated and the chance of random variation is reduced.

It would also be interesting to examine the importance of blending unplugged activities with technology-based tasks in a scouting environment. This integrated approach could provide students with a more comprehensive understanding, where they can see and experience the direct application of the algorithms they learn in unplugged activities within digital environments. However, the basis of a scouting setting needs to be considered when integrating plugged-in components. Scouting has already taken steps to integrate more technology components into their activities [DvB15], so combining some technology into the scouting setting is possible.

Moreover, the difference between boys and girls could be further examined. Investigation of how girls enjoy unplugged activities in a scouting setting could show scouting to be an excellent platform for making girls more enthusiastic about computational concepts. Future research should focus on identifying activities that particularly appeal to girls and help them enjoy these concepts more.

Furthermore, an unplugged activity in a scouting setting over a longer period could be examined. This would allow for more extensive data collection. The long-term effects of the activity on the participant's understanding of computational concepts can also be examined.

Additionally, more topics could be explored. Other topics might show more insight into the knowledge and enthusiasm. It could be interesting to get more insight into which topics show more enthusiasm of which topics fit a scouting setting better.

Finally, future studies could use a mixed-methods approach. Quantitative data such as surveys with qualitative insights from interviews could be combined. This would provide a better understanding of the reasons behind the participant's responses and gain deeper insight into their experiences and perceptions of the activity.

5.6 Conclusion

This study examines the extent to which the use of unplugged activities can improve the enthusiasm and understanding of computational concepts among scouts. After conducting the activity and analyzing the results, the following conclusions can be drawn.

The study demonstrates that unplugged activities fit well in a scouting environment, especially considering their low cost and the ability to adapt to various situations. The positive experiences and high level of enthusiasm rated by the participants underline that scouting is a suitable environment for such activities.

However, while the participants responded enthusiastically to the activity, indicating that they found it enjoyable and educational, this did not result in a better understanding of algorithms. This raises important questions about the clarity and effectiveness of unplugged activities. It draws attention to the possibility of misunderstanding that can occur when abstract concepts are taught separately from their real-world technologies. Particularly in non-formal educational contexts like scouting, where the guidance's may lack a deep understanding of computational concepts, it is important to provide clear explanations. With the right adjustments and focus on clear instructions, unplugged activities could be a good addition to the scouting activities. Future studies can investigate how learning outcomes and enthusiasm can be improved in a scouting environment, for example by combining unplugged and plugged-in activities and studying scouts opinions on various computational topics.

6 References

References

[AH19] Efthimia Aivaloglou and Felienne Hermans. How is programming taught in code clubs? exploring the experiences and gender perceptions of code club teachers. *Association for Computing Machinery*, 22:1–10, 2019.

[ALR19] Stefan Seegerer Annabel Lindner and Ralf Romeike. Unplugged activities in the context of ai. *Informatics in Schools. New Ideas in School Informatics*, 11913:123–135, 2019.

[AM20] Gnanathusharan ajendranb Judy Robertson Andrew Manchesa, Peter E. McKennab. Identifying embodied metaphors for computing education. *Computers in Human Behavior*, 105, 2020.

[BMR23] Tim Bell Bhagya Munasinghe and Anthony Robins. Unplugged activities as a catalyst when teaching introductory programming. *Journal of Pedagogical Research*, 7(2), 2023.

[BV18] Tim Bell and Jan Vahrenhold. Cs unplugged—how is it used, and does it work?, 2018.

[Che23] Yang D. Metwally A.H.S. et al Chen, P. Fostering computational thinking through unplugged activities: A systematic literature review and meta-analysis. *International Journal of STEM Education*, 10:47, 2023.

[Cor15] Thomas J. Cortina. Broadening participation: Reaching a broader population of students through “unplugged” activities. *Communications of the ACM*, 58:25–27, 2015.

[DG13] Andrew D.Wilson and Sabrina Golonka. Embodied cognition is not what you think it is. *Front. Psychology*, 4, 2013.

[DvB15] Eric Lagendijk Dide van Berkel. De waarde van buitenspelen. *DPS-groep*, 2015.

[ER02] Peter Eastwell and Léonie Rennie. Using enrichment and extracurricular activities to influence secondary students’ interest and participation in science. *Science Education Review*, 1(4):149.1–149.16, 2002.

[Erü20] Güven Erümit, Ali Kürsat; Sahin. Plugged or unplugged teaching: A case study of students’ preferences for the teaching programming. *International Journal of Computer Science Education in Schools*, 2020.

[FH17] Efthimia Aivaloglou Felienne Hermans. To scratch or not to scratch?: A controlled experiment comparing plugged first and unplugged first programming lessons. *Association for Computing Machinery*, page 49–56, 2017.

[Fre21] Jennifer A. Fredricks. Extracurricular participation and academic outcomes: Testing the over-scheduling hypothesis. *SLO*, 2021.

[FW13] Lucia Foglia and Robert A. Wilson. Embodied cognition. *Wiley Interdiscip Rev Cogn Sci.*, 4:319–325, 2013.

[GFK14] Anne Guèvremont, Leanne Findlay, and Dafna Kohen. Organized extracurricular activities: Are in-school and out-of-school activities associated with different outcomes for canadian youth? *Journal of School Health*, 84, 2014.

[HHT16] Lynne Hall, Colette Hume, and Sarah Tazzyman. Five degrees of happiness: Effective smiley face likert scales for evaluating with children. pages 311–321, 06 2016.

[HJ18] J. Hernik and E. Jaworska. The effect of enjoyment on learning. In *INTED2018 Proceedings*, 12th International Technology, Education and Development Conference, pages 508–514. IATED, 5-7 March, 2018 2018.

[Jar05] Ruth Jarman. Science learning through scouting: an understudied context for informal science education. *International Journal of Science Education*, 27(4), 2005.

[JdOM20] José Antonio Gonzalez-Calero Javier del Olmo-Munoz, Ramon Cozar-Gutiérrez. Computational thinking through unplugged activities in early years of primary education. *Computers Education*, 150, 2020.

[JS19] Joseph F. Santacroce P.E. Jiahui Song, Douglas Eric Dow. Girl scouts stem day. *Paper presented at 2019 ASEE Annual Conference Exposition , Tampa, Florida.*, 2019.

[Luc14] Dorothy Lucardie. The impact of fun and enjoyment on adult's learning. *Procedia - Social and Behavioral Sciences*, 142:439–446, 2014. The Fourth International Conference on Adult Education, Romania 2014.

[LY20] diSessa AA Graesser AC Benson LC-English LD Duschl RA. Li Y, Schoenfeld AH. Computational thinking is more about thinking than computing. *J STEM Educ Res.*, 3(1):1–18, 2020.

[Neda] Scouting Nederland. doelstellingmissie. `https://www.scouting.nl/over-scouting/wat-is-scouting/doelstelling-missie` [Accessed: 26-06-2024].

[Nedb] Scouting Nederland. Geschiedenis toekomst. `https://www.scouting.nl/over-scouting/wat-is-scouting/geschiedenis-toekomst` [Accessed: 26-06-2024].

[Nedc] Scouting Nederland. Spelvisie scouts. `https://www.scouting.nl/over-scouting/wat-is-scouting/spelvisie-scouts` [Accessed: 26-06-2024].

[Nedd] Scouting Nederland. Wat is scouting? `https://www.scouting.nl/over-scouting/wat-is-scouting` [Accessed: 04-04-2024].

[PC23] Ahmed Hosny Saleh Metwally Jari Lavonen Xiao Wang Peng Chen, Dong Yang. Fostering computational thinking through unplugged activities: A systematic literature review and meta-analysis. *International Journal of STEM Education*, 43, 2023.

[pfa] Rasperri pi foundation. Discover our projects and paths. `https://projects.raspberrypi.org/en/codeclub` [Accessed: 30-06-2024].

[pfb] Rasperri pi foundation. What is code club? `https://codeclub.org/en/what-is-a-code-club` [Accessed: 3-7-2024].

[SBD14] Sophie Jörg Sabarish Babu Kara Gundersen Shaundra Bryant Daily, Alison E. Leonard*. Dancing alice: Exploring embodied pedagogical strategies for learning computational thinking. *Proceedings of the 45th ACM technical symposium on computer science education*, page 91–96, 2014.

[SLO22] SLO. vier-domeinen, 2022. https://www.slo.nl/sectoren/vmbo/digitale-geletterdheid-vmbo/digitale-geletterdheid-vo/digitale-geletterdheid/vier-domeinen/ [Accessed: 28-03-2024].

[SLO23] SLO. digitale-geletterdheid-vo, 2023. https://www.slo.nl/sectoren/vmbo/digitale-geletterdheid-vmbo/digitale-geletterdheid-vo/ [Accessed: 27-03-2024].

[SLO24a] SLO. Actualisatie kerndoelen en examenprogramma's, 2024. https://www.slo.nl/thema/meer/actualisatie-kerndoelen-examenprogramma/ [Accessed: 12-07-2024].

[SLO24b] SLO. Leermaterialen, 2024. https://www.slo.nl/sectoren/po/digitale-geletterdheid-po/digitale-geletterdheid-po/leermaterialen/ [Accessed: 01-04-2024].

[SLO24c] SLO. Leermaterialen, 2024. https://www.slo.nl/sectoren/vmbo/digitale-geletterdheid-vmbo/digitale-geletterdheid-vo/leermaterialen/ [Accessed: 01-04-2024].

[SSS14] Neil Smith, Clare Sutcliffe, and Linda Sandvik. Code club: bringing programming to uk primary schools through scratch. *Proceedings of the 45th ACM Technical Symposium on Computer Science Education*, page 517–522, 2014.

[Staa] Laerd Statistics. Mann-whitney u test using spss statistics. https://statistics.laerd.com/spss-tutorials/mann-whitney-u-test-using-spss-statistics.php.

[Stab] Laerd Statistics. Wilcoxon signed-rank test using spss statistics. https://statistics.laerd.com/spss-tutorials/wilcoxon-signed-rank-test-using-spss-statistics.php.

[Unp] CS Unplugged. Computer science without a computer. https://www.csunplugged.org/en/ [Accessed: 01-04-2024].

[VC22] David Messer Valerie Critten, Hannah Hagon. Can pre-school children learn programming and coding through guided play activities? a case study in computational thinking. *Early Childhood Education Journal*, 50:969–981, 2022.

[vR12] Lydwin van Rooyen. Digitale geletterdheid ontwikkelingen en uitdagingen in het curriculum po en onderbouw vo. *Empirical Research*, 41:295–306, 2012.

[WH23] Yanyan Li Wanqing Hu, Ruiyan Huang. Young children's experience in unplugged activities about computational thinking: From an embodied cognition perspective. *Early Childhood Education Journal*, 2023.

[Wil02] Margaret Wilson. Six views of embodied cognition. *Theoretical and Review Articles*, 9:625–636, 2002.

[Win06] Jeannette M. Wing. Computational thinking. *Communications of the ACM*, 49:33–35, 2006.

[WPC15] Benjamin Wohl, Barry Porter, and Sarah Clinch. Teaching computer science to 5-7 year-olds: An initial study with scratch, cubelets and unplugged computing. pages 55–60, 2015.