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Introducing a Socio-Technical Perspective on Digital Competence Education Through Co-design

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Research paper

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Abstract

Digital competence and programming have been part of the Swedish school curricula since 2018. This paper demonstrates how co-design design activities can be conducted as a way to provide digital competence education from a socio-technical perspective. Such activities were conducted with novice designers in three sessions, each with two school classes, from a Swedish engineering upper secondary school program in 2019. The students gained hands-on experience with interaction design and co-design as they designed a mobile application using a Wizard-of-Oz prototyping system and evaluated the prototype with users. This trial is used to argue that time allocation for socio-technical perspectives on digital competence in the Swedish school curricula can be expanded to be able to provide students with a more holistic view of digitization beyond technical issues.

Keywords: Co-Design, Socio-technical Perspective, Digital Competence Education, Wizard of Oz, Prototyping.

1 Introduction

In 2017, the Swedish government commissioned primary schools and secondary schools in Sweden to reinforce students' *digital competency* as part of its national digitization strategy (Swedish Government, 2017b). Adequate digital competency can be defined as "the extent to which people are familiar with digital tools and services and are able to keep up with digital developments and their impact on their lives" (Digitaliseringskommissionen, 2015, p. 102, translated from Swedish). The goal of the national digitization strategy in the school system is to "be a leader in making the best use of the opportunities offered by digitization to achieve a high level of digital competence in children and pupils and to promote the development of knowledge and equivalence" (Swedish Government, 2017a, p. 14, translated from Swedish). When launching the strategy, the Swedish Government argued that digital competence is a matter of democracy and that the school system is a key player in developing the ability to use and create with digital technology and an understanding of how digitization affects society and individuals (Swedish Government, 2017a).

The argument and goal behind the national digitization strategy, and thus the incorporation of digital competence education in Swedish schools, is interconnected with the ongoing digitization of Swedish society. Without digitization, there would be less of an urgent need for society and individuals' knowledge about topics such as digital technology to be able to deal with opportunities and challenges posed by digitization, both from an organizational and individual perspective.

The information systems (IS) discipline is also rooted in digitization. Since computers were first used to process data, the IS discipline has focused on the development of IT applications and IT application's impact on organizations and societies, how data and information are processed and managed in society and by organizations, and how technology and social contexts interact (Avison and Elliot, 2006). Sarker, Chatterjee, Xiao and Elbanna (2019) argue that the socio-technical perspective is a foundational viewpoint of the IS discipline, meaning that the study of the mutual interaction between technical components and social components (individuals or collectives) makes IS unique. An IS perspective, or socio-technical perspective, on digital competence in Swedish schools would not be farfetched.

However, the socio-technical perspective on digitization is not common in the Swedish school curriculum; at least, it has not been explicitly stated.

Godhe, Magnusson and Sofkova Hashemi (2020) analyzed the revisions of the national curriculum and syllabi and found four reoccurring themes: (1) "Use of digital tools and media", which pertains to which tools to use in teaching and student work; (2) "programming" which is related to learning about how computers work, how to write step-by-step instructions and algorithms, as well as interdisciplinary content such as understanding how programming can influence which information is available in digital media and how digitization affects society; (3) "critical awareness" which is about the development of critical awareness of sources while "not much is said about how to critically understand and apply digital technologies in themselves" (Godhe et al., 2020, p. 87); and (4) "responsibility" which is about personal data and privacy. The most common theme is the "use of digital tools and media", which "strengthens students' digital abilities mainly on the operational level" (Godhe et al., 2020, p. 87). Of particular interest for the present study is how Godhe et al. (2020, p. 88) described the first two chapters of the revised curricula; that is, where the values and goals of the curricula are addressed: "Here connections to broader conceptualizations of digital competence are made, such as understanding changes in society, problem solving and processing of information."

Heintz, Mannila, Nordén, Parnes and Regnell (2017) also analyzed the curriculum, focusing on Grades 1–9. They argued that the introduction of programming to only mathematics and technology, may risk the broadening of "participation in CS [Computer Science] related study programs and jobs" since these subjects are the "traditional and expected choice" (Heintz et al., 2017, p. 127).

The focus on technical aspects, programming and use of digital tools in digital competency education in Sweden may lead to an understanding of digitization as a mere technical process, lacking knowledge about the interplay between systems, organizations, and people. In the present study we argue that digital competence education would benefit from incorporating a socio-technical perspective. Including concepts that concern the design of digital services such as the context within which the service will be used, who the user is and how the systems design work may be conducted in digital competence education, may enable a different and more complete understanding of digitization. Just as programming can be seen as a handicraft, like wood and textile crafts, interaction design could be another way of tinkering with digitization.

This paper presents an exploration of Wizard-of-Oz prototyping and co-design with novice interaction designers during the winter of 2019. The exploration exemplifies the implications of including a sociotechnical perspective in digital competency education. The trial was conducted at a Swedish secondary school (gymnasium in Swedish) with two different classes of an engineering program. The trial description is not intended to prove a ready-made teaching material to be used in all of the approximately 1200 upper secondary schools in Sweden.[1] Rather, it aims to explore a possible way of introducing other aspects of digital competence in a very tangible way (in a craft-like manner) to complement the teaching of programming.

1.1 Outline of the paper

The remainder of this paper is structured as follows. Section 2 summarizes how digital competence and a new craft subject (programming) was included in the national curricula in Sweden and some of the debate that followed. The third section connects socio-technical perspectives and co-design practices. Section 4 highlights one prototyping method that can be used for co-design, namely the Wizard-of-Oz technique. Then follows an introduction to the exploratory case study, the co-design trial conducted at a Swedish high school in Section 5. Section 6 provides a detailed overview of the three sessions conducted together with the high school students. The paper concludes with Section 7, which discusses considerations when introducing a socio-technical perspective to digital competence education by using a craft-like model of learning, namely co-design.

[1] According to Statista "Number of upper secondary schools in Sweden from 2012 to 2022", Available: https://www.statista.com/statistics/539304/sweden-number-of-upper-secondary-schools/ (visited on 31 May 2022)

2 The introduction of digital competence in Swedish schools

In 2015, the Swedish National Agency for Education began to investigate a national IT strategy on behalf of the Swedish Government (Swedish Government, 2015). The strategy was intended to include the usage of digital tools and teaching materials, changes in syllabuses to clarify the schools' mission to strengthen pupils' digital competence, critical awareness, and equivalence. Furthermore, the Swedish Government state specifically stated that the strategy should include changes to the curricula for primary schools (and equivalent) to reinforce and clarify programming as an element of education. As a part of this commission, the Swedish National Agency for Education mandated a review of current Swedish and international research and projects related to programming in Swedish preschools and primary schools. Kjällander, Åkerfeldt and Petersen (2016), who conducted the review, noted a lack of scientific basis and proven experience for the introduction of programming in preschools and primary schools. However, Kjällander et al. (2016) argued for the importance of introducing the topic but recommend a wider view of programming: that is, computational thinking, which includes aspects such as creative problem solving skills, thinking in multiple levels of abstraction and being able to make generalizations and a structural approach.

In 2016, the Swedish National Agency for Education handed over its proposal to the Swedish Government, detailing how digital competence and programming should be part of the various subjects and curricula (Ekström and Rosing, 2016). The report noted that the proposals "have been developed through a process involving teachers in different types of schools, children, pupils, subject experts and experts in computer science, as well as representatives of teacher education, authorities and organisations" (Ekström and Rosing, 2016, p. 1, translated from Swedish). A few of the consultation bodies critiqued what digital competency entails and that it is necessary to clarify which societal changes come from digitization, alongside comments on the need for skills development for teachers before the changes are implemented (Ekström and Rosing, 2016, p. 23).

The Swedish Government approved the Swedish National Agency for Education's proposal and commissioned the primary schools and secondary schools in Sweden to reinforce students' digital competence within a one-year timeframe starting from July 1, 2017 (Swedish Government, 2017b). The commission included a requirement for schools to reinforce students' ability "to use and understand digital systems and services" as well as "to develop an understanding of how digitization affects individuals and society" (Swedish Government, 2017b). In the specific changes to the curricula, these issues are not as prominent; instead, many changes are focused on the inclusion of programming. For example, mathematics and engineering curricula include programming from Grade 1. Social studies include source criticism in digital media and how digitization may affect work markets and infrastructure (from Grades 4 and 7, respectively) (Swedish Government, 2017b). Since 2018, digital competence has been a mandatory part of the Swedish primary and secondary school curriculum.

To summarize, there seems to have been a clear focus on programming already in the commission from the Swedish Government in 2015 (Swedish Government, 2015). While this is not surprising as such, programming can be seen as an important skill to master; what is somewhat surprising is the implication that gaining the programming skill will be followed by adequate digital competence. Of course, the remaining revisions of the curricula that pertain to digital competence may allow the pupils to gain more than operational skills. However, Godhe et al. (2020, p. 87) found that the curriculum revisions have "a predominantly operational and tool-oriented view of digital competence which emphasises digital tools and media and how to use them" and that "Critical aspects are predominantly related to evaluating information and the sources used, while not much is said about how to critically understand and apply digital technologies in themselves".

2.1 The debate around programming

There has been some debate and criticism against the inclusion of digital competencies and in particular programming as a skill taught in Swedish schools. Two years after programming became a compulsory part of mainly the mathematics and technology curricula, the National Union of Teachers (Lärarnas Riksförbund) in Sweden published a study about teachers' assessment of their own ability to teach programming (Lärarnas Riksförbund, 2020b). The report uses the answers to three questions included in a larger study about the digitization of Swedish schools. In total, 559 teachers from primary school and secondary school in mathematics answered the questions. At least 70 percent of primary school teachers stated that they feel rather insecure or very insecure in teaching programming. Of the secondary school teachers in mathematics, 68 percent stated that they feel “somewhat insecure”, of which 41 percent stated they are “very insecure” (Lärarnas Riksförbund, 2020b). The National Union of Teachers concluded, “It is clear that the state, which is the actor that decides on school policy documents, did not prepare teachers in advance for the reform.” (Lärarnas Riksförbund, 2020a, translated from Swedish)

Furthermore, programming inclusion was criticized in a debate article published in a Swedish teachers’ magazine. The researchers argue the varying levels of knowledge among senior teachers and newly graduated teachers in programming may risk equivalence in Swedish schools and further that teachers and researchers at the university may need increased knowledge (Ekelund, Olander, Wirstedt, Roosqvist, Johansson, Aasa, Jakobsson and Lindgren, 2018).

In a survey, the different conditions that teachers face when needing support when working with digital technology were highlighted, and the chair of the Lärarnas Riksförbund argued that this in, combination with the COVID pandemic, has inevitably increased the knowledge gap among Swedish students (Fahlén, 2020).

Vinnervik (2021) showed that the curriculum documents do not exactly formulate the meaning of programming knowledge and that teachers are left to interpret how to integrate programming into their teaching, which may compromise the equivalence. In an interview in the magazine of the Swedish Teachers’ Union (Lärarförbundet), Vinnervik emphasized the different understandings of programming teachers may have, such as using a digital system as part of a work process versus merely writing code, and proposed that the engineering subject should have the main responsibility for programming education (Tenfält, 2021).

Kristina Alexanderson, who is responsible for the Swedish Internet Foundation’s school initiatives, argued for the importance of raising awareness about digital services made by human programmers, and that these digital services are not “magical” or are functioning on their own (Ottoson, 2020). However, Cederqvist (2020) showed that pupils do not necessarily make the connection between technological solutions and program code, and may have difficulties transferring their understanding from one context to another. Cederqvist (2020) argued that a potentially important aspect in developing the understanding of programmed technological solutions among pupils is to improve the pupils’ systems thinking.

3 Co-design practices

In their well-cited article, Sanders and Stappers (2008, p. 6) defined co-design as referring to “the creativity of designers and people not trained in design working together in the design development process”. The authors noted that although co-design is a fairly new term (or at least it was in 2008), the practice of designers and non-designers collaborating in a development process has been around for much longer. Co-design practices stem from participatory design (PD), and co-design is now often used interchangeably with PD. However, in contrast to co-design, PD is historically intertwined with a democratic and worker rights perspective of digitization, where the early projects in the 1970s, conducted in an action research manner, aimed to grant people affected by workplace digitization a voice and power over their future work situation (Bjerknes and Bratteteig, 1995). In her historical exposé of socio-technical design, Mumford (2006, p. 318) described early PD projects as “socio-technical projects” and the practice as “socio-technical design”. She further argued that the primary objective of these projects was “to ensure that both technical and human factors should, whenever possible, be given equal weight in the design process” (Mumford, 2006, p. 318). In this sense, co-design can be seen as socio-technical design, and, thus, by doing co-design a socio-technical perspective can be given on digitization.

Doing co-design means bringing designers and non-designers together through different methods such as workshops, storytelling, acting or prototyping (Brandt, Binder and Sanders, 2013). Prototyping preferred here as it allows design collaborations of the digital artefact and its interactive aspects. Prototyping was applied during the early PD projects and it was acknowledged that different prototyping techniques – digital and analogue – could be used to ease the communication between researchers and non-designer participants and to communicate the otherwise abstract system designs (Bødker, Ehn, Sjögren and Sundblad, 2000). One prototyping technique is the Wizard-of-Oz (WOz) technique. While this technique is not especially common in the co-design literature, but, as will be explained in the following section, it can allow for creative and craft-like explorations of digital prototypes by designers and non-designers if applied in such manner.

4 The Wizard-of-Oz technique and the Ozlab system

The WOz technique has been utilized in experiments and tests of early prototypes and non-implemented systems and technical adaptations (cf. Kelley (1983); Schlögl, Doherty and Luz (2015); Bellucci, Zarraonandia, Díaz and Aedo (2021)). The idea is that by using a human experimenter as an interpreter, the functionality of a system can be tested with users without having to implement it programmatically first (Dahlbäck, Jönsson and Ahrenberg, 1993).

Just as there are numerous prototyping systems available to designers, several systems have incorporated the WOz technique (Pettersson and Wik, 2015). The Ozlab system is a WOz system that has been utilized in IS education at Karlstad University for some 20 years (Pettersson, 2020). In 2013, the Ozlab system was re-developed as a web-based system that made it possible to conduct user tests and co-design sessions on any device that can open a modern web browser. The Ozlab system is designed specifically to allow the prototyping of interaction design and graphical user interfaces. The system is not designed for creating high-fidelity prototypes, although it is possible to obtain a polished look by using imported images. By applying some of the "behaviors" available in Ozlab – combined with the wizard controls, which make it possible to, for example, switch dialogues or display new objects – it is possible to give the impression of a functioning system (Pettersson and Wik, 2014).

Traditionally, the terminology used when detailing WOz experiments has been that the one simulating the system's functionality (typically a researcher) is the wizard. However, as pointed out by Mavrikis and Gutierrez-Santos (2010), the term 'wizard' comes with some implications for the WOz setup. That is, in a traditional WOz setup, a test participant is on the receiving end of the simulations, and she or he is not aware that the interactivity and functionality are a simulation. However, the WOz technique has been utilized in several experiments without hiding the fact that the system is not yet developed and that the wizard can follow the participant's interactions with the system, and even respond to them accordingly (Pettersson, Wik and Andersson, 2018). In such experiments, the wizard may be called an 'expert' or a 'facilitator', and the role can be played by a teacher, a subject expert, or even a systems developer (Mavrikis and Gutierrez-Santos, 2010). The more explorative type of the WOz technique, where the wizardry is done in plain sight, can be combined with an informal interview or discussion between the wizard and the test participant (Wik and Bergkvist, 2022). By doing this, the WOz technique helps facilitate participatory design rather than just being a usability evaluation technique (Wik and Khumalo, 2020).

It is worth pointing out that not all WOz experiments need to or should be conducted in a usability laboratory, as doing so may decrease the ecological validity (Mitchell and Mamykina, 2021). However, WOz tests have traditionally relied on the laboratory setting, partly for technical reasons and partly since the experimental setup has demanded that the use environment can be controlled and that the wizard can be hidden. WOz experiments in the wild demand at least a lightweight WOz system, as pointed out by Mitchell and Mamykina (2021), and depending on the goals of the experiment some mending on the experimental setup.

Another aspect of WOz simulations is that by pretending to "be the computer", the wizard can become aware of which types of interactions and responses an interactive system handle, because without the wizard's interpretations and intervention, little or nothing will happen. The programmed actions of the computer could also be realized iteratively by reducing the facilities provided for communication between test participant and wizard, as in 'bandwidth tapering' introduced by Mavrikis and Gutierrez-Santos (2010).

5 Method

Before the exploration presented in this paper was conducted, a few trials of the co-design method were conducted. The first trial was during an undergraduate university course in 2018 on user testing and prototyping. During the course, the students evaluated their ideas for indoor way-finder applications over distance aided by the Ozlab system. Since GPS tracking does not work sufficiently indoors (especially not in buildings with several floors), the students were asked to take an explorative approach. The explorative design problem in combination with the WOz-based method, made it possible for the students to explore different ways of conducting user studies over distance and to identify which problems can arise during remote co-design studies for mobile applications. It also challenged the students to explore how to simulate the positioning functionality of the way-finder application, which provided good input for further studies.

The WOz testing over distance was explored further in a bachelor thesis project[2] conducted in an engineering program at an upper secondary school. Again, the design problem of a way-finder application for mobile phones was utilized, by using the WOz technique and the Ozlab system. During the bachelor's thesis project, one teacher at the secondary school declared interest in further collaboration, especially to incorporate some interaction design in the engineering students' education. Thus, a plan for the trial at the upper secondary school began to form, which would incorporate the exploration of a way-finding application by utilizing the Ozlab system and the WOz technique. This would present an interesting opportunity to introduce co-design and interaction design in a practical way to high school students. The lessons learned from the sessions, focusing on including socio-technical approaches in the teaching of digital competence, are discussed in Section 7. The following sections present how the sessions were conducted.

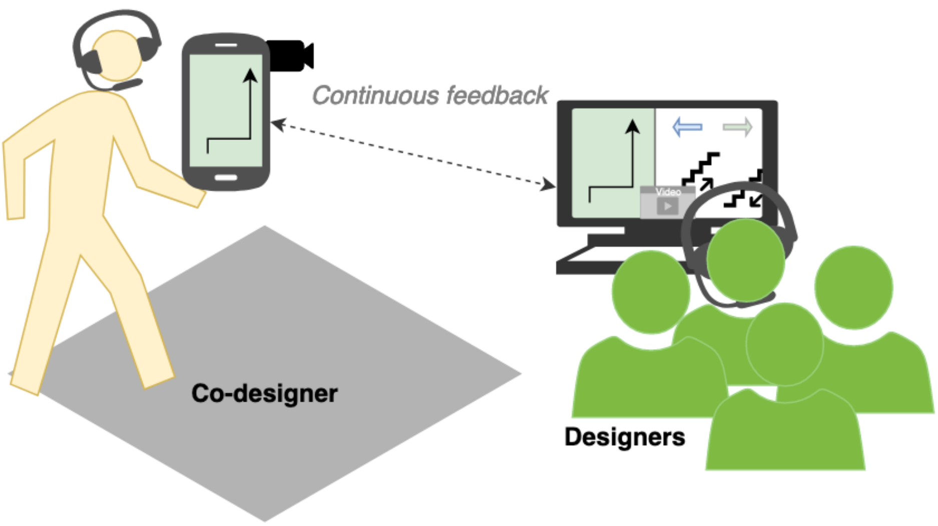

Figure 1. *The setup of the co-design sessions. The co-designer and the student group of designers could communicate orally and via the interactive WOz-controlled prototype. The positioning functionality of the way-finder prototype was simulated by observing what was captured by the back camera of the co-designer's device.*

5.1 The way-finder exploration setup

The way-finder application prototype was designed and run in the Ozlab system. This meant that a human operator controlled the prototype, for example, when the co-designer clicked a button, the operator interpreted the action and responded accordingly through the prototype. In the trial, the student group that designed the prototype is responsible for the WOz simulation. To make it seem as if the way-

[2] Mufic, E. (2019). *Undersökning av deltagande design via mobila enheter på distans: Digital prototyping med Ozlab*. Bachelor thesis. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:kau:diva-72953

finder prototype knew where the co-designer was located, the back camera was on and the image can be seen by the designers. Via the WOz system Ozlab, the interactions of the co-designer could be followed by the student group, who also had to correspond and alter the content of the prototype to match the location and interactions of the co-designer.

To capture the actions of the designers in the student groups and their co-designers' actions during the co-design sessions, the screen of the designer's computer (running the Ozlab system and thus the prototype) needed to be recorded. The screen recording also included audio (that is, the voices of the designers (the student group) and the co-designer), as well as the view of the back camera on the co-designer's device. The designers and co-designer communicated orally using a videoconferencing system. This system was also used to capture the back camera of the co-designer's device. The setup of the co-design sessions is illustrated in Figure 1.

5.2 Initial trial setup

In June 2019, the teacher at the upper secondary school was sent a written outline of a potential trial setup and some questions on practical and technical matters. At this stage, the outline of the trial setup was planned for three sessions (see Figure 2). Six dates (three dates for each class) were proposed. The lessons were about two hours each. The teacher proposed that the third session would be shortened to fit into the schedule. The teacher answered the practical and technical questions but asked to give feedback after the summer vacations regarding the setup.

5.3 Reducing the scope of the trial

Other study program advisors were contacted by the teacher to include classes from other study subjects. However, because of the limited number of hours for digital competence related education, it was not possible to establish a collaboration during the time of planning. After some back and forth during the early autumn of 2019, two classes from one orientation of the "Engineering program" (Teknikprogrammet) were included in the trial. For practical reasons, only the involved teacher's lessons could be used for the workshops and the time allocation for the trial needed to be reduced. Therefore, the whole trial was shortened to three sessions, each of which was 60 minutes in duration (see Figure 3). However, the teacher was asked if it would be possible to conduct interviews with the students after the third session; that is, after class. These interviews (see Session 3 in Figure 3) replaced the group-wise discussions and debriefing in the original trial setup (compare with Session 3 in Figure 2) and included the students' views of their co-design sessions, difficulties etc.

5.4 Ethical considerations

All students had been given the information letter 1.5 weeks before the first session and again during the first session when the research study and data collection were presented. All participating students were older than 15 years and could therefore consent to participate without their guardians' knowledge. All students signed an informed consent form during the first session. Data on the sex of the participants were not collected, but a majority of the students in the "Engineering program" are male.

It was agreed with the teacher that all students should join in the sessions to receive the same amount of education, but that they could opt out from being recorded and interviewed; that is, opt-out from participating in the research study. Since the students were supposed to work in groups, it would be necessary to gather their consent already during the first session although the recordings and interviews would be conducted by the last session. A group could not consist of students consenting and not consenting to participate in the study because of the recordings of sessions. Three students from Class A and four students from Class B chose not to participate in the research and were placed in separate groups.

To avoid capturing bystanders in the corridors on the recordings during the workshop in Session 3 (see Figure 3), the co-designers wore a headset and a plastic filter was put on the back camera of the co-designers' devices during their walks in the corridors of the school. Students who did not consent to collect research data did not record their screens or partake as co-designers in groups that recorded their screens.

The study was assessed by the Research Ethics Committee at Karlstad University and was not subject to the Ethical Review Act.

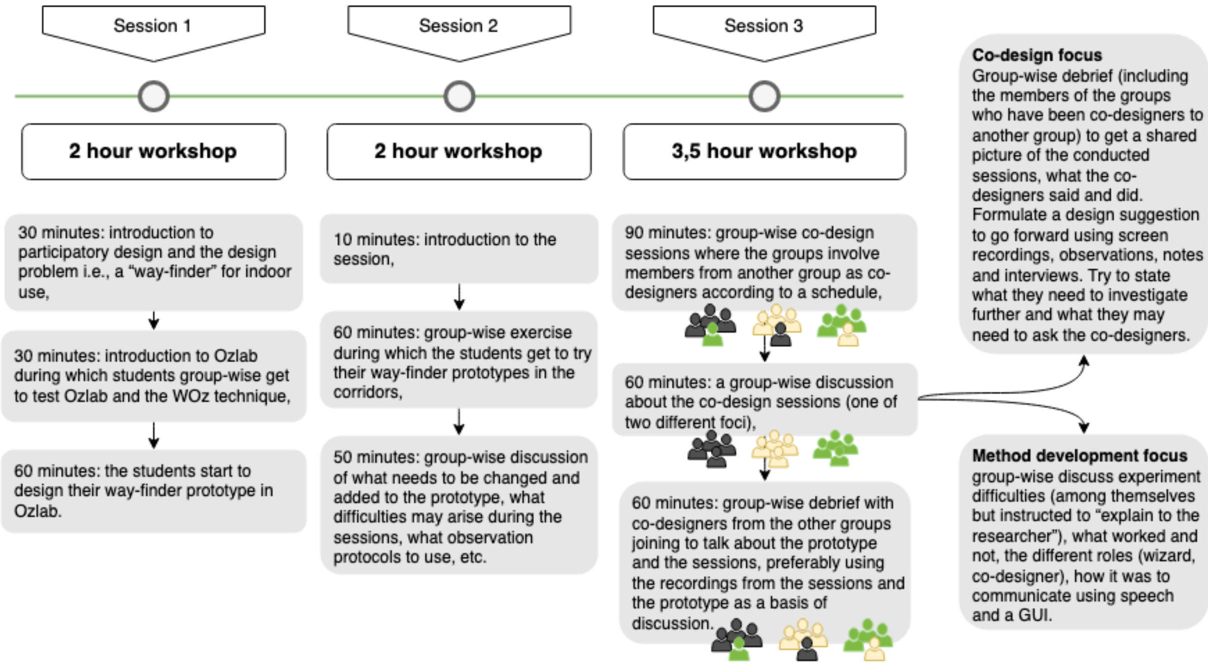

Figure 2. *The three sessions of the initial trial setup.*

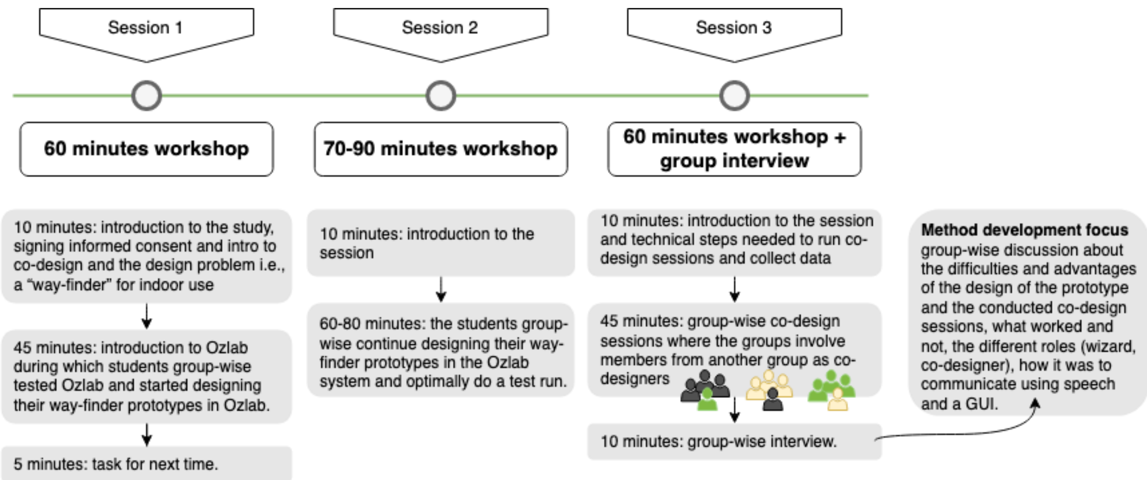

Figure 3. *The three sessions of the co-design trial.*

6 The sessions

As mentioned above, two classes from the Engineering program were involved in the trial. During the sessions, two or three people from the university who were well versed in the Ozlab system and the WOz technique assisted with practical issues, answering questions about the task and the Ozlab system.

- Class A was a web programming class, third year, approximately 25 students.
- Class B was a programming class, second year, approximately 35 students.

The teacher assisted in dividing the students into groups of 3–4 students to ensure that the student collaboration would go as smoothly as possible. All groups were given access to one Ozlab prototype each, with the same example texts and pictures. The same prototype was shown during the presentation during Session 1. The prototype did not contain any suggestions for how the app should show the navigation to the user, but did contain one example of how the prototype could look if the input of the destination was based on voice.

6.1 Session 1 A: Tuesday, 60 minutes, Class A

The workshop began with a short introduction to the three sessions and their task. After the groups had been formed, the concepts of co-design and interaction design were presented, followed by a short presentation of the needs analysis motivating the way-finder app that the students should construct a prototype of, followed by an introduction to the Ozlab system. After the brief introduction, the students were asked to log in to the Ozlab system and start to explore the prototyping system. The assistants and I walked among the students to guide them, answer questions regarding the task and the system, and keep them focused on the task.

The session was concluded with me asking the students to do three things before the next session: install screen-recording software (two different software were proposed), install a video conferencing system (one specific system was proposed), and not to look at each other's prototypes. The students were also told that they could continue to work with their prototypes and were provided contact information if questions occurred.

While some parts of the class seemed to have grasped the task at hand, the general feeling was still that the task (creating a way-finder prototype in a given prototyping tool) was a somewhat unclear, which is why the introduction needed some adjustment. The teacher also said that the task of creating a way-finder prototype could be clarified before the first session with Class B began.

6.2 Session 1 B: Friday, 60 minutes, Class B

This time the presentation began with a brief explanation of how the three sessions would be conducted and the task of creating a way-finder prototype.

After the groups had been formed, the theory behind co-design and interaction design was presented. Then the Ozlab system was demonstrated. Two of the assistants held up two tablets showing the test person's view in Ozlab. Session 1 B was otherwise run and concluded in the same way as Session 1 A.

6.3 Session 2 A: Tuesday, 70 minutes, Class A

The session began with a recap of the previous session (1 A). The PowerPoint slides used to explain the prototype idea to Class B in Session 1 were used. Then the agenda of the day was presented: "finish" the prototype and conduct one co-design test run in the corridors of the school with one of the assistants. However, none of the student groups had time to run a test run. One of the groups was close, but ran into some technical difficulties and had to abort their trials due to time.

During the session, a few groups sketched their ideas on paper before adding either their sketch to their prototype or implementing their idea in the system.

A few students who had not attended the previous session attended this session. They were given a brief introduction and two decided to be a part of an already formed group, while two decided to form their own group. One student joined a group that had appeared very eager and alert in the past session. However, this student, was somewhat skeptical about the prototyping process and wanted to discuss why they should not go ahead and program the application instead, saying that since the prototype looks so unfinished, etc., no users will like the concept. The group remained idle until they discussed the potential advantages of conducting prototyping before development with me.

6.4 Session 2 B: Friday, 90 minutes, Class B

The students continued to work on their prototypes. Some groups sketched their ideas on paper first, as in the previous session (1 B). During Session 2 B, one group discovered that the pages in one of their prototypes were gone. This might have occurred due to technical issues (Ozlab bug, database disconnect, etc.), forgetting to save before quitting, or – perhaps most likely– some other group happening to open the wrong prototype and deleting the pages they did not recognize as their own, or the group itself opening the wrong prototype during this session (at the time of the trial it was not possible to lock certain files and prototypes). Although it must have been irritating for the student group to have lost all their work, they made a new prototype and had time to do some test runs.

The class seemed positive and eager to try their prototypes out in the corridors of the school. At least six of the nine groups proceeded to conduct one or several trial runs within their groups and with the assistants as test participants. Some groups conducted several runs with different destinations, devices, and group members. It is difficult to say exactly how many groups conducted test runs as they sometimes proceeded on their own, and since the assistants and I supervised other students in the meantime.

6.5 Session 3 A: Tuesday, 60 minutes, Class A and Session 3 B: Friday, 60 minutes, Class B.

Since Class A had not come as far as Class B had during the second session, the students were made aware that even though they may not be finished with their prototypes, they simply had to work with what they had. Before the co-designing sessions could begin, a few technical preparations were needed: installing a screen-recording software, logging in to the videoconferencing system on the computer and the co-designer device, starting Ozlab on each device, borrowing a headset for the co-designer and a "lens filter" to the co-designer's device. Although the students had been asked to set up both the screen recording and the video conferencing account during the previous sessions, few had done so. There were some issues with getting the programs to install on the students' computers, such as compatibility with their version of Windows. The video conferencing system also took some time and energy for the students to set up, as some of them did not have an account beforehand and logging in sometimes required security codes and the like. There was also some unclarity regarding which device each program should be installed on and how the sessions would be conducted, such as how they would be able to see where the participant was and which device they should record on.

When all the groups had started their technical setup, the groups were instructed on how to go about with their co-design sessions. The student groups asked students from the other groups, the teacher and the assistants to join their co-design sessions as co-designers.

Each student group was asked to conduct at least two co-design sessions with a new co-designer for each session. Since they would only recruit co-designers from the class, they did not have to sign consent forms or do an introduction with the co-designers: everyone involved in the sessions knew about the sessions. However, the prototype that the co-designers got to interact with was new to them. The groups had not shown their prototypes to the whole class beforehand. Wearing a headset and holding a portable device, the co-designers were asked to use the prototype on the device to find their way to a place somewhere in the school (see Figure 3). Some groups let the co-designer decide on the destination, while other groups had decided beforehand where the app should guide the user to. If they wanted to, they could also discuss the prototype, interaction design, and content with the co-designer or give oral instructions. All of the groups in the two classes managed to conduct at least two co-design sessions in the corridors of the school.

7 Findings and conclusions

This paper provides an example (a trial, admittedly) of including a socio-technical perspective in digital competence education. With the sessions outlined in the previous section, this section aims to introduce important aspects to consider when having with students using co-design methods when designing interaction to include a socio-technical perspective in digital competence teaching.

7.1 Provide a suitable environment for co-design

The classroom that the classes normally use and in which the workshops were held was one room with tables placed in long rows (with a walking space in the middle). With the class taking up a majority of the rows, it was difficult to both support and observe the students without disturbing some other group. During some of the sessions, the classroom was stuffy and warm and some students complained to the teacher about the work environment.

The setting of the room and the noise that arises when 25–35 students begin to collaborate, start video conferencing calls, celebrate their successful sessions, etc. did not provide the best environment for allowing the student groups to talk with the co-designers during their sessions or discuss their designs among themselves.

Regardless of these difficulties, the energy and mood in the room were very good and the students seemed to have fun while working with their prototypes.

7.2 Develop co-design sessions iteratively

An agile and iterative approach to systems development is not new for IS researchers, but it is worth noting that co-design activities, as described in Section 6, followed a plan but were updated according to input from the teacher, the needs of the classes and technical constraints. Each session was run two times (one time per class), which provided the possibility to improve the instructions, the PowerPoint slides, the order of introduction of information, etc. between the first and second sessions. The biggest difference was in how the first session, in particular in how the introduction to the concept and the rest of the sessions, was conducted.

7.3 Allow enough time for co-design

When the workshops were planned, the intention was to introduce the students to how the co-design sessions could be conducted to involve the co-designer in the design as much as possible. This proved to be a challenging task. The students had no previous experience with user tests and interaction design. However, limited design and usability knowledge is not a problem per se. It is probably often the case for the participants in a systems development project with a user-centered design (UCD) approach. But the goal of a co-design session needs to be introduced to someone who should do more than participate in typical UCD activities such as a user test or a workshop. If the participants are supposed to conduct their co-design explorations with other participants, it is reasonable to think that some introduction and practice would be needed first. The time for a lengthier introduction and more practice was not available during this trial. If more time had been allowed for the workshops, it would have probably been used by the participants to elaborate on their prototypes *without* their co-designers; that is, trying to "finish" their prototypes and fine-tune the design (too much). Instead, since the time for hi-fi prototyping was limited, it gave the students a hands-on experience of rapid prototyping and bandwidth tapering (Mavrikis and Gutierrez-Santos, 2010), thanks to the use of the WOz technique. Thus, even if co-design interaction was minimized, so was also the vicious circle of a team developing a design without the users' input.

The originally planned 60 minutes for discussions between designers and co-designers (compare the third session in Figures 2 and 3), or an alternative whole-class discussion, would have benefitted the evaluation of co-design. For example, one could have discussed the fact that some groups did not communicate orally at all with their co-designers, while other groups combined their prototype with oral instructions and/or descriptions of the graphical user interface in their prototypes.

Finally, it is also possible that allowing more time for familiarization and setup of the technology could have been beneficial. It was complicated for the students to manage the setup required for the live and interactive co-design: that is; the two devices (the smartphone/tablet and the computer) and three systems (Ozlab, the video conferencing system and the screen recorder). Asking the co-designer questions about their prototype and execute design changes in the prototype according to the co-designer's feedback, probably should have been preceded by some time for exercising, just to make them mentally prepared for the dual tasks of executing the interaction design while being open for needs and suggestions of the co-designer. Some student groups in the second class (Class B) managed to try the setup and do a test run already during Session 2, but none of the student groups in Class A did so.

Admittedly, some of the issues during the co-design sessions described here were due to the collection of data for the research study. The use of screen recording software, the filter and headset was essential due to the collection of ethical research data, measures that were not needed if conducting similar activities outside of a research study.

7.4 Reflections on the WOz technique

When the novice designer designs, it is not a given that she or he will take into account the needs of the user. When the students designed their way-finder prototype, they did not have any formalized requirements or user needs to take into account, nor did they have access to specifications or models such as personas or scenarios detailing the user and use of the application. Instead, the students discussed among themselves and made ad-hoc decisions about the design. Admittedly, some design decisions were also the results of the Ozlab system and its available possibilities.

Therefore, the initial prototype design was not a co-design effort per se. However, watching the user struggle with the design during the co-session as these students did during their sessions can efficiently reveal shortcomings in a design (compare with a similar study conducted by the author herself only a couple of months later, in Wik and Bergkvist (2022)). Of course, for a novice designer or developer designing a system and then conducting the test sessions, someone more experienced in design might step in to turn the frustration over ‘dumb users’ who ‘do not understand anything’ towards the design as such instead. In doing so, another important socio-technical perspective on digitization could be highlighted. That is, when digitization is done well, it is done with a socio-technical perspective. When the technical component and the social component are given equal attention in systems development and digitization, the harmony between the two will help achieve usability (Sarker et al., 2019). By including the socio-technical perspective of the design of digital artefacts, students can obtain rich knowledge about how digital technology has an impact on society and individuals, especially if it is poorly done. This knowledge is one of the aspects of adequate digital competence. Tinkering with interaction design through co-design, as done in the trial and reflected upon above, may help highlight that aspect. Without a well-designed interaction design, there is no harmony or fit between the technical component (IT system) and social component (human), so digitization cannot help achieve instrumental or humanistic objectives (Sarker et al., 2019).

Programming is a skill that students should acquire as part of their digital competence education. However, students may not be able to make the connection between the functionality of the “magical” digital services and the programming (Ottoson, 2020). The above-mentioned trial was conducted with the belief that the application of the WOz technique may have a positive outcome regarding the ability to apply systems thinking, as also proposed by Cederqvist (2020). The WOz technique highlights that, without programming, the system will not react or respond to the interactions of the user because without the human operator’s intervention the prototype is not interactive. It is also clear from this trial that despite the noisy environment and short sessions, two whole classes of upper-secondary students were able to conduct the basic steps of the craft of interaction design and co-design.

7.5 Implications for school curricula

While not everyone will work in software development as a programmer after their graduation, an increasing number of tasks and jobs have some connection to systems and digital artefacts. Therefore, students must be given an early socio-technical perspective on digitization regardless of their choice of future studies or work. However, this could be difficult given the focus on tool use and programming in the current curricula (Godhe et al., 2020).

Although the involved teacher was very positive about including interaction design in the education, which generated interest in including more socio-technical aspects in the otherwise technically focused education, it was difficult to fit it into the tight schedule of the two classes. It may be even more difficult for teachers in other subjects to include a more holistic view of digital competence, as such formulations are lacking in the general curricula. As Section 2 shows, the debate around digital competence education in Sweden has largely revolved around programming, from a teacher's and student's perspective. The literature on the subject seems to concentrate on how digital competence should be taught and that equivalence is made between digital competence and programming skills.

The engineering program already get much of the technical competence, but lack other perspectives, and the situation could be worse for *non*-technical programs such as the art program. In the present study, those teachers never managed to find time to participate with their classes. The implications seem to be that all education must be allowed more time for a hands-on experience of user-centered design and possibly other craft-like socio-technical perspectives of digital competence in school curricula.

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