Understanding Coding Activities for teens: A focus on School Teachers' Perspectives

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Abstract

Over the last few years, researchers, teachers, parents, volunteers, and even IT companies have joined efforts to develop coding activities for children in K-12 education. These efforts include technological tools and programming environments as well as activities descriptions. Kodeløypa is a coding activity offered by NTNU, which focuses on engaging teens in creative programming. In this paper, we report about the design and implementation of an empirical investigation with 13 teachers who attended Kodeløypa as associated school teachers of the pupils from their respective schools. In this study, we have addressed the following research question: What are the teachers' understandings of coding activities for teens outside the schools? The goal of this study was to identify various factors that will help us to acquire knowledge on this important kind of stakeholders, and improve the design and implementation of Kodeløypa and other similar efforts. We have conducted a thematic analysis with the data and we expect the results of this study will help teachers and researchers to design and organize computer science learning activities more efficiently and collaboratively.

Author Keywords

Coding Activities; Programming for Teens; Computational Thinking; Teenagers; Kodeløypa.

Figure 1: An illustration of interaction of a pupil with a student assistant

Figure 2: An example robot from the Kodeløypa workshop

CCS Concepts

•Human-centered computing → **Human computer interaction (HCI);** *Haptic devices;* User studies;

Introduction

The importance of developing digital skills is now reflected in curricula all over the world [8]. In the USA, the CS10K initiative by NFS has aimed to employ 10,000 new Computer Science teachers in U.S high schools. Another example is 'Computing At School', a growing organization for improving the teaching of Computer Science in UK schools [2]. In Norway, the school curriculum has also been updated and extended recently in 2019 to target the needs for digital competencies and skills. In Fall 2016, 146 middle schools rolled out an elective programming course called *Elective Course in Programming (Valgfag i Programmering)* [13], which aims to teach teens (from 8th to 10th grade) topics like, how computers and programs work, alternative uses of programming languages, basic principles in programming and computational thinking, etc.

Researchers have explored and conducted many studies to examine how we can engage teens in computer science learning and computational thinking activities [9, 10, 5, 6]. According to [6], creativity has been pointed out as a positive factor in learning programming and Computer Science. While many studies look at how they can broaden participation in computing, some researchers also looked into specific factors that reflect the teachers' or educators' perspectives about computational thinking activities [14, 1]; where most of the studies are carried out in a formal environment inside the school, this study is built on the lack of insight regarding particular characteristics outside the school that can also increase the effectiveness of such activities. This research brings light to different factors that can help and affect students' learning for computer science or computing as an outside school activity, which contributes to filling a gap of absent research on quality and effectiveness of engagement, and how to deepen participation in computing [4]. In this study, the following research question will be addressed:

RQ. What are the teachers' understandings of coding activities for teens outside the schools?

This study can benefit teachers and researchers who want to design or organize learning activities for teens on programming or computational thinking. The goal of this study is to understand the teachers' points of view about the performance and effectiveness of such kind of activities.

Background

Kodeløypa [11] [12] is a workshop offered by NTNU each year to lower secondary school students to boost the kids' interest in computer science and programming. Kodeløypa is built on the idea that interactions between young students and artistic artifacts in creative programming activities are vital [7]. It is an out of school activity conducted informally, and the pupils attend the workshop for five hours in total with their respective school classes. The workshop is designed such that students without programming experience can participate, and at each workshop, two to four student assistants from NTNU are available to assist the pupils. Student assistants usually do not introduce the programming concepts to the pupil before they start programming, rather they introduce the concepts when and if needed, as shown in Figure 1.

In the first part of the Kodeløypa workshop, participants interact with digital art-robots in small teams. By using the extension Scratch 4 Arduino, the teams can control the robots using code blocks in Scratch. The student assistants provide a paper tutorial to the participants which contain exam-

Figure 3: A pupil working during the Kodeløypa workshop

Code	Subject
1	Programming
2	Programming
3	Programming
4	Mathematics
5	English and French
6	Mathematics
7	Technology in Practice
8	physical education, outdoor life, natural sciences
9	Natural Sciences
10	Natural Sciences
11	English, German and Religion
12	Social sciences, Norwegian and Physical education.
13	Mathematics and Natural Sciences.

Table 1: Participants of the interviews: Teacher Code, Subject taught by the respective teacher

ples describing how to interact with the robots. An example robot from the Kodeløypa workshop can be found in Figure 2, while a snippet of a pupil working with a robot can be seen in Figure 3. In this part of the workshop, the participants practice in small tasks, for example creating several loops to make the robots move, making the lights on the robots turn on and off, etc. The part usually lasts around 45 to 90 minutes.

In the second part of the workshop, the same teams are supposed to create their own game in Scratch. The teams are first told to concentrate on the idea of a game, reach a consensus, and create a draft storyboard before they start to code. If the student assistants think that the game is achievable in terms of time and complexity, the teams are free to create any game they want. The participants are given a new paper tutorial with examples of what they can add to their game, including how they can make characters move, react to touching something, jump, and adding points and time functionality. The pupil creates and tests their games iteratively during the process, and in the end, the teens can play games made by their classmates. The second part of the workshop usually lasts for three hours.

Research Settings

Interviews

To answer our research question, we conducted eleven face to face interviews with thirteen teachers (teachers 2 and 3; teacher 11 and 12 were interviewed as pairs); each interview lasted from 5 to 42 minutes. Following ethical approval from the Norwegian Centre for Research Data (NSD), participants received informed consent forms and one of the authors ran interviews with the teacher. The participants are the teachers who accompany each class of teens to the Kodeløypa workshop. Among the eleven interviews, six interviews were recorded, for the rest the interviewer took detailed notes. The interviews were transcribed and combined with notes for data analysis. In each interview, the interviewer provided a brief introduction of the study at the beginning. Each interview was conducted at the end of the Kodeløypa workshops. An overview of the participants is shown in Table 1. In the interviews, we asked the following questions to our participants:

1. Which preparation you did before Kodeløypa?
2. How well you know Scratch from before?
3. Which was your role during Kodeløypa?
4. How can Kodeløypa contribute to other subject learning?
5. How innovative is Kodeløypa? In which way?
6. Do you have any plan for follow up activities after Kodeløypa?

Data Analysis Method

We used the qualitative data analysis software ATLAS.ti to assist the qualitative data analysis. We initially performed open coding on transcripts and notes. The researchers independently coded the data first, and then shared, discussed, and resolved coded transcript and descriptive memos about emerging themes in the data. After all the interviews were transcribed, a table for each interview was made. Following the advice given by Cruzes and Dybå [3], each question got its row, sorting the data into themes. The transcribed data was added to the left side of the table and the long text was split into paragraphs. On the right side, notes were added when re-reading the transcription. If the transcription was difficult to understand, we listened to the recording. Categories were formed with similar pieces of codes and merged to get a broader sense of the data. We constantly updated the table, merging multiple opinions meaning the same, and arranged them into themes.

Theme	Important codes
Stakeholders & the process	Role of students assistants; Engagement of the teacher during the activity; Freedom to the pupils to create, try and fail.
Novelty of outside school framework	Task design; Organization; Exploring; Robots.
Perks (for students)	Empowering; Engagement; Peer learning; Change in routine and environment.
Perks (for teachers)	Teaching material; A shopping list; Brochure.
Challenges (for teachers)	Time; Training; Interest.
Challenges (for students)	Limited opportunity to attend; Gap of knowledge.
Time scheduling	Start earlier; From 8th grade; 10th grade is late.
Other school subjects	Mathematics; Social science; Natural science; Language; Art and Crafts.
Alternative technologies	micro:bit; Simulation; Computer games.

Table 2: Emerging themes and associated important codes

Results

In this section, we present the results from our thematic analysis of the interviews. In our analysis, we have tried to find out characteristics that can help us to increase the effectiveness of Kodeløypa. The interviews report reflections on the teachers' perspectives about the implications of Kodeløypa and how Kodeløypa can be improved in general. Here in Table 2, we present the emerging themes from the interviews along with some important codes from each theme; followed by a brief description of some important themes.

Stakeholders and the process: During the workshop, the teachers usually do not have any active role other than keeping the pupils calm. But few teachers who know Scratch or know programming believe that they can contribute usefully in helping the pupils along with the student assistants. Most of the teachers appreciated the way student assistants work during the workshop.

Novelty of outside school framework: The teachers usually find Kodeløypa innovative in the way it is organized, for example, open tasks, try and fail approach, no leadership from the instructors, etc. Most of the teachers agreed that the organization of Kodeløypa is different than what they normally do at school. Few teachers also mentioned that using robots for teaching programming is innovative.

Perks (for students): All the teachers agreed that Kodeløypa offers multiple benefits to the pupils. The approach of Kodeløypa makes the pupil self-sufficient, empowering their self-esteem, and working as a team encourages peer learning. Some teachers believe that change in the location (outside school) and a new environment also increased the motivation and engagement of the pupils. *Perks (for teachers)*: Some teachers mentioned that it would be useful for them to follow up coding activities at their schools if they get some kind of tangible helping materials from the workshops; as example teachers mentioned a few things like, paper tutorials, a brochure, a list of the items that are needed to make the robots or to organize similar tasks as in Kodeløypa.

Challenges (for teachers): For the teachers, the most evident challenge was time. Almost all the teachers who do not have any previous programming knowledge mentioned that they do not have enough time to learn to program now. When we asked them about doing or planning for followup activities, they also mentioned about this time constraint. Another challenge that few teachers mentioned is, the interest in doing programming or coding; if the teachers themselves do not have any interest in coding then most likely they will not try to integrate it in their classrooms either.

Challenges (for students): Teachers mentioned a couple of things that they believe are challenging for the students. One challenge is the gap in knowledge. Some pupils have programming as an elective course at the school and some pupils do not. So, when pupils with or without programming knowledge come to Kodeløypa together, there is this gap of knowledge, which sometimes may discourage pupils (who do not know programming) to participate in the tasks along with the pupil who knows to program. Another challenge mentioned by a couple of teachers is the opportunity of attending Kodeløypa; not all the pupils of the school get this opportunity.

Other school subjects: When we asked the teachers about how Kodeløypa can contribute to or relate to other subject areas, we got suggestions about a wide range of possibilities. One teacher mentioned that, there are probably no limitations (to what we can do). The most mentioned subjects include mathematics, natural science, social science, and science in general. But some teachers also mentioned

about Art and craft, languages, etc. as possibilities to integrate programming.

Time scheduling: Multiple teachers have suggested that starting programming or conducting coding activities like Kodeløypa should start from lower secondary school, for example from 8th grade, rather than 10th grade. One teacher also included that, 10th grade is a busy time for the children finalizing their upper secondary school, so it might be difficult for them to manage enough time to focus on programming.

Discussion and Conclusion

In this paper, we have reported an ongoing qualitative study focusing on understanding the teachers' perspectives on the performance and effectiveness of coding activities like Kodeløypa that aims to motivate kids for computer science and programming. Based on the eleven interviews with thirteen teachers, we have identified nine themes presenting the teachers' understanding, challenges faced both by the teachers and students when attending Kodeløypa, suggestions from the teachers to improve and increase the performance of such an activity, etc. We will further explore and analyze the themes to have a more concrete understanding of them, followed by refining our research question and defining our future work. We expect to conduct more interviews in the future exploiting other data analysis methods. From this research, we are trying to address the existing gap in collaboration between researchers and teachers. We expect the results of this study will help teachers, researchers, and volunteers in the future to design and organize computer science learning activities more collaboratively and efficiently.

Selection and Participation of Children

All the participants of this specific study were adults. Participation in Kodeløypa is voluntary both for the teachers and for the pupils. Before the workshop, teachers are sent consent letters so that the pupil can collect signatures from their parents. This letter contains information about the study and notices that the data will be collected during the workshop. If a parent signs this letter, they confirm that researchers can collect data regarding their child's activity. In this letter, we also inform the parents that participation of their kids is voluntary, and all results will be confidential, and withdrawal from the participation will not affect their kids' grades in school.

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