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Young People's Digital Skills Practices in Non-formal Learning Contexts: Observations, interviews, co-design

Davide Cino
Silke Brandsen
Nathalie Bressa
Eva Eriksson
Giovanna Mascheroni
Bieke Zaman

Please cite this report as:

Cino, D., Brandsen, S., Bressa, N., Mascheroni, G., Eriksson, E., & Zaman, B. (2022). *Young People's Digital Skills Practices in Non-formal Learning Contexts: observations, interviews, co-design. (Deliverable 6.2)*. KU Leuven, Leuven: ySKILLS.

DISCLAIMER

This project has received funding from the European Union's Horizon 2020 Research & Innovation programme under Grant Agreement no. 870612. The information in this deliverable reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.

DISSEMINATION LEVEL

Public

Project: ySKILLS – Youth Skills
GA: 870612
Call: H2020-SC6-TRANSFORMATIONS-07-2019
Type of action: RIA

Young People's Digital Skills Practices in Non-formal Learning Contexts: observations, interviews, co-design

Work Package 6 – Deliverable 6.2

Due date: **30 June 2022**

Submission date: **30 June 2022**

Lead beneficiary: **UCSC**

Authors: **Cino, D., Brandsen, S., Bressa, N., Eriksson, E., Mascheroni, G., & Zaman, B.**

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Executive summary

This report is based on findings from a **cross-national qualitative study** investigating young people's digital skills practices in non-formal learning contexts in **Belgium**, **Denmark**, and **Italy**.

The goal of this study was to ***gain better knowledge about how to foster digital skills acquisition and practices in non-formal learning contexts***.

This study combined 16 **observations** of digital skills workshops (i.c. programming and robotics workshops), 11 **interviews** with organisers and moderators of such activities, and 4 subsequent **co-design activities** with the collaboration of children, organisers, moderators, and researchers.

The research activities took place in **non-formal learning contexts**, such as public libraries, youth clubs, and school spaces used for extra-curricular activities (i.e., outside the formal curriculum). Due to different COVID-19 restrictions across Belgium, Denmark and Italy, flexibility with the research protocol was needed.

The main aim of the observations and interviews was to first map existing situated experiences of digital skills workshops across countries, investigate their structure and teaching philosophies, and inform co-design activities. Then, with the co-design activities, we aimed to gain knowledge about potential future trajectories, drawing insights from best practices and formulating recommendations, with Italy focusing on teaching style, Denmark on technology and tools, and Belgium on policy.

Our work allowed us to address several research questions, investigating three main areas to be understood as broader thematic units.

As a first thematic unit concerned with *teaching*, we questioned how the philosophies that drive the digital skills workshops ran by moderators and organisers have an impact on the workshop organisation in terms of their formality, activities chosen, teaching styles, imaginaries and values. Indeed, we argue that these matters should not go unnoticed, as part of a *hidden curriculum* (Gordon, 1982), as these are likely to impact children's and young people's digital skills acquisition and practices.

Secondly, as for the theme of *learning*, we investigated whether and how the formality and structure of the non-formal digital skills workshops may have influenced children's digital skills practices and learning, what types of learning strategies were promoted by moderators, and what practices were enacted by the children themselves.

As a third theme sensitive to *including*, we aimed to understand who participates in digital skills workshops and who is excluded, and why, questioning for instance potential sociocultural or material barriers (or absence thereof) shaping the democratisation and distribution of the learning opportunities.

Key takeaways

- Digital skills workshops in non-formal learning context are designed and run with the **mission of promoting children's collaboration and active participation**, moving beyond the normative and asymmetrical logic typical of formal education. In this context, across countries, moderators emphasised that they are not to be seen as teachers, but rather as facilitators, framing participants as the main actors of their educational experiences, echoing previous research studying digital skills practices in non-formal learning contexts (Livingstone & Blum-Ross, 2020).

- Although collaboration and active participation are key words in moderators' and organisers' imaginaries, most of the times **the structure of the learning activities, the affordances of the digital learning environment, and the choices of the children themselves, promoted individualistic practices**, where each child worked on their own to achieve their own personal goals. We hereby acknowledge that any educational activity is characterised by, at least partially, asymmetrical relationships, where adults are the ones who are likely to make choices for children. In this sense, the choice of activities, software and, generally, the organisation of the workshop itself, comes down to adults. To counteract this tendency, in implementing teaching strategies, social goals and learning goals should be put forward during the non-formal learning activity.

- The spatial organisation of the workshops including the features of the technologies and tools can both hinder or facilitate collaboration and learning practices. It is important to align these to the intention and orchestration of moderators so that the **room, the physical materials, and the technologies** contribute to the overall goals. Also, to design situationally appropriate learning technologies and activities that integrate with current practices, it is important to understand the implicit and explicit social and material structures that constitute the activities and interactions with technologies.

- Our study further **challenges the myth of the digital native**, showing that children need appropriate and meaningful external support, individual effort, and motivation to become digitally skilled. Even if informed by a narrow understanding of programming skills as an individual achievement, digital skills workshops are promising for children to train digital practices and acquire new digital skills.

- **A "free" and "open door" approach** to the organisation of digital skills workshops **does not necessarily mean that it is inclusive**, not even when all materials are provided for free by the organisation. Apart from initiatives specifically tailored for usually under-represented groups (including girls, children from lower socio-economic status (SES) households, ethnic minorities), digital skills workshops are mainly attended by upper- or middle-class boys, showing **how organisers and moderators struggle in attracting a diverse range of participants**. The degree to which parents value programming as beneficial for their children's future achievements turns out to be one of the main incentives to participate in digital skills workshops, together with the child's genuine interest in the topic.

- To foster inclusivity, our findings suggest that workshops should **allow a certain degree of open-endedness and freedom**, **so that children can adjust and embed the projects into their own lived experiences and future-oriented imaginaries**. This also means adapting the educational proposals to suit the interests, needs and competences of a wide variety of children with different backgrounds and aspirations. This way the activities can be meaningful for participants to be able to express themselves using technology, while taking into consideration external factors such as the influence of parents and schools which contribute to the opportunities and attendance by participants.

- Finally, the organisation of digital skills workshops and initiatives should **become embedded in the social fabric of the city and/or youth work**, conceiving of them as a communitarian effort. This means that an active dialogue between policymakers, organisers and moderators, researchers, parents, and, of course, children themselves from different backgrounds is needed. Participatory co-design among these actors can be a key strategy to promote child-centred approaches that move beyond individualistic accounts of learning, towards the creation of more collaborative, and more inclusive digital skill activities through a systemic and holistic approach.

Task 6.1 in a nutshell

YOUNG PEOPLE'S DIGITAL SKILLS PRACTICES IN NON-FORMAL LEARNING CONTEXTS

AIM

Discover how non-formal learning contexts influence young people's digital skills practices.

STEP BY STEP

16 observations of workshops.
11 interviews with organisers and moderators.

Map experiences of digital skills workshops in three countries,
Investigate the workshops' structure and teaching philosophies.

\+

4 co-design activities with children, organisers, moderators and researchers.

Gain knowledge about future trajectories,
Draw insights from best practices,
Formulate recommendations.

WHERE

Public libraries
Youth clubs
School spaces
(for extra-curricular activities)
in Belgium, Denmark and Italy.

Research questions on three main areas.
Teaching: how philosophies influence organization, activities chosen, teaching styles and values.
Learning: strategies used by the moderators, children's enacted practices, whether and how the formality and structure of the workshop influence children's digital skills practices and learning.
Including: who participates in workshops and who is excluded and why.

KEY TAKEAWAYS

Digital skills workshops have the mission of promoting children's collaboration and active participation.

In the three countries, moderators are seen as facilitators where children are considered the main actors in their educational experiences.

The structure of the learning activities designed by adults, the affordances of the digital learning environment, and children's choices contribute to individualistic practices in workshops.

Social and learning goals should be put forward as complementary during the non-formal learning activity.

The organization of space, the tools and access to technologies influence overall goals.

Social and material structures may function both as hinders or facilitators to collaboration and learning practices.

Children need appropriate and meaningful external support, individual effort, and motivation to become digitally skilled.

Young people are not digital natives.

"Open door" and free workshops do not mean inclusivity.

Organisers and moderators struggle in attracting a diverse range of participants. Parents' and child's interests function as the main incentives.

To foster inclusivity, workshops should allow a certain degree of open-endedness and freedom.

Workshops should be adapted to suit children's interests, needs and competences.

Community effort should be made when organizing initiatives and workshops.

Coordination between policymakers, organisers and moderators, researchers, parents, and children can be a key strategy to promote child-centred approaches and more inclusive digital skill activities.

1 Introduction

1.1 The ySKILLS project

The ySKILLS (Youth Skills) project is funded by the European Union (EU's) Horizon 2020 programme. It involves 15 partners from 13 countries to enhance and maximise the long-term positive impact of the information and communications technology (ICT) environment on multiple aspects of wellbeing for children and young people by stimulating resilience through the enhancement of digital skills. Starting from the view that children are **active agents in their own development**, ySKILLS examines how digital skills mediate the risks and opportunities related to ICT use by 12- to 17-year-olds in Europe (see https://yskills.eu).

The overarching aim of ySKILLS

To enhance and maximise the long-term positive impact of the ICT environment on multiple aspects of wellbeing for all children by stimulating resilience through the enhancement of digital skills.

ySKILLS will **identify the actors and factors** that undermine or can promote **children's wellbeing** in a digital age. The relations between ICT use and wellbeing will be critically and empirically examined over time.

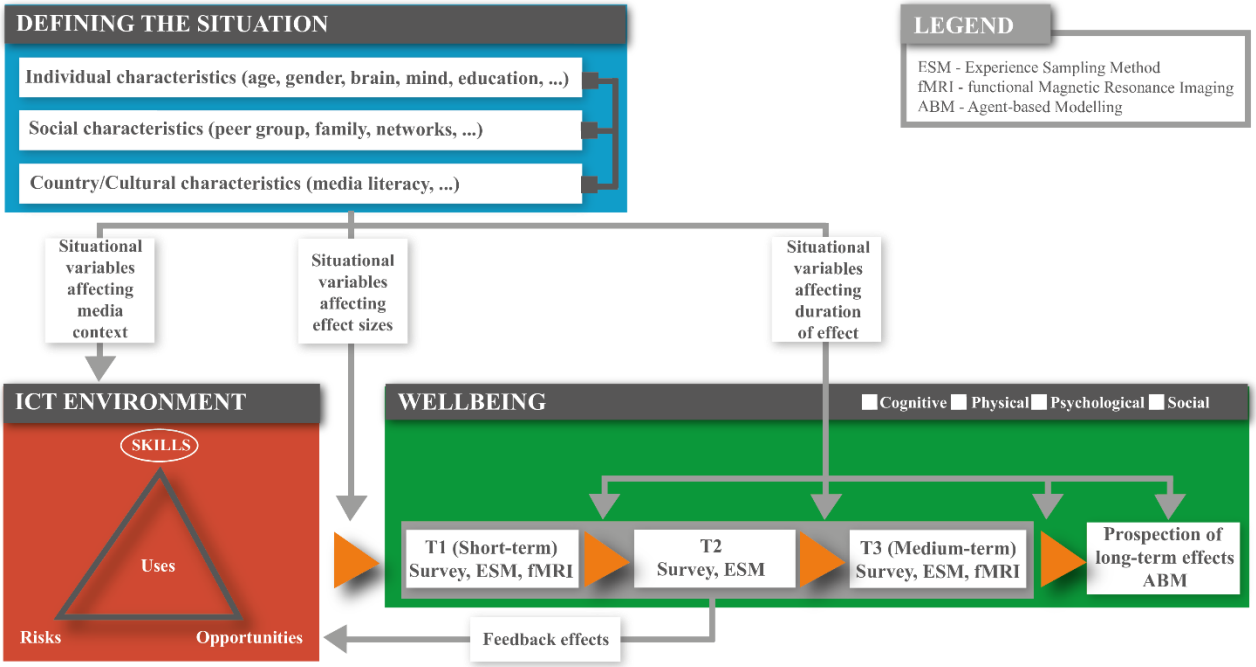
ySKILLS' research objectives

1. To acquire extensive knowledge and better measurement of digital skills.
2. To develop and test an innovative, evidence-based explanatory and foresight model predicting the complex impacts of ICT use and digital skills on children's cognitive, physical, psychological and social wellbeing.
3. To explain how at-risk children (as regards their mental health, ethnic or cultural origin, socioeconomic status and gender) can benefit from online opportunities despite their risk factors (material, social, psychological).
4. To generate insightful evidence-based recommendations and strategies for key stakeholder groups in order to promote European children's digital skills and wellbeing.

This report contributes to achieving objective 3, and will further our understanding of how at-risk children can benefit from online opportunities despite potential material and/or social risk factors.

ySKILLS has proposed, and will continue to develop, its **conceptual model** (see Figure 1):

Figure 1. ySKILLS CONCEPTUAL MODEL



This report focuses on the relationship between the situational variables (individual, social and country characteristics) and children's media contexts. More specifically, it focuses on the role of individual (age and gender), social (socioeconomic background) and cultural characteristics (e.g., availability and characteristics of digital skills workshops in non-formal learning contexts such as public libraries, youth clubs, extra-curricular activities in schools, etc.) in children's digital skills practices in non-formal learning environments.

1.2 This report

This report presents the research design and research findings of Task 6.1, which, together with the other in-depth studies of WP6, set out to advance ySKILLS objective 3 by providing a more fine-grained understanding of how digital skills (defined according to the four-dimensional framework of digital skills developed by Helsper et al. 2020) improve or undermine at-risk (vulnerable or disadvantaged) children's and adolescents' wellbeing. To achieve research objective 3, Task 6.1 also aimed at learning whether at-risk (vulnerable or disadvantaged) children and adolescents equally benefit from digital skills, or whether, by contrast, disadvantaged children need different policy and practice responses. Moreover, Task 6.1 set out to generate methodological innovation for the study of digital skills practices among at-risk youth.

The participating countries are Belgium, Denmark, Italy—countries that score differently on both the DESI Index (with Denmark at the top, Belgium scoring high, and Italy low) and the index measuring the risk of poverty or social exclusion (AROPE, see Eurostat, 2016, – with Belgian and Italian children and adolescents being more likely to be at risk of poverty than young people in Denmark).

Understanding this diversity in terms of sociodigital inclusion (Helsper, 2021) and the situational variables shaping digital skills practices, may help us to provide in-depth explanations for the variations found in the ICT environment and young people's wellbeing (see Figure 1 above).

The research of Task 6.1 was articulated in two subsequent phases. In the first phase, observations of 16 digital skills programmes in non-formal learning environments across Belgium, Italy and Denmark were conducted, purposively sampled as explained in Section 2 (Methodology). Based on the results of the observation phase, co-design sessions were carried out to reflect on and shape potential future intervention programmes revolving around digital skills practices for and with children and adolescents, with a focus on 1) the role of tools and equipment (Denmark); 2) teaching style and practices (Italy); and 3) policies (Belgium).

1.3 The context: non-formal learning environments

Education, as an epistemic object, has often been studied and framed through the lens of "formal" education, i.e., those activities taking place in institutionalised educational environments ranging from pre-schools to upper secondary schools and universities (Tramma, 2009). Even though schools are not the only educational loci individuals have experience of, up to the 1970s they had been recognised as the primary and privileged educational agencies in society due to a school-centric framework applied to education, where expert educators were framed as institutional actors supposed to transmit knowledge, skills, and values to new generations (Giovannini, 1987).

While this view would recognise other educational opportunities people could have experience of outside formal contexts (primarily the family and the church), it wasn't until the 1980s that educationalists started to conceptualise the idea of an educational polycentrism, which led to the recognition and formal development of polycentric educational experiences that would recognise the educational potentiality of many actors, contexts, and experiences beyond the school, with differentiated to completely absent degrees of institutionalisation (Giovannini, 1987).

Indeed, it is at the beginning of the second half of the 1980s that Reischmann (1986) came up with what is credited as one of the first formal uses of the term "lifewide learning", emphasising that education takes place not only during an individual's whole lifespan (lifelong learning), but also across many and differentiated contexts which may also broaden the opportunities for people to acquire knowledge and skills that are not sufficiently promoted (if at all) within formal educational milieus (Jackson, 2012). This led to the conceptualisation of formal, non-formal, and informal learning environments, to account for the complexity and ubiquity of education and learning (Tramma, 2009).

In this report, we draw on the definition developed by the OECD and Tisza and colleagues (2019) which builds on The Council of Europe's (COE) and Eshach's (2007) conceptualisation to better frame the different educational opportunities and contexts children may have experience of. According to this framework, we can distinguish between formal, non-formal and informal learning.

Formal learning follows a syllabus, typically happens at school, and tends to be structured, prearranged, and sequential. Formal learning is led by a teacher, who evaluates the learning outcomes, offering feedback that formally evaluates students' efforts building primarily (but not exclusively) on their extrinsic motivation.

Non-formal learning takes place outside formal learning environments but within an organisational framework of some kind (e.g., amateur choir, sports clubs, etc.). It is mostly supportive and non-sequential, with the activity being guided or led by a moderator, without being fully pre-determined. The learning outcome is usually not formally evaluated, and students' motivation is typically intrinsic as their participation is mostly voluntary.

Informal learning takes place everywhere and at any time, encompassing all the relational and communicative experiences of an individual where frameworks of references, skills, systems of beliefs, and the like can be learned by people, both unintentionally and intentionally (Tramma, 2009). Unintentional informal learning may occur when communicating spontaneously with someone about a certain topic, playing together with peers, and the like, while intentional informal learning can be prompted, as an example, by the explicit explanations that parents give to their children as part of their upbringing strategies.

When looking at this triple conceptualisation, we can appreciate that the main hallmark of both formal and non-formal education and learning, compared to informal experiences, is that they are always intentional: this is to say that intentionality, as a pedagogical category indicating that what is done is not casual, is what makes a difference. In other words, while informal education can happen both unintentionally and intentionally, formal and non-formal education is always intentional, thus never neutral (Bertolini, 1988). Intentionality brings into play another dimension that characterises education: axiology, or what education works for in terms of values to transmit, goals to achieve, and ultimately the type of citizens that we want to inhabit the social world (Besozzi, 2006; Biesta, 2015).

This report focuses on non-formal educational activities aimed at promoting children's digital skills practices, with a particular interest in how these activities can reach and be beneficial to a wide variety of children, including vulnerable children. It allows us to explore what kind of opportunities and resources are being mobilised in society beyond the national and standardised educational curricula, focusing more on local and context-specific initiatives in our three different geographical contexts.

Our understanding of non-formal learning aligns with Sefton-Green's (2013) conceptualisation of "not-school" activities as part of "an overall ecology of learning opportunities for young people" (p.5), recognising that school is far from being the only educational agency individuals rely upon to learn. Non-formal learning can also be understood through the lenses of the Connected Learning framework (Ito et al., 2020): a type of learning that in merging young people's interests, relationships, and opportunities, unfolds within different contexts not necessarily confined to formal education, such as after-school clubs, community centres, online networks and so forth. Theories that emphasise that learning and development are entrenched within social connections and cultural environments underpin connected learning.

The Connected Learning framework also recognises the importance of rooting learning in learners' interests, emphasising the value of peers and tutors to scaffold the process of acquiring new knowledge. A main concern of Connected Learning, though, in line with considerations by Sefton-Green (2013), is that conceiving of educational opportunities outside of the school context calls into question matters of accessibility, or the extent to which these learning opportunities are accessible to a different range of young people so that they will not contribute to growing social inequalities. According to Ito and colleagues (2020), although non-formal learning allows to move beyond traditional understandings of learning environments specifically tied to schools, failing to keep a

focus on equity of access risks transforming any educational opportunity in "another way to reinforce the advantage that privileged individuals already have" (p.6).

Against this background, we explored non-formal educational activities aimed at the acquisition of digital skills in Belgium, Denmark, and Italy. The goal was to identify patterns of similarities and differences between countries, keeping in mind theoretical dimensions from the Connected Learning framework, such as the role of learners, moderators, and accessibility (Ito et al., 2020). Specifically, we dealt with questions investigating what kind of digital skills activities are promoted, who the beneficiaries are and who –in turn- remain excluded, what kind of teaching philosophies and strategies are practiced in non-formal contexts where participation is voluntary, what imaginaries on teaching digital skills prevail, what it means to be a digital competent young person in today's society and how these factors are put into practice in non-formal education.

1.4 Glossary

In this glossary we list, in alphabetical order, some words and concepts to explain their situational meanings with respect to this report. While other and more complete definitions certainly exist, the purpose is to help the reader understand what we meant in this context when using them.

Child-centred teaching style: starting from the 18th Century with philosopher Jean-Jacques Rousseau, deemed to be the "father" of contemporary pedagogy, moving to the *romantic* pedagogy characterising the intellectual and practical work of educationalists such as Pestalozzi, Schiller, and Fröbel, the child has begun to be seen as an active actor whose interests should be at the forefront of an educational relationship (Cambi, 2016). These ideas informed the understanding, further development and construction of child-centred teaching styles which, as reported by Lerkkanen and colleagues (2016), are based on a constructivist epistemology where the child is seen as an active actor of the educational experience and not a passive recipient. Methodologically, this translates into paying attention to children's needs and interests, as well as allowing them to co-construct knowledge around a domain through first-hand experience and cooperation with peers, with educators acting as facilitators of the educational process.

***Digital skills acquisition*:** by digital skill acquisition we refer to those processes that may enhance and foster digital skills learning. In the context of this report, given the qualitative nature of our study, we did not measure children's digital skills levels before and after the workshops, and no causal relationships are established, nor assumed. Thus, when using this expression, we refer to what children showed to have learned based on our observations (e.g., by completing a task during a workshop after following instructions or through personal insights), and what we were told by the moderators and organisers we interviewed who have a clearer grasp in terms of the digital skills acquired throughout the workshops.

Formality: The level of formality can vary in non-learning activities, as illustrated e.g. by Pienimki (2021). It can range from a more facilitator-led, structured curriculum and approach on the one hand to a more child-led and open curriculum and approach on the other.

Moderators: We define as "moderators" people who participate in the workshops as facilitators of the activities, providing children with guidance, instructions, and support, scaffolding them. These are not necessarily IT professionals or educators but can be volunteers who are dedicated to the cause and use their knowledge to be of help for children.

Organisers: When talking about "organisers", in turn, we refer to those who organise the activities, coordinate the educational programmes, reach out to participants and orchestrate with the moderators the direction taken by the workshops. It is important to note that in some instances organisers also served as moderators.

2 Methodology

This section presents the research design of Task 6.1. It consisted of an initial phase of observations and interviews with workshop organisers and moderators. A second phase built on co-design intervention programmes that could leverage these insights to yield future oriented knowledge on how to promote digital skills practices and design inclusive programmes, i.e., sensitive to the needs and competences of diverse children and adolescents.

The following sections will present the methodology for observations of workshops (n=16), interviews with workshop moderators (n=11), analysis, and co-design sessions (n=4) separately.

2.1 Observations

Our initial goal was to identify workshops promoting various digital skills in public libraries in each of the participating countries. More specifically, we aimed at purposefully selecting different types of digital skills initiatives organised in libraries located in relatively high versus relatively low SES neighbourhoods (n=2 in BE, n=2 in DK, n=2 in IT), to compare what was offered to children and adolescents of different socioeconomic backgrounds. Moreover, we planned to adopt the four-dimensional classification of digital skills (Helsper et al., 2021) to include a diverse and rich range of initiatives encompassing technical operational digital skills (including programming and robotics), as well as communicative and content-creation digital skills (such as developing a social media campaign, producing content for Instagram and YouTube).

However, many public libraries had suspended such initiatives until spring 2022 due to COVID-19 restrictions. Therefore, we turned to other organisations that managed to continue some of their activities in the autumn 2021 and winter 2021-22. In all the participating countries, we turned to organisations such as CoderDojo[1], that organise and conduct workshops either in public libraries, youth centres, museums, or afterschool programmes in schools or, in the Danish case, in high schools or on the Aarhus University campus.

The shift to programming workshops organised by CoderDojo and similar organisations influenced the sociodemographic characteristics of the participants. In fact, some of these activities were also attended by children younger than the ySKILLS age group (12-to-17-year-olds) and by children of medium-high socioeconomic backgrounds.

For an overview of the in total 16 observed workshops (BE=4, DK=9, IT=3) see **Table 2.1.1**. All workshops were free of cost, and with all resources freely available for all.

Table 2.1.1. LIST OF OBSERVED WORKSHOPS

Country	ID	Target	No. of children	No. of moderator	Technology	Venue
BE	BE1	Children 7-18	12	2	Scratch, Micro:bit, Lego Spike & Education	Building owned by the city
	BE2	Children 7-18	15	2	Scratch, Python, Lego Boost, Arduino	Science and technology museum
	BE3	Children 7-18	16	4	Scratch	Library
	BE4	Children 7-18	4	3	Scratch, VR	Building owned by the city
DK	DK1	Girls 9-11	9	2	Lego Spike	X-lab at Aarhus University
	DK1	Girls 9-11	9	2	Lego Spike	X-lab at Aarhus University
	DK1	Girls 9-11	9	2	Lego Spike	X-lab at Aarhus University
	DK1	Girls 9-11	6	1	Lego Spike	X-lab at Aarhus University
	DK1	Girls 9-11	9	2	Lego Spike	X-lab at Aarhus University
	DK2	Girls 16-21	26	11	Lego Spike	Aarhus University
	DK3	Girls 16-21	28	11	Greenfoot	Aarhus University
	DK4	Children 16-18	29	1	HTML & CSS	High school
	DK4	Children 16-18	12	1	HTML & CSS	High school
IT	IT1	Children 6-17	13	4	Scratch, Python	Public library
	IT2	Children 7-12	10	4	Scratch, micro:bit	Business school
	IT3	Children 7-13	6	4	Lego WeDo 2.0	Youth club

The participating children and their families were informed about the nature and scope of the Task 6.1 research and the broader ySKILLS project. In most cases, parents were asked to provide their informed consent even though the researchers avoided collecting personal data (only field notes and, exceptionally, photographs of the setting were taken).

The partial restructuring of the mapping and recruitment of digital skills initiatives and the iterative nature of the qualitative inquiry led us to refine, adjust and increment our research questions as follows:

RQ1- Teaching

- What teaching philosophy (ideas, values, imaginaries) informs moderators' and organisers' practices?
- How are these values and ideas embedded in the workshop activities and teaching style?
- How do these imaginaries, values, and practices shape opportunities for children's digital skills practices?

RQ2 - Learning

- How does the formality, structure, and moderation of the workshop influence children's digital skills practices?
- How does the moderation create opportunities or limitations for children's digital skills practices?

RQ3 - Including

- What are the opportunities and barriers for low SES children's participation in non-formal digital skills practices?

To address these RQs, we designed an observation protocol, which was tested by the Italian team during a programming summer camp in July 2021 (see **Appendix 1**). This protocol focused on dimensions like space organisation and tools available during the workshop, children's role and participation, moderators' role, teaching styles, the underpinning technological imaginaries, as well as children's pre-existing and newly learned competences. So, while we did not directly test children's pre- and post-workshop digital skills, we observed children's digital skills practices and their ability to achieve the assigned tasks. For more details on the observation procedure for Belgium, Denmark and Italy separately, see **Appendix 3**.

2.2 Interviews

When designing the overall methodology for Task 6.1, we had initially planned to conduct four to five post-workshop interviews for each observed activity. However, practical and epistemological considerations led us to reconsider the scope and target of these qualitative interviews. In fact, the test observation session conducted in Italy in July 2021, as well as the initial observations conducted in Denmark (see **Table 2.1.1**), showed that interviewing children at the end of the workshop was not feasible, for several reasons. First, children, especially the younger ones, were usually picked up by their parents at the end of workshop. Second, researchers could not interview children in the venue where the workshop was held, as the organisers and moderators had to collect their equipment and clean the venue. Third, due to COVID-19 restrictions, only one researcher was allowed to observe each workshop in the same room in Italy. Therefore, interviewing four or five children would have meant waiting a long time or postponing the interviews to a different moment and location—which was equally problematic during a pandemic.

More importantly, though, the reason to abandon interviews with children in favour of interviews with organisers and moderators was motivated by epistemological and conceptual considerations. In fact, the refinement and enrichment of the research questions underpinning the observation (as presented in section 2.1) in line with the preliminary findings of the observations, prompted the researchers to reconsider the knowledge objectives and the target of the interviews. Indeed, workshop organisers and moderators could provide us with complementary information on the role of their teaching philosophy, the moderators' technological imaginaries and their understanding of digital skills in shaping children's learning and participation in the workshops. Moreover, already when establishing informal contacts with the workshops' organisers during recruitment and the practical planning of our study, we learned that organisers had a clear picture of the background, education and technological imaginaries of families encouraging their children to attend programming workshops. Moderators and organisers also shared their perceptions on children's acquisition of digital skills during workshops. Therefore, we designed a qualitative interview guide which could complement the field notes drawn during observation, providing information on the activity, the space and tools, the teaching styles and imaginaries, children's background, their digital skills practices, etc. (see **Appendix 2**).

Table 2.2.1	LIST OF INTERVIEWS		
Country	**ID**	**Interviewee's'role**	**Interview mode**
Belgium	BE1	Organiser	Online
	BE2	Organiser	Online
	BE3	Organiser	Online
	BE4	Volunteer	Face-to-face
Denmark	DK1, DK2	Moderator	Face-to-face
	DK4	Organiser and moderator	Online
Italy	IT1	Organiser	Online
	IT1	Moderator	Online
	IT2	Organiser and moderator	Online
	IT2	Moderator	Online
	IT3	Organiser and moderator	Online

The interviews were conducted online, using different tools for videoconferences (such as Microsoft Teams, Zoom or Skype), or face to face, after the workshop. They were audio-recorded and transcribed for analysis (see **Table 2.2.1**.for a list of the interviews).

For more details on the interview procedure for Belgium, Denmark and Italy separately, see **Appendix 4.**

2.3 Analysis of field notes and interviews

The field notes and transcriptions of the interviews were analysed thematically by each national team using a shared coding scheme. The final coding template was constructed collaboratively and iteratively through various meetings, using a combination of inductive and theoretical thematic analysis (Braun & Clark, 2006; Fereday & Muir-Cochrane, 2008). The initial thematic coding was theoretically informed by the concepts discussed in the literature and included in both the observation grid and the interview guidelines (i.e., participation, teaching style, space organisation, etc.).

Overall, four main themes were identified, consistently with both the literature on non-formal learning and our findings: Activities, Spaces and Tools, Children, Moderators. Additional codes and adjustments to already existing codes (including re-labelling certain codes or grouping different codes under a common theme) were jointly discussed after the initial thematic coding was performed independently by each national team. The secondary coding was, therefore, primarily inductive in nature and grounded in data. Two further themes were identified in the joint discussion of the secondary coding by all team members, namely Modes of participation and Competence.

2.4 Co-design sessions

When designing the overall methodology for Task 6.1, we had initially planned to conduct one co-design session in each country with children in a library context. Due to the uncertainty of COVID-19, we decided to take three different approaches to co-design based on what was practically feasible in each country.

Beyond practical considerations, the choice of three distinctive focuses of the co-design sessions was informed by the different expertise of each national team, and the opportunity to suggest three

complimentary approaches to study what can make a programming workshop inclusive, with Italy focusing on teaching style, Denmark on technology and tools, and Belgium on policy.

Co-design refers to the creativity of designers and people not trained in design working together in the design development process (Sanders & Stappers, 2008). It echoes a key priority as identified in several contemporary academic and societal domains in Western countries that advocate for the inclusion of citizens, including children, in decision-making processes ranging from the design of new technologies to policy-making and urban planning (Kränzl-Nagl & Zartier, 2009). It builds on contemporary approaches to citizenship (see e.g., Jones & Gaventa, 2002; Lawy & Biesta, 2006), in which children do not passively consume or undergo the conditions of their lives, but instead become co-designers of potential futures (Biesta, 2004).

In academia, we have seen a tipping point around the 1990s in which (design) researchers became interested in the lives of children and young people and in the conceptualisation of the child from a passive subject we do research on to the notion of the child as an active agent who we do research for and with. It is in this context that early work on co-design with and for children can be situated, see for instance the pioneering work of Scaife et al. (1997) and Druin et al. (1997) in that regard. The participatory rationale for involving people in co-design processes has traditionally been positioned with a focus on democratisation and end-user involvement in the design of new technologies in line with the Scandinavian traditions of participatory design (Ehn, 2008). Except for democratising the design process, it is also known for the importance of bringing the participants' 'tacit knowledge' into the design process (Ehn, 2008). Next to co-design driven by a moral commitment to whether the *process* is indeed genuinely participatory and empowering for those who will eventually be affected by the changes, we also see the adoption of a parallel co-design rhetoric in societal discourses and practices for pragmatic reasons, typically driven by the question whether the *outcome* yields economic success (Zaman, 2020). In this report, we are driven by the participatory agenda of co-design to give voice to the people who will be affected by future changes.

Co-design builds on the following two premises. Firstly, co-design starts from the premise that people can become part of the decision-making team as 'expert of their experiences', and hence co-designers of future opportunities (Sleeswijk Visser et al. 2005). Secondly, co-design further builds on the premise that all people are creative, and that participation of a broad set of stakeholders is valuable and worthwhile to explore meaningful options.

Although there is no fixed or systematic set of practices, theories or studies describing how co-design must be conducted and understood (Halskov & Hansen, 2015), we can identify the following three key common characteristics. Firstly, co-design goes hand in hand with methods that give people influence in and on decision-making processes. In research and design with children, it proves an alternative model to the hierarchical expert (adult) versus (child) relationship (Combo, Eriksson, & Iversen, 2019). Secondly, it builds on processes of mutual learning (Bødker et al., 2021), in which the different stakeholders learn from each other through an openness for each other's expertise. Finally, it builds on co-realisation that will bring change. The scope of change can range from new or improved technological artefacts to changing people's competencies and quality of life (Halskov & Hansen, 2015).

Table 2.4.1.	CO-DESIGN SESSIONS	
Country	**Co-design approach**	**Session ID**
Belgium	Co-design of a multi-stakeholder approach Children, researchers, (policy) stakeholders	BE5 BE6
Denmark	Co-design of new tool and technology Researchers, developer, and moderator	DK5
Italy	Co-design of learning activities and teaching style Children, moderator, researchers	IT4

In our ySKILLS project, we started from the typical co-design premises and adhered to the key characteristics of co-design as explained above. This also helps us to explain how it yielded complementary findings to the insights revealed through the interviews and field observations. While the interviews and field observations helped reveal the current state and practice of digital skills workshops for children in non-formal learning contexts, the co-design phase rather had a future orientation. So, the task for co-design here is, based on what we know so far, to account for the perspectives of the children, the organisers, and moderators as well as the infrastructural affordances to explore how things can be improved in the future.

For this, we took three different approaches, see **Table 2.4.1.** In Belgium, children and researchers came together to co-design new learning activities. In Denmark, researchers, developers and one moderator came together to co-design a new software tool and learning activities. In Italy, children, the moderator and researchers came together to co-design learning activities and develop teaching.
For more details on the co-design procedure for Belgium, Denmark and Italy separately, see **Appendix 5**.

3 Mapping programming workshops

In this part, we present the national findings on the observation of programming workshops. Results are organised as follows: first, we report on findings concerning the six common axes of analysis we referred to when coding the observation notes for each country. Specifically, each country section will outline the types of activities observed, a description of the spaces where these activities took place and the tools used, considerations on children's and moderators' roles and practices, as well as elements outlining children's participation and previous and/or acquired competences during the workshop. Second, we implement our observation findings with interviews' excerpts to better contextualise them. Finally, we reflect on the similarities and differences between the three countries under study.

3.1 Belgium

This section summarises the findings from the Belgian observations and interviews articulated within the six axes considered in the data analysis process.
A distinction can be made between the 'traditional' CoderDojo workshops (BE1, BE2, BE3) and the CoderDojo4All workshop (BE4). Whereas the 'traditional' CoderDojo divisions focus on organising free programming workshops for all children between 7 and 18 years old, the CoderDojo4All workshops have a more targeted approach. Several different target groups exist (girls, immigrant youths, young people with a disability…), but the observed CoderDojo4All workshop targeted underprivileged and/or immigrant youths in a specific area. The workshop was actively promoted by a social worker of the city. The traditional CoderDojo workshops and the CoderDojo4All workshops differ in the reached audience and the familiarity that the children have with the offered technologies and activities prior to the workshop.

Activities

The four local CoderDojo divisions all offered Scratch, which is a free programming language aimed at children. At BE3, Scratch was the only offered activity. At BE2, the main focus was on Scratch, but they also offered Lego Boost, Arduino and Python for children that were more familiar with programming and for whom Scratch had become too easy. According to the organiser, Scratch is considered as the basis and afterwards children can progress to other tools and technologies. BE1 offered Scratch, micro:bit, Lego Spike and Lego Education. This organiser also mentioned that Scratch is considered more as a programme for beginners, but unlike the organiser of BE2, he mentioned that if children didn't enjoy Scratch they could immediately start with another tool. At BE1, the children could choose which tool or technology they wanted to work with, but they needed to choose this already while enrolling for the session. Since there were only limited sets of Lego Spike, Lego Education and micro:bit, there was a maximum capacity. There was no limit on the Scratch enrolments. At the BE4 session, the workshop was intended to be Scratch only. However, as the children did not want to continue the activity after the break, the organiser let them instead play with VR headsets.

All 'traditional' CoderDojo workshops followed a rather similar structure, which was not the case for the CoderDojo4All session (BE4). During this workshop, the children arrived one by one and were rather late. Since only four out of eleven enrolled children showed up, the workshop started 17 minutes late. There was nothing planned during this waiting period. The children simply had to sit and wait. Once the activity started, they received very clear instructions and had to copy what the moderator showed on the screen. After only 35 minutes, they took a break and afterwards the children

did not want to continue programming in Scratch. The organiser then brought VR headsets to play with, but this only kept the children interested for about 20 minutes. At 11:40 am, the children went home even though the workshop was not supposed to end until 12:00.

The other three observed workshops all started quite smoothly. Except for the communicated starting hour, there was no clear starting moment, in the sense that the children arrived one by one and immediately chose their spot and started working without awaiting some sort of plenary welcome session. The organisers of BE1 and BE3 provided booklets with a step-by-step introduction guide about Scratch for those children who attended a CoderDojo workshop for the first time. Afterwards, they could easily start working on their own. At the BE2 workshop, most children got started right away, but the moderator also gave a presentation aimed at first time participants during which he explained the basis of Scratch. At BE1, all children started on their own with experimenting with the offered tools and technologies. The moderators provided help to those children who had difficulties getting started. In all three observed workshops, there was a break after half of the activity during which the children received a drink and snack and were encouraged to leave their computers. At BE1, the children went outside to play during the break. The three workshops all ended with a "show and tell" moment approximately 30 minutes before the end of the activity. Parents and siblings were invited for this "show and tell" moment and the children were encouraged to present the project they had been working on during the session.

Spaces and tools

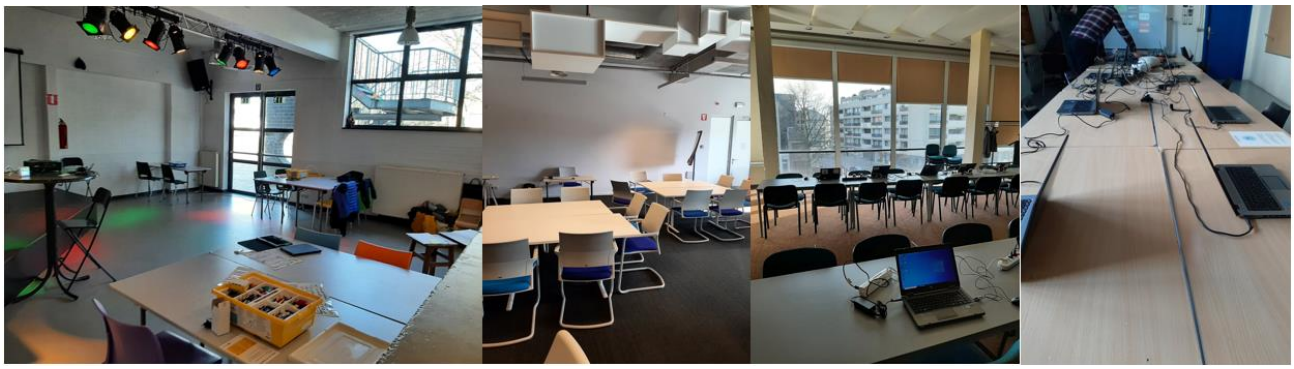


Figure 3.1.1: Four workshop spaces in Belgium – From left to right: BE1-BE2-BE3-BE4

Thanks to the cooperation between CoderDojo Belgium and cable broadband service provider Telenet, each local division has several laptops at their disposal that the children can use for free during the workshop.

The BE1 workshop took place in a building with a ground level and a first level that was owned by the municipality. On the ground level, there were three islands created with tables with on each table the infrastructure to play with either micro:bits, Lego Spike or Lego Education. The organisers decided in advance where each material would be and reorganised the tables so that they would form collaborative islands. The moderators also put a tablet on the tables where the children could play with Lego Spike or Lego Education. As there was only one tablet for each table, the children had to cooperate if more than one child wanted to work with that technology. On the table with the micro:bits, there were laptops available. On the first level, one big island was created with tables so that the children could sit at the same table. This set-up contained all the necessary infrastructure to play with Scratch on a laptop. There were extra laptops for children who did not bring one from home, as well as outlets and extension cables. Several children brought their own materials, such as a laptop or tablet, a headset or a mouse. A projector was installed so that the organiser could show things. This

projector was also used during the “show and tell” moment. There was also a cabinet with booklets on Scratch. These booklets had pedagogical value as they showed exemplar projects at different difficulty levels. They were made by local organisers and shared with other CoderDojo Belgium sections. All booklets were in Dutch. During the interview, the organiser mentioned that the Lego Spike and Lego Education boxes as well as the tablets were property of the city.

The BE2 workshop took place in a conference room of a science and technology museum aimed at children. There were five islands created with tables with on each table the materials to play with either Scratch, Python, Lego Boost or Arduino. There were also laptops on each table. Each island was created by placing tables together with chairs around it, so that the children could sit together at larger square tables. In the middle of the room was a table with the coach’s laptop on it and a chair behind it, so that it looked like a desk. There was also a projector directed at the wall next to the ‘desk’. On every table, there were educational materials provided, such as booklets with step-by-step explanations of Scratch projects. There were also some books and booklets that suited the technology present at that particular table, such as books about Python, coding a website and programming for children.
When the children entered the room, they were told they could sit anywhere they wanted. The moderator of the BE2 workshop explained to the researcher that he wants the children to sit at the tables in such a way that children with different levels of experience are mixed. He hopes that this way the children will be able to help and learn from each other. Since several children were positioned around one big table on which everyone worked with the same or a similar technology, cooperation was possible. However, as each child had its own device and project to work on, the degree of cooperation was rather limited. Since most of the parents stayed during the activity, almost all chairs were occupied. Therefore, the children were not able to move around the room or to change to a different table or activity. Although the workshop itself was free of charge, it took place in a conference room of a science and technology museum for which admission tickets are fairly expensive.

The BE3 workshop was organised in a separate room on the second floor of the city library. Originally, there were two long tables with chairs facing each other. As more parents than expected stayed for the whole duration of the workshop, extra space was needed. Therefore, the volunteers placed another table in between the other two tables so that everyone would have enough space. There was a small stage in the room of about 50 centimetres in height. There were lots of books and booklets about Scratch provided on the stage. Each book and booklet had several copies so that multiple children could work on the same project at the same time. The booklets had stars on them to indicate the difficulty level. All the materials were organised by difficulty. The children had access to a computer, which they either brought from home or borrowed from the organiser. Therefore, the children were not expected to share devices. However, as the laptops were close together, it was easy for the children to cooperate. Indeed, children often worked together with their neighbours or watched each other’s screens.

The CoderDojo4All workshop (BE4) took place in a local community centre. Six tables were put together to make one long table. At one end of the table was a projector aimed at a whiteboard. The projected screen was relatively small, but after numerous efforts the volunteers gave up trying to make it larger. The lights had been turned off to make it easier to see the projection, but this made the room relatively dark. There was no heating in the room, so it was very cold. Two girls and one volunteer kept their coats on during the entire workshop. The organisation provided laptops for the

children. They were installed before the start of the workshop. There were no extra materials such as computer mice, headsets or educational booklets. The activity offered was Scratch. After the break, the children did not want to continue so the organiser brought VR headsets to play with.

During the interviews, all the organisers indicated that the way the space was organised was a conscious choice. By placing the tables in squares or long rows, the organisers tried to stimulate collaboration. All interviewed organisers further mentioned that they wanted the children to ask each other questions first before asking one of the moderators for help. The organisers of BE1 and BE2 explained that different types of activities are kept separate to make it easier for the moderators to help the children and for the children to see each other's work.

We chose from the beginning to group the programmes and the stuff they are working on anyway. We didn't do that in the beginning and then it was also very difficult for the supervisors to jump over. It's also easier for us to spend an afternoon with Scratch than an afternoon with four different things. Especially if there are not many of us, that is very difficult. It's also nice for the children that each group is working on the same thing. You can take a look at your neighbour, you can ask all sorts of questions... Actually, the idea is that you have an "ask three and then ask me"... So that they can actually ask each other and look for solutions, rather than coming to us. (BE1, organiser)

Yes, so up to now the room has always been organised that way because we just offer one thing, namely Scratch, and that makes it convenient for the coach to be able to pass through and for the people to be able to choose a seat next to each other and thus be able to help each other out if something happens. (BE3, organiser)

Children

The number of children who took part in the CoderDojo workshop varied for each session: 12 at BE1 (aged about 8-13 years old, 8 boys, 4 girls), 14 at BE2 (aged about 9-13 years, 11 boys, 3 girls), 16 at BE3 (aged about 10-15, 10 boys, 6 girls) and 4 at BE4 (aged 11-12, all girls). Eleven children (boys and girls) enrolled for the BE4 workshop, but only four girls showed up. The organiser could not explain why several children who enrolled were absent.
Although we determined from the observations that the gender ratio was unbalanced with more boys participating than girls, except for the BE4 workshop in which only girls eventually participated, the organisers answered during the interview that they considered the gender balance to be almost 50-50. The organiser of BE1 even said that he thought more girls attended the observed session in a 60-40 ratio in favour of the girls.

In terms of gender, it is a good ratio I think. I don't have the actual figures in front of me, but when I think back on the group, I think it's about 50-50. Maybe a little more boys, though. I think it's really somewhat even. (BE3, organiser)

We do have the impression that more girls are coming and that the girls can also work in a more abstract way. (...) I think the division is 60-40 roughly, if I can look at it that way. Girls-boys. (BE1, organiser)

Although CoderDojo workshops are aimed at children aged 7 to 18 years old, it was observed that the participating children were rather young. During the interviews, the organisers gave the COVID-

19 pandemic and losing interest when you get older as possible reasons as to why children stop coming to the workshops when they are in high school. At BE1, the organisers deliberately chose to focus on children younger than 12 years old as the COVID-19 restrictions were less strict for this age group. This also became clear in the following excerpts:

No, it is up to 18 but we have focused for the past two years mainly on under 12s. Also for a very practical reason: because that was still workable with the corona measures. (BE1, organiser)

In terms of age, I do hear, both at our location and at others, that they drop out as soon as they reach puberty. But I think this is also the case with other hobbies. (…) And of course, because of the corona crisis, a lot of things for many young people stopped abruptly actually. (BE2, organiser)

In terms of age, they are mostly young kids now. Well, young in the sense of 9, 10, 11 I think they are. Because it is actually from 10 to 18 years, but in terms of older there is one who is 15 and for the rest they are all relatively young (BE3, organiser)

Only once, there was a teenager. Only once. Last time, there was a teenager. But normally they are all 10, 11, 12 years old. (BE4, volunteer)

We did not collect sociodemographic information from the individual participants, but some assumptions could be made based on location and observed situational factors. As BE1 took place in a city with a large number of wealthy inhabitants and most children brought their own devices, it could be inferred that these children had a rather high socio-economic status. The BE2 session took place in a science and technology museum for which the admission tickets were fairly expensive. It was also located quite far from the city centre and was therefore rather inaccessible as there is only one bus that goes there every hour. Based on this information, we assume that the participating children had a rather high socioeconomic status. At BE3, approximately half of the children brought their own laptop, while the other half had to borrow one. However, for this last workshop, we did not have enough additional data to estimate the socioeconomic class of the participating children. This was also acknowledged by the organiser who stated: *But I do notice that there are a lot of computers, or that it's 50-50, so that about half of them take their own computer with them and the other half take a computer with us. But then is that because they don't have a computer at home, or is that because they have a fixed computer at home? It's hard to say anything about that. (BE3, organiser)* Since BE4 is a CoderDojo4All workshop that is specifically designed to improve inclusion and is aimed at disadvantaged and immigrant youth, we can assume that those children had a low socioeconomic status.

In total, 8 children who did not speak Dutch at home participated in the sessions, of which 3 in BE2, 2 in BE3, and 3 in the BE4 workshop. The fact that Dutch was not their mother-tongue language did not appear to have a severe impact on their participation in the session. The moderator of BE2 had a rather heavy accent which sometimes made it difficult to understand him. However, we observed the children quickly moving. They seemed to have found a way to understand the instructions.

Across all observations, most of the children were already familiar with the offered technologies prior to the observed workshop. Only a few children had no prior experience with any of the activities. Scratch was considered as the basis and therefore as the easiest activity. However, different levels of skills could be observed. Children with no prior experience used step-by-step introduction booklets. BE1, BE2 and BE3 provided booklets with Scratch projects in a variety of difficulty levels. Most

children autonomously worked on one of these projects from the booklets, based on their own skill level. However, some children were observed working in Scratch without a booklet. They were inventing their own projects. These children were usually slightly older. BE1 and BE2 provided also other activities, such as Arduino, micro:bit, Python, Lego Boost, Lego Spike and Lego Education. There were booklets with pre-made projects, but most children were experimenting on their own. In the BE4 workshop, the moderator showed via a projector which buttons the children had to press in Scratch and what they had to type or add. Since the children only copied the instructions, it is difficult to assess their familiarity and digital skills with Scratch. It is also unclear whether these children would be able to make the project on their own.

The interviewees all indicated that the children were quickly familiar with the technologies and programming software. This was also mentioned by the organiser of BE2: *When they come the first time, they have never worked with it before. But I do find that after one time, so after a few hours, they can usually make something with it. (BE2, organiser)*
Difficulties seemed to arise only with technical issues such as making a back-up or browser problems, such as stated by the organiser of BE1: *When they ask for help it's really about technical things like sorting files or up- and downloads and actually very technical things. (BE1, organiser)*
However, the moderator of the BE4 workshop did mention that he noticed that children are more familiar with smartphones and tablets than with computers or laptops, stating: *But the computer is mostly a new thing to the children. It's interesting to me. I didn't know this. For example, they are really familiar with a touchscreen but I think PC is like old-fashioned. (BE4, volunteer)*

Except for the BE4 workshop during which the children only had to copy instructions, all other children mainly experimented in an autonomous way. If another child was sitting nearby, the first reaction when stuck seemed to be to ask the neighbour for help. A couple of situations were observed in which the child deliberately chose a spot next to another child who was more experienced. When the neighbour could not help, the children would ask the moderator for help. The organisers all indicated during the interview that they really encourage this way of working. The child should first try to solve the problem by themselves, then ask another child for help and only as a last resort ask the moderator for help. This seemed to work. Some children were even observed looking up answers via YouTube tutorials.

First you have to try it yourself, then you have to ask your neighbour and only then should we as a coach intervene. (BE3, organiser)

Yes, but we do encourage them to find a solution because at the end of the day, that's the goal of programming and of learning to program to find a solution. So you have children who ask 25,000 questions and actually expect you as a coach to provide the solution. But of course that's not the goal. The fun is in finding a solution. You can make the comparison with a puzzle. You as a parent or coach can make that puzzle yourself, but what does the child actually gain from it? (BE2, organiser)

One of the rules for a supervisor is that you just stay off the keyboard of a child. (BE1, organiser)

However, in the BE2 and BE3 workshop, several parents stayed present during the session. This seemed to have had a negative impact on the independence of the child. When the parent was present, the child seemed to ask more questions than other children whose parents were absent. The parent

would usually answer immediately and sometimes even take over the computer to solve the problem. The moderator of BE3 indicated that most parents help their children more than is needed because the children can actually solve it on their own: *But because there are so many young children, we find that many of the parents just stay the whole time and actually take on that role as a coach a bit. (...) Sometimes you notice that the parents are more involved with the computer than the ninjas themselves. So that's kind of the downside. (BE3, organiser)*

The children worked mostly autonomously. The children had a lot of agency in the type of project they chose to make and seemed to be very involved in the programming activities. The fact that they very quickly picked up the programming activities after a break, even without the organisers reminding them or having to encourage the resumption of activities, is an indication that they had positive experiences during the session. Moreover, several children also continued working during the "show and tell" moment. The exception to this was BE4. This activity was cut short because the children did not want to continue. This could be due to the fact that these children had no voice or input in the activity since they were only allowed to copy the instructions without having their own ideas or suggestions.

During the interviews, the organisers of BE1, BE2 and BE3 indicated that several of the attending children already had prior experience with programming and/or coding or that the children were already in advance interested in the activities. Often, the children were encouraged to participate in the workshop by their parents because they saw added value in obtaining digital skills. These findings are supported by following interview excerpts:

Sometimes it's a bit like preaching to the choir, in the sense that a lot of children who come to CoderDojo are already triggered. (BE1, organiser)

We also notice that kids who come also have parents who are often already digitally interested or are professionally involved in that. (BE1, organiser)

But there is a commitment, also because there is an awareness I think that it is a necessity to be involved in that. It doesn't have to be at a top level, but a little basic knowledge [about programming] is something that most people realize is necessary. (BE1, organiser)

I think that often the parents themselves either have a job in that sector, are in IT or are IT-minded and that they find it interesting for their children to learn that too. (BE2, organiser)

No, usually it's because their children, yes, already knew about Scratch from school and thought it was cool. Or because they just notice that "oh yes, he often uses an iPad or a computer so he can handle it well so it might be good to build up some underlying knowledge". So it's not like they think "he must learn this or that". It's mainly for the pleasure of the child, I think. (BE3, organiser)

Moderators

The number of moderators differed for each workshop. Originally, there were two moderators at BE1. The first moderator was the lead coach. He was familiar with all the offered technologies (Scratch, Lego Education, Lego Spike and micro:bit) and also knew about the overall organisation of the workshops (e.g., registrations). The second moderator only had Scratch experience and was only

involved in the workshop at the date itself. However, on the day of the workshop, the lead coach got sick and had to go home. His wife came to replace him. At BE2, there were two moderators. As this was considered as too little, one of the moderators asked his four sons to help as well. Especially the oldest two sons were helping a lot during the workshop. There were four moderators at BE3, of which one was also responsible for the practical organisation. At the BE4, there were three moderators. There was also an officer responsible for the culture policy at the city and the community centre. The latter provided practical support, such as arranging registrations and booking the venue. On the day of the workshop, he was present at the very beginning when the children arrived and came back during the break with VR headsets. One of the moderators at BE4 was only just beginning to learn Dutch. He was also not very proficient with English. Except for one female coach in BE3, all moderators were male.

During the traditional CoderDojo workshops (BE1, BE2 and BE3), the moderators tried to implement a child-centred teaching style. Although these moderators decided on the structure of the workshop and what activities were available, the child was free to choose which project to work on and how to proceed. Autonomy and experimentation were supported, and the moderators were available to give help or advice and answer questions. The moderators invited the children to first try figuring out the projects themselves or ask their neighbours before asking them. The moderator of BE1 said during the interview that he encourages children to press even random buttons. He further explained that children should learn not to be afraid of trying something, because computer issues can almost always be fixed. Additionally, the children could call the moderators by their first name. By not imposing the use of the terms “meester” or “juf”, which are the typical pronouns given to teachers, the moderators wanted to distance themselves from a school-like approach. Yet during the observations, we heard some children calling the moderators “meester”. Also, the offered booklets looked a bit like school materials and most of the children still raised their hands if they wanted to ask a question, just like they do in school. The BE2 workshop started with a presentation of a step-by-step introduction of how Scratch works. This was a very formal teaching style in which the children had a passive role. At BE3, stamp cards were used to track the difficulty level of the children. Although the children could choose which projects they wanted to make, the stamp card indicated how many projects in each difficulty level still had to be completed. This was explained by the organiser: *No, the thing is that in the beginning they all get a basic booklet actually to start with Scratch where very simple and very short exercises are explained. And when they finish that booklet there are two more mandatory exercises that they have to do for when they get a yellow ribbon. For that yellow ribbon they also have to be able to tell something on a show and tell, so actually show something. And after that they are free to work on a project of their own or choose one of the other assignments in front of them. (BE3, organiser)*
Irrespective of the teaching style, the organisers said it was important for the children to have fun during the workshop. The BE2 organiser gave the following example: *Our intention is not to teach. Our intention is really to have free time. There are other agencies for that. We don't want to seem too hard like school. It has to be enjoyable. Getting together with other peers, with other like-minded souls. Coding is also often, if you do it at home, often alone anyway. Here we come together in group. (BE2, organiser)*

During the BE4 workshop, a very formal teaching style was adopted. One of the moderators showed step by step how the project had to be made by using a projector. This was also mentioned by the interviewed volunteer: *Children normally follow the volunteers. We decided before that. But we are open to advice. (BE4, volunteer)* The children simply had to copy the steps. They had no input in the

session and it was never checked whether they actually understood what they were making. The other moderators were constantly looking at the children's screens and intervened immediately whenever the child seemed to do something different than was instructed. The children could not experiment or learn by trial and error. After the break, the children did not want to continue so the moderators let them use VR headsets.

In general, the moderators of all workshops (including BE4) seemed to interact with all children in an almost equal manner. Some children needed more assistance, for example children with little programming experience or for whom there were language barriers. At BE2 and BE3, the children whose parents were not present, received more attention and help of the moderators than children whose parents were present.
The moderators were very involved and enthusiastic. Only one of the moderators of BE2 seemed to be bored as he was frequently looking at his smartphone. He was originally not supposed to be present, but he came to cover for his mother who was sick.

Modes of participation

In general, there were no real power differences observed between the children in the same CoderDojo workshop. However, power differences could be noticed between participants in the 'traditional' CoderDojo workshops (BE1, BE2 and BE3) and the CoderDojo4All workshop (BE4). In the traditional workshops, the children were given agency in their choice of project within the stipulated framework of the session. The CoderDojo4All participants were only allowed to follow instructions and therefore had a very passive role without power.

Although no power differences were observed between children in the same workshop, there were indications of different roles or team leaders within the same session. There were instances where a child would place him/herself next to an older child that was more experienced so as to be able to ask for guidance. This was also acknowledged during the interview with the organiser of BE3: *There are a few children who I think deliberately put themselves next to older children, and you also notice that if something doesn't work out, they ask a neighbour boy. (BE3, organiser)*
At BE2, the children of the moderator were asked to help out because of a shortage of moderators. A similar situation occurred in the BE1 session during which one of the moderators had to go home due to illness. His son also took on the role of the 'more experienced child'. The other children in the BE1 and BE2 workshops seemed to acknowledge that these sons were more experienced and familiar with the technologies and accepted their help and advice.

Even though the moderators of BE1, BE2 and BE3 emphasised how important the child's autonomy during the workshop is to them, the moderators still make many decisions. They decide upon the framework in which the workshop takes place, the structure and the offered activities. However, within this structure, the children are given as much freedom as possible. This was supported by the following statements:

> *They can switch during the session, but during registration they are asked what they want to do. (...) Until the break we try to be busy with what they had chosen. Also because if they choose something and it turns out to be difficult, they do not give up because of a technical stumbling block. Then we give an easier exercise or we put it together with a child who is already a little further. So yes, we do try that a little bit... But they are free to choose. (...) Scratch is usually used to start, but it's definitely not a must. If you really don't like doing that, then do something else. (BE1, organiser)*

In itself, we mainly want the kids to, yeah, kind of learn about programming and working with a computer and so on. But it's not like we're saying "oh, you have to achieve this or that". We mainly want them to have a great morning, to see for themselves what they feel comfortable with. (...) It's all very noncommittal. (BE3, organiser)

These three 'traditional' workshops ended with a "show and tell" moment. The children were encouraged to present their work to the parents and other children. Part of the 'show and tell' moment, was also the discussion on the projects' process and outcomes during which the audience could ask questions about the presented projects and during which the participating children were invited to reflect on their own work, triggered by questions such as "What would you do next time to improve this project?". The organiser of BE2 mentioned: *We also stimulate them to present. So even if they're new, even if they're very young, we try to get them to present. So, they also learn to say something in front of a group. And if they are very young and haven't done this much yet, they won't get much out of it. But that is a kind of interview actually. Then we ask a number of questions as the lead coach to the child so that they can answer back what they actually made or what they wanted to achieve. And then, that is also a stimulus for the next time to build on that. (BE2, organiser)*

Although the moderators valued collaboration, there was not much cooperation between the children. If there was any interaction, it was mainly with the child sitting next to them, typically a friend they knew prior to the session. Some occasions were observed during the BE1 workshop when children cooperated between groups, looking at what the other groups were doing and getting inspiration from that.
During the break the children interacted more with each other than during the programming activities. This contrast was most prominent at BE1, where the children went outside to play tag during the break but worked almost exclusively on their own during the programming activities. If they cooperated, it was only with one or two children, while playing tag was done together with all the children. The organiser of BE3 explained the cooperation as follows: *They don't know each other and they have to talk to each other during the break. They don't have to, but you see that they do. Dare to ask questions if something doesn't work out, etc., so these are also social skills that we want to develop. (BE3, organiser)*

Competence

Across all observed workshops, the children all got the same chance to contribute to the activity as there were enough materials provided for each child to experiment on its own. Therefore, all children within the same workshop received the same opportunities to develop their competences. Within the three 'traditional' CoderDojo workshops (BE1, BE2 and BE3), the moderators had the goal to improve the programming skills of children, but within this goal the children were responsible for choosing the projects that would allow them to accomplish their own goals and targets for that specific session. As all the observed activities built on previous CoderDojo sessions and will consequently continue in further sessions, the children were made responsible for mapping out their own trajectories in acquiring digital skills. The children thus choose their own pace and what they want to focus on. Consequently, the children also had agency in the competences they acquired and improved.

Within ySKILLS we understand digital skills as a diverse set of operational, information navigation, communicative and creative competences. These competences were primarily stimulated during the three 'traditional' CoderDojo workshops. The information navigation competences were reinforced by providing booklets and books. The children were encouraged to experiment with the technologies offered to find the desired solution, but they could consult these booklets and books to find answers whenever experimentation did not help. By stimulating the children to first look for the answers

themselves, the moderators supported the information navigation competences. The experimentation, in turn, can have an impact on the creative competences, as acknowledged by the organiser of BE3:

These are the social skills that are definitely developed as a result. And yes, also how they deal with technology. Especially their thinking pattern. Often in the beginning they follow the book step by step, but once they've been there a few times they start inventing new things themselves or they want to make their own games. Or they take another book or they expand on it. So, it's that creativity that's developed a bit more as well." (BE3, organiser)

The communication competences were encouraged by organising the "show and tell" moments during which the children could present their work. The moderators of BE2 and BE3 acknowledged that these skills improved over time and that in general, children first needed to obtain some confidence before wanting to present.

We also stimulate them to present. So, even if they're new, even if they're very young, we try to get them to present. So they also learn to say something in front of a group. And if they are very young and haven't done this much yet, they won't get much out of it. But that is a kind of interview actually. (BE2, organiser)

But usually when you see that the children have come the first time and then after three times or so, then you notice "oh yes, they already dare to ask more or they already dare to present at the show and tell". Because that's usually not the first time they dare to do that. Well, you always have exceptions. But then you notice that once they've had some examples of how easy-going such a show and tell is, they then have the confidence to go on stage and say something in that microphone. So it's nice to see that you can see that ok... (BE3, organiser)

So I think it's mainly the social skills that are supported, or that are developed as well. Daring to speak in front of a group and then trying to develop these thinking patterns in a different way, in a more problem-solving way. We hope that we can teach that. (BE3, organiser)

During the workshops, the children adopted a problem-solving mentality. In addition to programming related skills, the children trained time management and planning competences as they had limited time to finish the project. According to the interviewees, the children also obtained a better understanding of how technologies work by attending CoderDojo workshops, which in their opinion will be an essential asset in their future lives. During the interviews, the moderators of BE1, BE2 and BE3 mentioned several skills that they considered important for the children's future lives that they want to stimulate during the workshops. Overall, the organisers value critical thinking, problem-solving skills, creativity, curiosity and willingness to learn, as indicated in the following interview excerpts:

I think we have to realize that we have to learn every year and every time and that what you learned 10 years ago is not worthless but you will have to convert it to new skills. And that's what we try to impart to the kids anyway, that continuing to learn, that's what it's going to be. That will also be one of the biggest plus points I think you can ever put on your CV, is that you are willing to learn. (BE1, organiser)

We hope that children will become more familiar with digital things. In the broad sense of the word and that they actually see that creative things can happen with it. Rather than that being an obstacle. That's just tutoring a language that you're going to need anyway. You need those skills.

We try to package that as a foundation that you need to take with you, but rather than an obstacle. That's just a source of inspiration. (BE1, organiser)

Of course, you also learn to think logically, step by step. Breaking down your problem into sub-problems. (BE2, organiser)

And besides that, it's also true that with Scratch, you teach them a certain way of thinking that you may need for the rest in other subjects or in your life. (BE3, organiser)

3.2 Denmark

In Denmark, the researchers observed a total of nine workshops including on series of five workshops with the same children and one workshop that was observed on two instances.

Activities

The activities observed in Denmark were all focused on programming spanning physical computing, game development, and website development with all activities being free of charge with food and drinks provided. In the following, we will give an overview of the four different activities DK1, DK2, DK3, and DK4. We observed DK4 in two different instances and DK1 was a workshop series organised by Co-Coders, that we observed on five occasions. DK2 and DK3 were part of the same week-long event: an IT camp for girls and DK1 and DK2 were facilitated by the same moderator.

In the workshops DK1, participants created a mini version of MGP (Melodi Grand Prix), a Danish song contest for children. With Lego Spike Prime and other building materials, the participants created stages with moving singers and dancers for a performance. The workshops were structured into introducing the participants to Lego Spike Prime by building walking grasshoppers in the first two sessions, then in the next three sessions building their stages, and at the end of the final instalment showcasing their stage and song in a performance with their parents and the organisers watching as an audience.

The DK2 workshop was a part of the *IT camp for girls* at Aarhus University which is a week-long camp where students interested in studying computer science or IT can participate to learn more about the programs and subjects. In the two-hour workshop, the participants built a Lego robot with a pen that could drive to draw on a piece of paper to create an art piece. At the end, the groups presented their art pieces in an art exhibition with the best art piece receiving a price.

DK3 was also part of the *IT camp for girls* at Aarhus University. In DK3, participants created a Pac-Man game using the educational IDE GreenFoot. Participants worked with existing code, including a UI that they had to complete to get the game to work.

The DK4 workshops were organised by Co-Coders. In the workshops, high school students learned the basics of HTML and CSS to create a website in 2 hours to get them interested in programming. During the workshop, the participants created a basic website in Visual Studio Code by reproducing what the facilitator showed on the projector on their computer. The event was branded for girls, but everyone could participate. The activity took place after school in high schools on a voluntary basis. The researchers observed two instances of this activity in two different high schools.

The activities followed different degrees of instructions and independent work by students. In the DK1 workshop series and the DK2 workshop, students worked in groups and could decide on their own of how to approach the tasks and what they wanted to focus on. In DK3, students were given a task and framework to work with, but were free to decide how to solve the task and explore further with the coding. The DK4 workshops were characterised by step-by-step instructions from the teacher that the students would follow.
As a result, especially in the DK1 Workshop series, playful interactions between students were frequent such as racing each other with their robots, playing with elements of the stages that they built, or decorating their robots and stages based on their individual preferences. Similarly, in the DK2 Workshop and DK3, students would play with their Pac-Man games or their robots. In the DK4 workshops, at the end a few students would stay longer and try out displaying different content on the websites that they created.

Spaces and tools

The observed activities took place in different classrooms at Aarhus University and the high schools where the DK4 workshops took place.

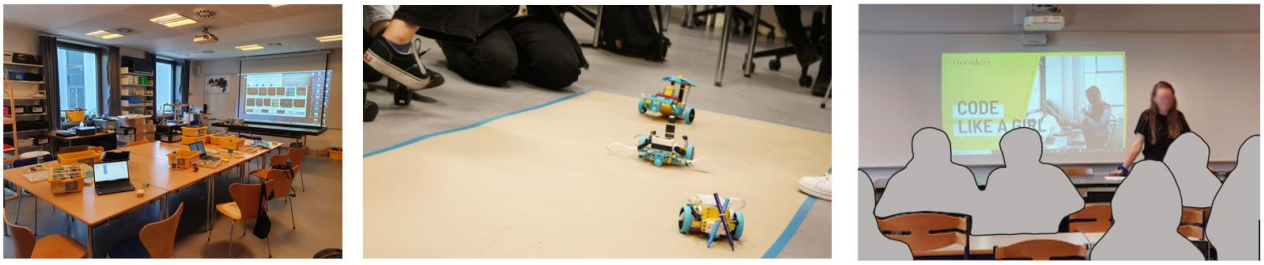


Figure 3.2.1. Three workshop spaces in DK - From left to right: DK1, DK2, DK4.

The DK1 activity took place in the Lego Lab (X-lab) at Aarhus University, a medium-sized room that held Lego equipment and other building materials in shelves around the room. The participants were seated around a big table in the middle in groups of two for the first two sessions and in groups of three for the last three.
The DK2 workshop took place in a bigger classroom at Aarhus University. The tables were organised for groups of three with three chairs and one Lego Spike Prime kit on each side of the room facing the front. At the side of the room was a row of tables with Lego parts, writing utensils, and paper for students to walk up to and take. In the middle of the room, a big strip of paper was taped to the floor where the groups could test out their drawings.
The big table and the big strip of paper on the floor respectively worked as a shared space for participants to see each-other's work and progress and to share materials with the intention of the moderator:

> *To make the room inviting, to stand up and draw in the middle, because then they see each other and see each other's activities and maybe talk to each other and create something like a fire camp, where we can sit around and do something. (DK1&2, moderator)*

The spatial organisation of the activity in both the DK1 and the DK2 workshop was dynamic and changed throughout the activity.
At the beginning of the DK2 workshop, the participants sat at their desks for the introduction. When they started building their robots, they slowly left their tables to spread out over the room with some sitting on the floor or on the desks. Similarly, in the DK1 workshop, the participants would move around freely in the room to grab materials from the shelves or to look at the other groups' work. The arrangement and progression of the changing spatial layout was intentional by the moderator:

> *I do not tell them they can take a piece of paper from the table and sit at their own table to do drawings. In the beginning, I say: 'Do it without the pen in the beginning, on the floor, so it doesn't fall down. Then do it with a pen on the common paper [...] to make some initial drawings... and finally, do it on your own paper. (DK1&2, moderator)*

While the DK1 and DK2 workshops emphasised group work, facilitated through the intentional spatial layout of the rooms, both the DK3 and DK4 workshops focused more on individual work. This was similarly reflected in the spatial layout of the activities. Both workshops took place in a classroom setup where students sat in rows working on their individual laptops facing the teacher at the front. For the moderator of the DK4 workshops, the spatial layout was not intentionally pre-arranged due to practical reasons of uncertainty with regards to where the workshop would take place: *I don't know what kind of room we're going to be in [...] so, I don't do anything. (DK4, moderator)*

The DK2 and the DK1 workshop series were based on physical computing with Lego and Lego Spike Prime. In the activities, the participants used motors and sensors of the Lego Spike Prime Kit to create robots and stages using laptops and tablets to programme the Lego Spike elements with a block-based programming language. In the DK1 workshop series, the children additionally worked with wooden cubes that they built their stages in. Materials to build the stages included paper, foam, Lego, stuffed animals, cardboard, Christmas decorations, string, and feathers as well as tools such as scissors, cutting knives, and a hot glue gun. The moderator of these two workshops, intended for participants to *express [themselves] by means of programming*. *(DK1&2, moderator)*

The moderator saw advantages in physical computing to learn programming due to its material qualities, stating:

> *It´s not very easy to make the correspondence to what´s happening on the screen and then the programme, as it is with robots or light or movement. (DK1&2, moderator)*

For the DK4 workshops, participants worked on their individual laptops, using Visual Studio Code to create a website in HTML and CSS. For the moderator of the DK4 workshops, the choice of the tools used during the workshop was motivated by working with technology that professional programmers would use to provide a realistic setup, stating: *It's important for me that they are working with tools where I can tell them that professionals are working with this as well. (DK4, moderator)*
HTML and CSS were chosen by the moderator due to the perceived simplicity of the language with the moderator remarking: *They chose HTML because it's quite visual. So, if you want to show people who are maybe a bit more creative, then [...] it's an easier language to learn. (DK4, moderator)* This builds onto the familiarity of participants with the web technology being able to get fast results: *Everyone can visualize a webpage with a title and an image [...] so it's easier for them to work with.*

And then they quite fast get a product, so it just takes five minutes and then they have something to see in a browser. (DK4, moderator)

In DK3, participants completed the code they were provided with in the Greenfoot IDE while working on their own laptops, similar to the DK4 workshops. Participants switched between the code and the UI of the game to test their changes to the programme. While the moderator emphasized that they could work alone or in groups, participants mostly ended up working on their own projects.

Children

A varying number of students (from 6 to 26 children) participated in the different activities, see **Table 2.1.1.**. The DK1 workshop series, DK2, and DK3 were specifically organised for only girls. The DK4 workshops were advertised for girls, but open to everyone with the gender balance being relatively equal in those classes according to the moderator, who stated: *I think it's more or less 50/50. Sometimes we have a bit more women, or girls, than boys but more or less 50/50. (DK4, moderator)*

We did not collect sociodemographic information from participants. For the DK1 workshop series, parents were sometimes present (which might be related to the younger age of participants) while for the other activities the students were unaccompanied. For all activities except for the DK1 workshop series, participants brought their own laptops to work on.
For the DK2 workshop (and by association also DK3 as the participants were the same), the moderator thought participants had different backgrounds: *I think the participants are [from] all over the country and a lot of different high schools, so I guess they have a very varied background. (DK1&2, moderator)*

Both interviewed moderators remarked that participants often got the motivation to attend these types of workshops from their parents. One moderator mentioned: *I've heard several students say that their mom or their dad did some coding and they thought it looked fun and they would like to try it out themselves, so I think that has an impact on the students. (DK4, moderator)*
The moderator of the DK1 and DK2 workshop made a similar remark: *We know if you are interested in science, computing science and technology, then it very often comes from your mother or your father or some other part of the family. (DK1&2, moderator)* The moderator also acknowledged that for the DK1 activity, the parents had a background in computer science: *I know that [...] a lot of parents are computer scientists, I know them. So, they are either computer scientists or engineers. (DK1&2, moderator)*
In the case of the DK1 workshops, the moderator reported tensions between parents' expectations and the intentions of the moderator in relation to the non-formal setting by saying: *There was a mother [...] I think it was on the first or third day that said: 'When will they start coding?' That was her purpose for sending her daughter, right? Maybe a lot of the parents from coding-pirates send their kids for this, but that´s not a good purpose, I think, because they are not going to school. (DK1&2, moderator)*
In relation to decisive factors for attendance, the moderator of the DK4 workshops also emphasised the influence of the schools for students to attend the workshops: *Some schools [...] just ask us to come and then we go there, do some advertising and then they don't do anymore. And some schools they tell the teachers as well so they can [...] ask the students during classes, [...] so they remember to attend the workshop. (DK4, moderator)* The moderator also mentioned that teachers might have preconceived notions of which students might be interested in the workshop: *The teachers think that they should look for, for example, the math students or the people that already attended some other tech or coding class [...]. There is some communication that's kind of hard. Because you need to*

change the mindset of both the students and the teachers to attract the people who are not the science students. (DK4, moderator)
Due to the non-formal setting, the moderator of the DK4 workshops thought that it was difficult to get students without a prior interest in coding to attend unless it would be mandatory. This became clear in the following interview excerpt: *We would like to have more from [...] not math and the science directions attend the workshops [...] if we should succeed with that, we need to have the workshop as a part of the daily schedule, so they have to attend it as a class. When it's on a voluntarily basis it's hard to attract those people. (DK4, moderator)*

The familiarity with programming varied amongst participants and workshops. In each of the activities, there were a few of participants who reported having prior programming experience or having worked with the technologies before when asked by the teacher at the beginning, while the rest had no prior experience with programming.
The moderator of the DK4 workshop remarked that most students were new to programming in the workshops: *My experience is that one or two students for each workshop [have] tried to code before, and the rest of them are quite new to it, so [...] it's a new experience for most of the people who attend the workshop. (DK4, moderator)*
With regards to confidence in participants' digital skills, the moderator thought that there were differences between genders, stating: *My experience is that the guys believe more in themselves, they're just jumping right in to it, while the girls are a bit more insecure. (DK4, moderator)*

Moderators

The observed workshops were facilitated by three main moderators with the DK1 workshop series and DK3 having the same moderator. The DK1 workshop series was additionally supported by one other moderator and the DK3 and DK2 workshop had around ten moderators that were organisers of the *IT camp for girls* helping out.

The moderator that facilitated the DK1 workshop series and the DK2 workshop encouraged independent and autonomous thinking in their teaching approach giving students freedom to explore their own interests and to express themselves artistically through creating their own performances and art pieces by means of programming. This was also mentioned during the interview: *I think you can make them programme, if it has a purpose and [...] they end up with something that expresses themselves, within that purpose. (DK1&2, moderator)*
Creating a welcoming space and making participants get to know each other were the main goals for the moderator within the general frame of programming. The moderator mentioned: *It is about taking a bunch of students and make an activity that is relevant in the field of programming and technology, but also to make them do something that brings them together, to get to know each other. (DK1&2, moderator)*
The moderator set a theme for each of the workshops (create an art piece/create a musical performance) that the participants could approach independently, as was indicated in this excerpt: *We´ve developed this idea about having programming and technology useful in challenges within a frame, where we tell a story or we set up a theme, and that seems to work for that age group. (DK1&2, moderator)*
As the workshops were set in a non-formal setting, the moderator emphasised the freedom to play instead of following specific learning goals, stating: *If you give them a lot of freedom [...] instead of narrowing down the things, they should do, then you will have a lot of them just playing [...]. I don't care about that, it is fine in an informal setting. (DK1&2, moderator)* and *They really enjoy freedom, especially in an informal setting. (DK1&2, moderator)*

The moderator also focused on collaboration by having students work together on projects and by creating shared spaces in the classroom that would facilitate a shared awareness of what other groups were doing. The moderator had the specific goal for participants of the workshops to be able to copy from each other as the moderator saw it as a natural part of children's play culture. During the interview, this was indicated as: *Normally in their play culture, they [...] go out into the playground and then they copy and remix what the other kids are doing"* which got eliminated in school: *"they really do it as a normal thing in being together when you are three, four, five years old and when you come to school you are not allowed to do that. (DK1&2, moderator)*

For DK3, the moderator encouraged independent work within the frame of the set task to create a working Pac-Man game where students solved the task on their own with the support of the moderators. Beyond that task, students could additionally explore the game and got additional tasks from moderators if they wanted to. For that, moderators would come up with additional tasks on an individual basis when walking around and talking to participants. While the moderator told participants that they could work in groups if they wanted to, most participants ended up working on their own laptops.

In the DK4 workshops, the moderator followed more set instructions where the participants would copy what the moderator was showing on their own individual laptops. The moderator also emphasised the importance of individual work and making mistakes to understand programming, mentioning: *It's harder if you do it yourself and you have to find your own mistakes. But I think it's an important thing to learn. That you can make mistakes, but you can also find the mistakes and then correct them. (DK4, moderator)*
According to the moderator, having participants work on their individual projects would usually lead to all students actually working on the task: *My experience is that everybody has their own computer and they of course help each other and sometimes they are also doing the same things, but [...] all the students are [...] typing the code. So, they're not just sitting next to a person who does everything for them. (DK4, moderator)*
Based on the observations, most participants ended up working on the task with some being more engaged than others and helping each other by looking and pointing at their neighbour's computers.
Reflecting on the audience and the non-formal setting, the moderator thought that it was important to create a feeling of success quickly, stating: *With the students I try to create like a wow factor. They need to see something quickly. (DK4, moderator)* The moderator also acknowledged that it was important to give participants the freedom to decide whether they wanted to engage in the tasks: *If they don't want to do the coding, I don't want to point any fingers at them, because they're there because they choose to be there. So, they decide what they want to get out of it. (DK4, moderator)*
The moderator's main motivation was to create curiosity for programming: *I would just like them to go home and be curious about coding. And feeling successful and believing in themselves. (DK4, moderator)*

With regards to how the moderators saw their roles, the moderator of the DK4 workshops thought of themselves as a teacher as well as a possible role model with regards to learning to programme: *Primarily a teacher I think but hopefully some kind of role model as well. (DK4, moderator)*
For the moderator of the DK1 and DK2 workshops, they saw their role as having the responsibility to ensure that participants were engaged and enjoying themselves, indicating: *It´s mostly to be there and to be present and observe that everyone is having a good time and that they are engaged*" and "*make sure that no one is sitting isolated and [...] that they are doing something meaningful. (DK1&2, moderator)*

Modes of participation

Participation of children in the activities was influenced by the degree of freedom and the different group dynamics within the activities.

In the DK1 and DK2 workshops, participants were given the freedom to pursue their own interest within a general theme which led to participants coming up with their own solutions to the tasks. In the DK1 workshops specifically, the groups would take increasing ownership of their stages throughout the different sessions. In the later sessions, the participants started working on their stages immediately after arriving continuing their work from the previous week without specific prompting from the moderators. For the DK3 and the DK4 workshops, the tasks were more set with the option for participants to explore independently based on interest initiated by the participants: in DK3, some participants modified the game and in the DK4 workshops, some participants added additional elements to their websites. Whether participants would more independently pursue the task and go beyond the given instructions was up to each individual in these cases.

Both the DK1 and DK2 workshops had a shared activity at the end where participants presented their work to their peers and, in the case of DK1, also to their parents. These shared activities acted as a concluding event to the workshops and as a possibility to show the outcomes of the activity to everyone included *for the kids, to see what each other have been doing (DK1&2, moderator)* and to create a *common understanding of what they were doing. (DK1&2, moderator)*

In all activities, there was some level of cooperation or collaboration between students to different degrees. While DK3 and DK4 were more focused on individual work with each student working on their own project and laptop, students still cooperated with each other by looking their neighbour's laptops and helping by pointing at each other's laptops or code and discussing the task.
In the group-based activities, different group dynamics influenced how participants collaborated with each other. The moderator pointed out that there were often different roles: *One of them is good at programming, one of them is good at figuring things out, [...] one of them is good at inventing how they should drive around, so that´s what they bring into the activity. (DK1&2, moderator)*
However, some of the participants would be more knowledgeable or interested in the coding than the others and took on more active or leading roles. This was mentioned by the moderator during the interview: *The three girls here, one of them, she was very much doing things with her hands putting things on machines, but not very interested in programming, although she was part of it, right? Then one of the other girls [was] very good at programming. She invented having two processes running with different motors, she figured out how to do that. (DK1&2, moderator)*
The moderator remarked on the difficulty of creating the groups based on factors such as different skills in non-formal environments as participants would often want to work with others that they already knew: *I´ve tried making groups. But then some of them know each other from school, and they wanted to be together. They got mad at me, so that doesn't work [...] in informal settings. (DK1&2, moderator)*
The moderator also reflected on efforts to get the participants on an equal footing by facilitating conversations during the breaks and the importance of spending time on such endeavours: *When we ate the sandwich, that was a very important moment, because there they talked together in a different way [...] Some of the younger girls [...] they were very active during that. Maybe some of the older*

girls they were better at making some of the activities, but when they were in that room, they were equal on other terms. (DK1&2, moderator)

Figure 3.2.2. From the workshop DK1 - Space, tools and materials, activities, product, and final exhibition of products. For more information, see video named MGP leg (Teknologifantasi, 2021).

Competence

Different levels of pace amongst students could be observed in all activities with some participants solving the tasks relatively quickly while others needed more support. In the DK1 workshops, the ages varied among participants with the younger groups needing more assistance from the moderators at times.

For the moderator of the DK1 and DK2 workshop, the main goal was: *To make an activity that is fun for the kids. It´s playing, it´s fun, it´s engaging. (DK1&2, moderator)* The priority was not on teaching a specific set of skills due to the non-formal setting: *[what] I´ve been doing [...] that´s not school. I´m not very eager to make sure that everyone understands a program or how to connect connections or Bluetooth. (DK1&2, moderator)*

The moderator of the DK4 workshops hoped that participants would be encouraged to go home and look into programming on their own but were uncertain if they would actually do so, mentioning: *My hope is of course that they go home and do something on their own, but I'm not sure [...]. Hopefully we have given them a good experience that they will remember later on, but I'm a bit unsure if they'll go home and do a project on their own. (DK4, moderator)*
The moderator emphasised that for participants to use some of the skills of taught in the workshops in the future, there was a need for additional activities:

I hope that they, maybe in some school project will remember that you can make a website [...] and maybe they will include it in some of their schoolwork, but on a voluntarily basis I don't think they will do anything more. [...] I think we will have to do some follow-up with them, so they get the time to do it. (DK4, moderator)

The moderator of DK1 and the DK2 workshop had related reflections on following up after the activities based on conversations with teachers on the difficulty of keeping students engaged, stating: *I´ve worked together with teachers from schools to get their knowledge on how they actually do in their everyday life [...] There was this teacher once, that said to me: 'It´s very easy for you to come here with Lego, all the kids are happy, you are here for three hours and when you are away, I have them again for all the dull stuff. (DK1&2, moderator)*

3.3 Italy

As outlined before, three programming workshops were observed in Italy. Below, we summarise and triangulate findings from observations and interviews articulated within the six axes considered in the data analysis process.

Activities

As in Table 1 (**Appendix 3**), the activities we observed were focused on programming and robotics tasks. All these activities have the main general purpose to foster children's digital skills with respect to these areas and are free of charge, thus potentially everybody can participate.

More in detail, the workshop proposed by IT1 has mainly focused on programming, with children using programmes such as Scratch and Python. The workshop was divided in three main activities carried out in the same area of the library that, however, was organised in three micro-spaces: Scratch for beginners (in this case young children, but more generally newbies who are not familiar with Scratch); Advanced Scratch users (for those who are already familiar and used it at least once); Python (for children with higher skills). Scratch was used to create interactive stories and animations; Python to programme a game ("Whac-a-mole").

The workshop conducted by IT2 revolved around programming and robotics activities. Children could pursue their own projects on Scratch, such as designing a story based on witches and unicorns, while the two boys, who were older and more skilled, programmed a mini robot (micro Maqeen) with micro:bits. After the break, children were all asked to do the same activity, namely programming a drone with the goal of making it fly on a square route.

Finally, the activity carried out by IT3 focussed on the use of Lego Education WeDo 2.0, an educational robotic set allowing players to engage in programming activities to build artifacts based on the traditional Lego bricks and make them do different activities through a computer-based programme, which in this case was Scratch, plus an additional Scratch extension specifically suited for Lego WeDo 2.0. The goal of the activity was twofold: to build the Lego Robot (which is commonly called "Milo"), and to connect the robot to the computer via Bluetooth to operate him.

Across the three workshops, activities followed a different degree of formality and directedness: on certain occasions children were left free to work on projects they choose themselves (although within a specific and predetermined framework), as it was the case when using Scratch at IT1 and IT2, more often for younger children; other times, participants would have to follow clear instructions, such as when programming a drone at IT2, or when working with Python at IT1, and when building up a robot through Lego We Do at IT3, with the latter being the most structured activity. More experienced children at IT2 were also invited to engage in playful activities, by programming a robot and then racing their own robots around the room.

Despite the formal organisation of the workshops, each with its specific goals for the day, some occurrences were observed where participants would engage in playful and spontaneous activities, such as when some children started playing with the Scratch cat making it "meow", making everybody laugh.

Each activity, however, had to deal with time constraints, since the workshop would last only two hours. While generally the goals of the day were achieved, some children lagged, but this was not an issue per se, since they were invited to save their work and continue the next time.

Spaces and tools

The activities described took place in different locations: the IT1 workshop took place in a public library in a small town; the IT2 workshop at a brand-new campus in a large city; and the Lego We Do workshop at IT3 in a medium-sized town.
One of the first things we observed was how the space was organised and what kind of tools were used during the workshops. The space organisation is an important variable to keep in mind, as it may hinder or foster children's collaboration (i.e., working together for a shared goal), or at least cooperation (i.e., helping each other) (Biamonti, 2007; Dettori, 2017; Weyland & Attias, 2015). However, the COVID-19 policies in place at the time of observations influenced greatly how the space was arranged. Such a disruption was also recognised by some moderators themselves even before the activity started, knowing that it would have posed a problem since it would not allow children to promptly and spontaneously work together.
In the different workshops, children were either sitting alone or in tables of two or four. In all activities square tables were positioned across the room.
In the library used for the IT1 workshop, the space was separated by corridors filled with books. This created two "separate" environments, even though the corridors did not act like walls but did provide a sense of "separation" between two halls. In one hall, one half of the space was empty, while in the other there were two tables, each accommodating two students, for a total of four pupils. These were young children (approximately around 9-10 years of age) deemed to be "advanced" Scratch users because they had already used the software once. Moving to the other hall, on the right we could find the "Scratch newcomers": very young children who had never used Scratch before. Here we had five children: four sitting at two tables for two, and a fifth one sitting alone. On the left, on the other hand, were four pupils: two boys and two girls, in their teenage years, working on Python with a moderator sitting with them. The space was thus organised according to children's age and skills. This organisation either hindered collaboration and cooperation or only allowed for it for those children sitting at the same table. This was evident also on the IT2 workshop, where 10 children sat in three square tables, and this organisation favoured collaboration mainly between the children who were sitting next to each other who worked in pairs. With respect to the Lego We Do workshop at IT3, only a child was allowed to a single table.
If it wasn't for the COVID-19 related restrictions, the spaces could have been used differently to allow children to work together. No barriers, nor facilitators were overall evident.

Figure 3.3.1 - Three workshop spaces in Italy – From left to right: IT1, IT2, IT3

When interviewing the activities' moderators, the rationale behind how children were divided during the activities became clearer, even with respect to how things would normally work and how they were re-arranged due to COVID-19 measures. Three different motivations emerged, one for each organisation, whereas in IT1, children were grouped according to the types of activities and skills level, in IT2 in terms of preferred activities, and at IT3, when possible, according to participants' personality. The following three excerpts account for that:

We try to organise and separate [the spaces] by type of activity: some do programming with Scratch, some with Python, if possible also on different places. With respect to who sit at what table, we separate by skill level. Mostly because if there is a need for the less experienced to have an almost frontal lesson you have them all there, so it's much more practical for us. (IT1, moderator)

When we could have more children per table we would try to put several kids at a table who wanted to do the same activity. We used to try to put them together to talk to each other and share what they were doing. Social distancing prevents us from doing that now, so the organisation of physical spaces is as it comes. But we try to create "islands" so that they can communicate based on common interests. (IT2, moderator)

We try to arrange the tables also according to participants' personalities, especially with the groups we know. I mean, we try to mix up the compositions, so that there can also be a possibility of contamination between the beginners and those who are more skilled, the more confident and the shyer. We are now constrained by social distancing though. (IT3, moderator)

As for the tools used, children would work on both hardware (e.g., laptops), and software equipment (e.g., Scratch). While most children had their own laptops, these were also provided by the moderators in case someone did not have one or, as it happened during the Lego We Do workshop (IT3), if any technical issue would happen (such as the computer being slow).
Other tools, such as those used to build up a robot or the Arduino hardware platform were provided by the hosts, so that all children could have access to them.

Figure 3.3.2 - Tools and materials in Italy – From left to right: IT1, IT2, IT3

Once again, the interviews further clarified the choices of the tools, trying to pick the most affordable so to make the activities inside and, potentially, outside of the organisation accessible for all, as remarked in the following excerpts:

The choice of both hardware and software is aimed at open platforms so that they are available to everyone. (IT1, moderator)

With respect to the tools, they have to be affordable so that everyone can say 'I'll get it too', and also because our resources are limited. (IT2, moderator)

With respect to objects and tools I select what is appropriate to propose based on the time available and the cost, because these devices often cost a lot of money. (IT3, moderator)

Thus, the choice of the tools appears not to be casual, but motivated both by pedagogical goals and as well as financial constraints.

Children

The three workshops saw the participation of 29 children in total: 13 at IT1 (aged 7-15, 11 boys, 2 girls), 10 at IT2 (aged 7-12, 8 girls, 2 boys), and 6 for the Lego We Do Activity organised by IT3 (aged 7-13, 4 boys, 2 girls). Apart from the workshop held by IT2, where more girls were present – surprisingly, as suggested by one of the moderators – the overall gender ratio was imbalanced in favour of boys. The interviews showed a complex picture in this regard, suggesting that while there is, in fact, a more general trend echoing discourses according to which boys are more likely to engage in certain digital activities than girls, other variables may play a role in this scenario, not only in terms of children's aspirations, but also age, parental perceptions, and curriculum choices:

Let's say that in terms of gender, we noticed a big difference when kids move from primary to secondary school, not to mention upper secondary school. In the sense that as long as they are at primary school the gender difference between participants is not that high, we are around 50%, whereas from secondary school onwards there starts to be a big difference. We are quite in line with international statistics, in the sense that we have seen that we don't have more than 20-25% of girls anyway. […] Another thing I noticed about gender is that sometimes if there is a choice to be made by families, even at a very unconscious level, if in the family there are a boy and a girl, parents tend to encourage the boy more. I mean, they let them both participate, but there is a maybe involuntary encouragement for the boy which is quite evident. (IT1, moderator)

It is difficult that girls over 12 will join, they tend to decrease in number and almost disappear. It is easier for them to come if there is at least one girl friend who comes with them, because they expect to be in a male-dominated environment. But we fail to solicit their interest enough. It is not a question of competence, of course. [...] I'll give you that gender difference for sure because statistically we see this tendency in Coder Dojos worldwide. (IT2, moderator)

Gender-wise, in our activities we have always managed to have around a 25-30% of female presence. This means that we also pay more attention to how we construct our proposals. Because if we do a workshop in which you have to create an animated story using Scratch, the characters, the story and its development must also be able to accommodate the differences, so we leave more freedom to choose characters and settings, which is usually welcomed by the girls participating, who often achieve better results than the boys. But you need to pay attention not to make the initial proposal too rigid. (IT3, moderator)

While we did not collect sociodemographic information from participants, nor was it possible for us to certainly infer children's backgrounds, almost everyone attended the activities with their own personal laptops; while most children were of Italian origins, the IT2 workshop was also attended by children from other nationalities s. The interviews revealed additional background information in terms of children's background, such as their socioeconomic status, suggesting that despite the activities being free of charge, most of the attendees were children from middle to high socioeconomic status. As in the words of a moderator from IT2: *I regret to tell you that the children who come here have a fairly high standard of living, I don't know for sure, but when I see them and talk to some of the parents, I get that impression. I say this with regret, because usually the weakest sections of the population lack these experiences the most. We are completely open, in the sense that you don't pay anything, enrolment is free, but given the target group of children a lot has to do with parents, who are generally people working in informatics and the like. (IT2, moderator)*

As for differences in terms of ethnicity, the interviews confirmed that most attendees are, in fact, white Italian-born children, though there might be exceptions, as reported by a moderator from IT1: *There are foreigners who participate in our activities, but they are European, so there are some English or French parents [that bring their children], some Asian, but there is no representation from North Africa, for example, and if I look at the national statistics to see the number of migrants here, there are many, but they do not participate, they do not come. This is curious because a lower secondary school teacher once told me that they noticed that when it comes to the choice of high school, the families from North Africa tend to push the boys towards the technical institutes and the girls towards accountancy. I was a bit surprised because we don't see them taking part in our initiatives, so there must be a gap we are not able to fill. (IT1, moderator)*

Additionally, the fact that these children were there accompanied by their parents may speak for some sort of parental interest in their children's digital education, and overall involvement in education, an impression reinforced during one of the observations by a father who at the end of the IT2 workshop told the researcher that his daughter attends a Montessori school. The level of parent involvement was further testified during the interviews, showing a multifaceted phenomenon in terms of what parents expect and aspire to, as in the following excerpts:

> *Some parents have expectations, especially at the beginning, thinking that they are letting their child participate in a course, but it is not a course, it is not organised as a course, firstly because we cannot guarantee that we will be there every Saturday of the month and secondly because we think that it is a task for others. (IT2, moderator)*

> *There are parents who bring their kids for their own [the parents'] personal interest, while the children don't care and so it is difficult to involve them in the activities. There are parents who have no idea [about technology], but they have realised that these things might be interesting, but they don't know much about it, and these are the two extremes. I saw the latter more than the former. Then there is a larger number of parents who do know something about technology but don't perhaps have the skills, knowledge, and time to be able to do this kind of activity at home with their children, and so they are happy to find someone who can try to spark this interest in their children. (IT3, moderator)*

Children showed different degrees of familiarity with the activities. As confirmed by the workshop's moderators themselves, while some participants were habitué, regularly attending all (or al almost

all) the workshops organised, others were newbies. The uneven degree of familiarity with programming resulted particularly evident in the way children approached the task, with some looking more confident, and others requiring more attention from the moderators or looking somewhat "lost". This spoke also for a different level of digital skills, with some peers being more expert than others. The interviews confirmed this impression, as in the words of these moderators:

> *These children have 'proximity' with technologies, but as passive users. When you ask them to do something they go into crisis because they only know how to use those four keys that they need to operate the software they use. I haven't seen much confidence in what we do. (IT3, moderator)*

> *Outwardly these children are familiar with technology, but on a practical level they are not. They use a computer as they might use a remote control. We try to teach them the cause-effect relationship of the computer. (IT2, moderator)*

Still, during the observations some occurrences took place where children, generally boys, showed off their ability, speaking for their digital self-confidence, such as a boy in the IT2 activity who suggested the moderator's code for the drone route was wrong when it actually was not, or another at IT3 bragging with his peers that he was able to do activities for older targets. Sometimes, though, children would also find independent solutions to the tasks, like a 13-year-old guy at IT3 who had an insight on how to stop a robot they created moving without using the brakes but only by putting the strength to zero, soliciting positive feedback from the moderators.

Finally, it is striking to notice that while it was within the philosophy of these organisations to have more skilled children acting as "more knowledgeable others" with their peers (Vygotsky, 1980), most of the time children completed the tasks individually, as we shall see in the next section, with some occurrences of spontaneous cooperation—as was the case with IT1, where a more expert girl working with a less knowledgeable female peer and two boys on Python would help her keep the pace of the task.

Moderators

A total of 12 moderators were involved in the three workshops: four moderators at IT1, four at IT2, and four for the Lego We Do workshop at IT3, which includes the organiser (a moderator himself) and three high school students volunteering as part of their educational curriculum.

Across the three workshops there seemed to be a shared constructivist teaching philosophy (which, however, was hindered by the COVID-19 social distancing measures), according to which students should first and foremost do things on their own and cooperate, while facilitators should intervene as needed. Interestingly, the four moderators of IT1 preferred to be called "facilitators" to further emphasise that they are not "teachers" and they are not taking on a directive role, but they are there to facilitate what children are doing. In this regard, moderators shared some mottos to better stress their philosophy, such as "when we share ideas, we get better ideas" (IT2), or "before asking me [the moderator] something, ask three of your peers". Several times moderators across workshops remarked the difference between these activities and school, inviting children to "copy" from their peers" and reminding them that they are not there to compete, to get a grade or to win, but to learn while having fun with their peers. By recognising the value of "copying" from others, moderators

aim to clearly differentiate their educational proposal from the way formal education works, where children are sanctioned if they copy from others. In turn, in these workshops copying from others is seen as a legitimate way of learning something new. Our interview data further emphasises this aspect, showing a critical and sometimes strong stance moderators have towards formal education and the way schools work in general, as in the words of this IT2 moderator: *School ruins them. I know it's a strong statement. But you realise that when you tell them that they can copy here, and they look at you as an alien. If you then tell them "you can make mistakes here" they don't believe you, because they grow up with the idea that every mistake you make is a failure, that collaborating with others is not good, there is an exasperated individualism, and therefore you have to compete with others and not collaborate. You can see that in most cases they don't spend much of their time in an environment that promotes collaboration. In fact, we are happy when someone lacks a computer and works in pairs with another partner. So we explain to them that the computer is just a tool and you work with your head, and it's nicer if you have two heads* [working together]. *(IT2, moderator)*

By offering stimuli and leaving children working on their own, moderators aimed at fostering creativity and autonomous thinking, even though some differences were observed. For example, the moderator of the IT3 workshop would use a lot of theoretical explanations to ground children's experience to some sort of framework, while the others seemed more prone to a more practical approach— that, however, was still shared by all the three contexts observed.

Overall, moderators appeared generally present for children when needed, providing one-to-one support for those more in need and positive feedback when children would succeed with a task. No occurrences where children were reprimanded were observed, even when they made some mistake. This was the case with a child in the IT3 activity, whose robot fell from the table and broke, prompting the moderator to adopt an encouraging approach to rearrange it.

Modes of participation

While we did not observe, nor could infer first-hand relevant background disparities between participants across the workshops, sometimes it was evident that their skills and modes of participation would differ, suggesting some sort of "power" differences between children. For example, younger participants were generally less skilled and took more time to complete some tasks, with some notable exception, such as the 9-year-old boy of the Lego We Do activity (IT3) who was already familiar with the assignment (and bragged about it). Some children were also already familiar with Scratch, since they already used it at school and knew better than others their way around it. Finally, power differences were also observed with respect to the novelty of children's personal tools, as it was the case for the 13-year-old guy who had to ask for a different computer because his was too slow.

While the workshops were based on a clear philosophy that does differentiate them from schools and formal educational contexts, and although children's creativity and autonomous thinking was clearly promoted, the activities tended to follow a pre-established structure to some extent, in terms of what to do and how. This is not surprising since, as we saw in paragraph 1.3, non-formal education is always characterised by intentionality, so at least to some degrees the asymmetrical relationship between children (as the recipients of the interventions) and adults (as coordinators) remains. In this sense, little could we explore in terms of what children might have wanted to do *beyond* what was already proposed to them and the options they could choose from. This was also confirmed by the

moderators of IT3 who claimed: *I have to be honest, children are not very involved in the design. Involvement may be 'deciding what to focus on in the game', but not the overall organisation of the encounter. (IT3, moderator)*

There were cases where children resisted what they were asked to do, as with two 11-year-olds at IT2 who did not pursue one of the moderators' tips on how to programme the robot.

In terms of leadership, no significant occurrences took place where a child would take the lead and guide the others. Although collaboration and cooperation were certainly recommended, they were hindered by the COVID-19 social distancing norms, which may have caused a disruption to the natural unfolding of the activities. A case worth mentioning, however, concerns a child from the IT1 workshop working on Python, who did act somehow like a "leader" or a "spokesperson" to his group by repeating what the moderator just said to the rest of the group (not necessarily because they did not get it).

Competence

What children bring home from these educational experiences could be observed both in terms of tangible outcomes, as well as more conceptual learning.
As an example of the first occurrence is the material production of an artifact, like a robot to operate, which would give children a palpable result of their effort. On the other hand, children's creativity and reflexivity were also stimulated throughout the activities, by asking them to adopt a problem-centred and "get-your-hands-dirty" approach, with moderators scaffolding them as needed. As an example, during the IT1 activity, the Python moderator decided to project a syntax with a bug, asking participants to find out where the problem was. Instead of giving out the answer immediately, such an approach promoted a shared reflection between participants, fostering collaboration. Even the trial-and-error method of problem solving was useful in this regard, as it was evident when children would not succeed at first but were invited to try again to achieve their goals.

Overall, children were observed engaging in new digital skills practices and strengthening their pre-existing skills, while also promoting creative and autonomous thinking. While it was out of scope for the nature of our study to measure skills before and after the interventions, pairing the observational and interview data suggested that children do, in fact, acquire new skills thanks to these experiences, as expressed by a IT2 moderator who claimed: *I definitely noticed a little more confidence in using technology as a result of our meetings. Like moving a file from one folder to another, or that if they don't save their work, it's a pain. (IT2, moderator)*

The interviews, however, also revealed that learning would vary depending on several attributes, such as children's pre-existing digital skills level and age, suggesting that less skilled children would seemingly still fall behind their more advanced peers and that older children may be more motivated in moving forward in their understanding and competences related to digital technology. As in the words of these moderators:

Where there is a pre-existing gap between different children, unfortunately that gap stays. Let's say that we do see a growth in terms of [digital] skills, but there is never a levelling among participants if the starting points are different. They grow at their own personal pace. (IT1, moderator)

More than once I have heard children tell me that they have changed the way they use some software because we have used it, we have talked about it. I can't give you a percentage, but it has

happened to me. I've noticed very little difference regarding socioeconomic status and gender, but about age, I did. As some kids grow up, they discover that digital things are important to them, and they dive into that more deeply. (IT3, moderator)

3.4 Similarities and differences

In this section we describe the recurring patterns across the workshops observed in the three countries.

Workshop activities and structure

The workshops were similar in terms of the activities offered, namely, programming with Scratch, Python or Unity, or programming robots with micro:bit or Lego robotic sets.

Our findings further show that the workshop's structure shapes children's engagement and motivations to participate in the tasks. The degree of formality of the workshops varied, with children sometimes being instructed to complete individual tasks following a detailed step-by-step guide, and other times being let free to pursue their own goals. Organisers and moderators recognise that while non-instructed programming is more tailored to each child's individual skills and preferences, this may narrow down opportunities for collaboration. On the other side, organisers and moderators also notice that more formalised activities seem to promote opportunities for collaboration among children, each individually completing the assigned tasks.

Teaching style

In all countries, moderators adopted a similar teaching style, aimed at fostering children's autonomy, reflexivity and creative thinking. Independent and creative thinking was stimulated through a problem-solving and "get-your-hands-dirty" approach, with occasional scaffolding from moderators. Moderators were especially actively engaged with beginners, sitting next to them and guiding them through the start of an activity.

Moderators equally emphasised the importance of collaboration. In fact, collaboration was explicitly mentioned by organisers and moderators as what distinguishes non-formal learning from formal learning in schools, with children being encouraged to "copy" from their peers. However, in most of the workshops, children were assigned tasks that required individual work, rather than teamwork, irrespective of the level of formality—namely, irrespective of whether they were given step-by-step instructions, or whether they were let free to experiment and learn by doing. Additionally, our data also suggest –as in the words of an Italian moderator – that children's collaboration may be hindered by a previous scholastic mindset that negatively reinforce students working together promoting autonomy, which reflects a state of disconnection between different sites of learning in terms of values and teaching strategies already documented by Livingstone and Sefton-Green (2016).

In the absence of an activity based on teamwork, collaboration was encouraged along with autonomy. While the moderators were ready to step in to assist children who need help, they usually encouraged children to ask their peers first. Indeed, we observed children occasionally looking at their neighbour's laptops and helping each other by pointing at their codes and discussing the task. Moreover, there were instances in which children sat next to an older and more experienced child, to be able to ask for guidance. The ability to work at their own pace and to express their own interests

occasionally led to the emergence of "leaders" or "masters" whom other children turn to get advice, which in turn is an important catalysator to learn from peers. However, it was not uncommon to observe that collaboration among participants remained limited and children remained focussed on their individual projects.

Our findings thus suggest that, on the one hand, fostering autonomy through individual achievements is likely to go the detriment of collaborative work and peer learning, but on the other hand, is also likely to facilitate the scaffolding of digital skills practices.

Learning environment and tools

Our results show that material space arrangements and tools shape children's participation. In all three countries, organisers and moderators gave examples of situations in which they re-arranged the spatial organisation of the room, including moving tables and chairs around, to facilitate children's learning and collaboration practices.

These material space arrangements were in turn also impacted by situational demands. This became clear in Italy, where the interviewees lamented having limited opportunities to arrange the space due to the COVID-19 restrictions in place, that required social and physical distancing. In fact, moderators acknowledged the COVID-19- related disruptions to their habitual practices as a barrier against children's spontaneous collaboration.

Finally, the findings from Denmark also made clear that opportunities for collaborative learning practices followed from material space arrangements not only at the level of the venue but also by the software, the latter typically designed for individual use and not for knowledge sharing.

Children's participation

We identified two different strategies to foster children's participation and inclusion. On the one hand, there are workshops that are targeted at a particular, usually under-represented groups, such as the workshops in Denmark that mainly targeted girls of different age groups. On the other hand, there are workshops that are open to a wide group of children and thus not really targeted at for instance a particular age or gender.

Our findings suggest that the latter "open doors" or "one fits all" approach was not always successful at including a diverse range of children. Despite the workshops' non-formal, flexible structure involving different possible activities for beginners and advanced programmers as well as for primary school children and high school pupils, CoderDojo moderators and organisers reported that most children tend to participate only at a young age (7- or 8-year-olds) and tend to leave when they grow up.

In terms of gender, again with some notable exceptions, the majority of the CoderDojo workshops observed in Belgium and Italy were attended primarily by boys.

As for indicators of socio-economic parameters, all workshops implemented strategies to promote greater inclusivity, with organisational safeguards in place so that the workshops were free and that for instance that extra laptops and equipment were provided. Yet, with the exception of the BE4 CoderDojo4All workshop, the socioeconomic background of the participants seemed rather homogeneous (mainly middle- or upper-middle-class).

In Belgium and Italy, children were typically accompanied by their parents, who manifested their investment in children's digital education. While parents have a beneficial role in motivating children in their first approach to programming, their presence during workshops has been observed as an important barrier to children's autonomous learning.

Implications

The findings of this first phase of research informed the planning of the co-design activities. The co-design activities, in fact, were aimed at gaining knowledge on how to better promote children's inclusion and participation in non-formal digital education experiences.

In this light, our findings have shown that:

- No major economic barriers to the accessibility and inclusivity of the programming workshops could be identified: all the workshops we observed were free, some provided extra laptops or tablets, offered snacks and drinks for the break, and were generally held in inclusive spaces (libraries, schools, youth clubs). Despite these efforts to promote diversity and inclusion, participants in these workshops seemingly had a rather homogenous socioeconomic and cultural background.
- Instructing children to achieve a certain programming task that is not related to their own interests fails to keep them engaged. On the contrary, a child-centred teaching style is far more engaging and more likely to keep them motivated in the long run.
- The main incentives to participate seem to stem from the child's genuine interest in programming, and/or because of their parents valuing programming as beneficial for their future academic and professional achievements.
- What makes current programming workshops less attractive for vulnerable children is that these workshops rest on a narrow definition of digital skills as an individual achievement that is future-oriented (and related to better school- and professional performances), as it is usually represented in social discourses (Livingstone & Blum-Ross, 2020). Such a narrow perspective does not necessarily link to children's own future aspirations. Therefore, more inclusive understandings of digital skills informing policy interventions as well as programming workshops, along with diverse and inclusive child-centred teaching styles, could compensate for the lack of diversity and inclusivity observed in our fieldwork.

4 Lessons from co-design workshops

In this section we outline lessons learned from the co-design workshops conducted in the three countries. As it will be evident, these vary in scale and scope, due to the different theoretical and practical goals each national team tried to pursue, as well as constraints faced.

In order, we report first on Italy's findings and considerations on teaching styles, then on Denmark's findings and reflection on technology and tools, and finally on Belgium's findings focussed on policy.

While each country treated a specific theme during the co-design workshops, these are to be understood as profoundly interrelated since technology and tools as well as teaching styles reciprocally influence each other, with policies representing a macro-level of analysis encompassing all these areas.

4.1 Teaching style in Italy

In Italy, a children's consultation was first carried out to foster reflexivity in terms of the educational activities taking place at IT4. Because adults typically make decisions for children also in non-formal education, we believe that including children's voices as competent actors in informing moderators' teaching styles may allow for a less asymmetric relationship and imbalanced power dynamics. Following this consultation, we conducted a participatory observation of a workshop where children were asked to take on the role of "peer tutors" to teach and show other children, but also moderators and researchers, about a project related to coding and programming they had been working on and getting feedback on it.

4.1.1 *Participatory consultation*

As reported above, during the consultation, children were asked the following questions:

1. Can you please tell me why you are here today?
2. And can you tell me what you like the most about the activities you do here?
3. Is there something you would like to do but did not get a chance to do here so far, or that you feel you should do more?
4. Is there anything you would change in the ways these activities are organised?
5. Would you like to conduct an activity for your peers? And if yes, how would you do that?
6. Now, please think of a person of your age who has never done anything like the things you do here before. How do you think she/he could be encouraged to participate? Is there anything you believe the workshop could offer to get her/him involved?

Below we report on main findings from this consultation as a set of elements moderators and, in general, educators working in non-formal learning environments may consider in terms of children's desires, aspirations, and critical stances towards what is offered and how things are done.

- *Reasons for participating in coding workshops*

In terms of reasons for participating, some children provided insights on why they were attending CoderDojo and what they would hope to bring home from this experience. Two ten-year-old boys reported their future aspirations as a main motivation to participate: they both wish to become programmers when they grow up, with one of them emphasising his passion for creating video games and the desire to strengthen his computer skills. The willingness to reinforce one's digital skills was also brought up by a thirteen-year-old boy, who claimed that he likes programming, but that is something he has not done properly at school if not for just a two-hour course, so he finds in CoderDojo an opportunity to implement what, in his own words, is seen as a lack of investment in programming skills at school. Many participants used to attend these workshops before the pandemic, so this was the first opportunity for many of them to attend the IT4 workshops in two years. Two sixteen-year-old boys mentioned they were there to see whether the course could offer something new to learn and work on. The only girl attending the co-design workshop that day, a nine-year-old, did not really know why she was there since her mother brought her, but she claimed to be curious about it. However, this was the only occasion in which the girl participated in the discussion, possibly because she was not very interested or motivated, or because – as emerged from some of our interviews with moderators and organisers – the male-dominated environment and the fact of being there for the first time would not help.

- *What children like about these workshops*

The main thing children reported to like about the workshops was the opportunity to programme. Two young children, an eight-year-old and a ten-year-old, specifically said they like being there to use Scratch since it enables them to create fantastic stories, emphasising the playful and creative dimensions of participation. Two older children, a thirteen-year-old and a sixteen-year-old, in turn, were more focussed on learning how to programme, stressing more an instrumental and operational aspect. Only a sixteen-year-old reported that he appreciates the communitarian dimension of being in a nice physical environment with his peers and other kids, spending a couple of hours together, and possibly even learning and doing more than what he would be able to do at home on his own.

- *What children would like to do or would do more*

When it comes to things children would like to do or do more during these workshops, we noticed that all children had some sort of improvement of their digital skills acquisition in mind, whether it be by reinforcing their existing knowledge of software they were already familiar with in order to achieve sophisticated tasks, or learning to use advanced programming languages and software. Progression on the ladder of CoderDojo was also mentioned, with some participants expressing the wish to achieve an advanced CoderDojo's belt- in fact, within CoderDojo, children are attributed a different coloured belt every time they demonstrate having achieved new skills.

A ten-year-old, for example, expressed the desire to learn to create a digital cartoon and a videogame; so did an eight-year-old. Another ten-year-old, in turn, claimed he wants to focus on creating a longer and more complex game, since those he created in the past to level up and get a new belt were now deemed too easy, and less stimulating. Another ten-year-old emphasised his willingness to level up and get a new belt, seen as the tangible materialisation of his evolving programming skills, such as learning how to create a digital story and a video game.

Two sixteen-year-olds and a twelve-year-old explicitly asked to start using more complex and advanced software and programming languages than Scratch, such as Unity and C++, to create more sophisticated and fine-grained games.

Overall, all children taking part in the discussion clearly stated they wanted to move forward in their digital skills practices, merging both intrinsic (i.e., learning to do something more difficult for themselves) and extrinsic motivations (i.e., to get a more advanced recognition within the organisation).

- *What else children would change*

The consultation allowed children to express their opinions also on other things they would like to change about the organisation of these workshops. Apart from suggestions on the activities and tools highlighted in the previous section, several participants expressed their desire for bigger spaces so to accommodate more tables and thus more children. Other also mentioned the opportunity to organise more frequent encounters. CoderDojo Italy takes place approximately once a month, depending also on the availability of moderators who are all volunteers. As for the space, although this aspect is not of easy solution for other questions at stake, it was striking to notice how children expressed the desire to have a bigger room for them to use, so to allow more peers to participate and, one may argue, more opportunities to work together in a non-formal learning environment, offering something different from what is done in schools.

- *Children as moderators*

When asked about the possibility to act as a moderator for one activity, two children, a ten- and a twelve-year-old, explicitly manifested their interest to do it. Children were also asked what they would do differently if they had a chance to take the lead. The ten-year-old said that he would probably pay more attention to newcomers since they may feel disoriented and out of place so that they can be better integrated in the group and the flow of activities. The twelve-year-old, in turn, claimed he would like to introduce the other participants to new and more complex programming languages, showing what they are, how they are used and what they could do with them.

- *Children's stance on accessibility*

Children were finally consulted on how to make these workshops more accessible for a more diverse audience who currently does not take part in these activities. Among the answers, a ten-year-old said that it would be useful to prepare and distribute a pamphlet to explain how this workshop works, a thirteen-year-old emphasised the importance of talking about these activities in schools, so that more children could know about them, and finally, a sixteen-year-old said that it would be important to implement the hardware equipment, in terms of available laptops, so that even peers who do not have these tools at home can come without feeling a priori excluded.

The information gathered through the consultation with children showed several areas of intervention and reflection that organisers and moderators could keep in mind, as well as other educational practitioners and policymakers. First, they show the importance of giving children a voice to better understand how they feel about what they do and how they would do it. Second, they raise attention to things adults may not have thought about, or maybe not have fully developed. In sum, they show that children are, in fact, competent actors with their own meaningful ideas and opinions who should be granted agency in the co-construction of an educational environment: agency that may be compromised in formal settings but promoted and sustained in non-formal contexts.

All of the above, if actively listened to, can be an important step to promote reflexivity among moderators in particular, and educators in general, offering precious insights in terms of how to adjust and revise one's teaching style, but also what to keep and further reinforce. Listening to children, as insiders of an educational experience, can in this sense help shape and revise the intentionality and axiology of educational interventions that finds in the adoption of certain teaching styles and strategies one of their main manifestations, to make them more child-centred.

4.1.2 *A peer tutoring experience*

After the consultation phase, the organiser and moderators and us, researchers, had time to think about and conceptualise a strategy to start putting in practice what we learned from children's voices. As in the paragraph above, several areas of interventions were outlined. These findings will prove useful for future improvements and changes where, with time, organisers and moderators of IT4 (and, more broadly, whoever works in similar non-formal learning contexts) will have the opportunity to better address children's request, and possibly make a habit out of this consultation strategy to involve them in co-design activities regularly. However, because we wanted to do a follow-up together with IT4, to begin translating in practice what we learned during the first phase of the co-design process, we consulted with the organiser to plan an activity that was feasible to prepare for everybody in a time-effective fashion. While it is in the declared intents of the organiser and moderators to further implement their curriculum to accommodate participants' requests to the best of their capacity, some of these changes required more time (such as the use of new language programming, or reaching out to a more diverse audience, and the like). As such, we opted for a peer tutoring experience, since two participants said they would have liked to act as moderators and conduct a piece of the workshop for their peers.

The organiser, then, sent out invitations to participants who could manifest their interest to present something they had been working on in advance (by emailing the organisation) or decide to do it in the moment during the workshop. The day of the workshop, two participants volunteered to present their works: a twelve-year-old who presented his very own website he created himself using HTML and CSS languages, and an eight-year-old who presented a game he created with Scratch (Fig. 4.1.2.1)

Figure 4.1.2.1 - Peer tutoring in Italy - From left to right: the website of the thirteen-year-old, the videogame of the eight-year-old, the working space

During the presentations we observed three main phases of the peer tutoring experience, as reported in figure 4.1.2.2 below: *peer-to-peer teaching*, *peer review*, and *moderators' review*. These phases are not to be intended as separate discrete units, but as part of an iterative process.

First, in the peer-to-peer teaching, the peer tutor would show the other participants, the organisers and moderators, and the researchers his own work, explaining how he did it and how his peers could do something similar. In the meantime, the other participants would spontaneously raise their hands,

asking questions and providing feedback and constructive criticism of their peers' works in a process of peer reviews. The moderators would also intervene to facilitate the discussion, help the peer tutors explain themselves better, offer feedback and scaffold the whole experience. The process would then repeat itself, with the peer tutors continuing explain their projects and start asking questions to their peers for feedback, peers giving out feedback, and moderators providing support and suggestions. In this articulated and recursive exercise all members had the opportunity to work together, focusing on a problem and reflecting on it, fostering at one time a mutual symmetrical and asymmetrical relationship, where everybody got a change to share their differentiated skills and knowledge about the topic being discussed.

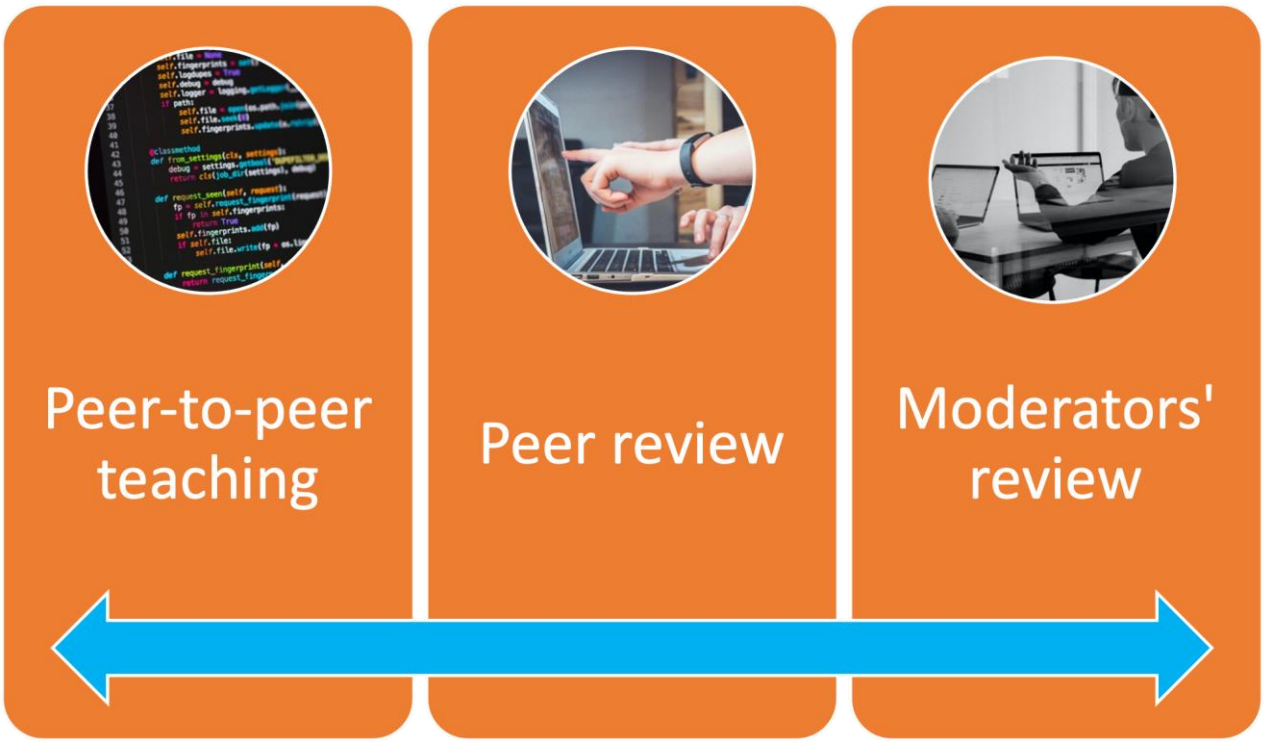


Fig. 4.1.2.2 - A peer tutoring experience: three interconnected phases

Below we report on some examples of the two presentations highlighting the three interconnected phases of peer-to-peer teaching, peer review, and moderators' review that recursively shaped this peer tutoring experience.

- *Creating a website: the experience of a twelve-year-old*

Vittorio (fantasy name), a geek twelve-year-old, volunteered to present his own website (which was completely in English), where he defines himself as a "Java programmer" with a passion for videogames. He proudly shows his website to his peers, claiming that he created it because he wants to be a programmer and see this space as a first experiment to start moving in that direction. Using an articulated and professional jargon, he shows his peers the articulation of the website and its HTML code. The moderators intervene to invite him using a simpler language that everybody could understand, emphasising the importance of using practical examples to explain articulated things. He then goes on showing an anti-idle kick script he created himself, which in layman's terms is like an application that avoid a gamer to be "kicked out" of a game if he doesn't play for more than 20 minutes by simulating fictional inputs. When showing the code, the other participants ask him if they

can download it and he agrees, since it is open access. The participants then try to test the code themselves. One of them raises his hand to say that he would change something in the code to make the application more customisable. Specifically, he argues that the user should be able to decide even a different amount of time from that already set by the creator to simulate the fictional input (he suggested the time not be three seconds, but two). The peer tutor then explains that this is already doable. The moderators intervene again emphasising the importance of open-source materials, allowing the users to personalise the codes someone else prepared, in line with the underpinning philosophy of these laboratories according to which copying from others is a good and productive thing. They also show the group that even though their peer used a different programming language, this is only formally different from what they do with Scratch, and not substantially.

At the end of his presentations, the moderators and the rest of the room congratulate the boy for his effort. On his side, he immediately went on adjusting the code for his application, correcting some bugs that emerged during the presentation, and changing the time for the fictional input as suggested by his peer. Although this was not necessary because the code was open and the other members could do it themselves, the child showed he found the advice valuable to implement his product.

One of the moderators then sent the boy an intermediate HTML and CSS badge testifying the knowledge of and ability to use these languages as made evident from his presentation (Fig. 4.1.2.3)

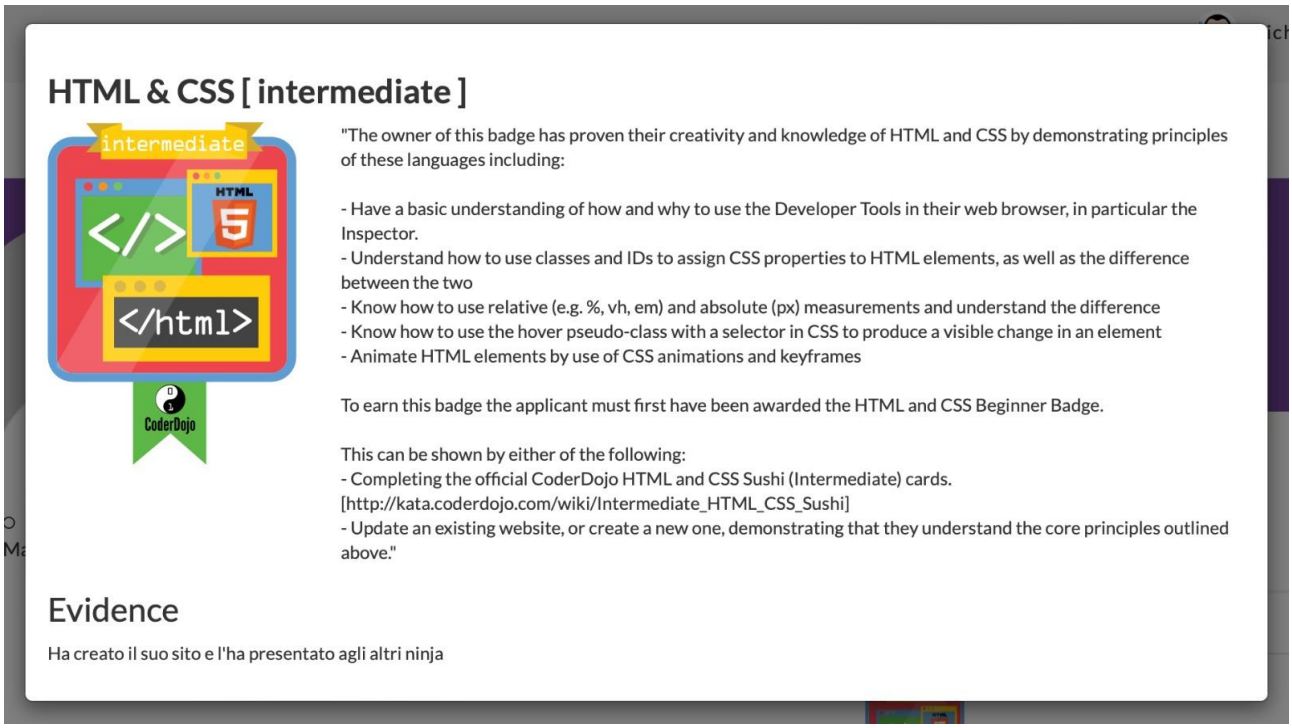


Figure 4.1.2.3 - HTML & CSS intermediate badge

- *Creating a videogame: the experience of an eight-year-old*

Francesco (fantasy name), an eight-year-old boy, presented his own videogame created with Scratch. The game has two main characters: a hedgehog and a pterodactyl. The aim of the game is to have the hedgehog defeat the flying pterodactyl by throwing apples at it. The game has been set up so that the gamer must totalise 50 points before winning. However, the number of points is assigned randomly every time the pterodactyl is hit, so the duration may vary. In this case, given also the younger age of

the child, one of the moderator sat close to him. The peer tutor showed the others the code he used and explained the rationale behind his choices. The other participants immediately noticed some bugs with respect to the flying speed of the pterodactyl, but also the problem that the boy himself raised concerning the random attribution of points. While he did not think that it would invalidate the whole game, he was still interested in knowing from his peers how to make it work better. The other participants suggested ways to do it, and another child also came up with an idea: to insert a timer indicating how much time the player has left to finish the game, otherwise he loses (features that was not present in the original code).

In this case it was interesting to notice that of the five other participants, two were the most active in helping out the boy: the 13-year-old who presented his work before, and a fifteen-year-old. The mentors also intervened to facilitate the discussion and give their own feedback and suggestions on how to improve the game.

Naturally following the same steps described before, in a circular process the child would teach his peers about how he created his game, the peers offered advice on how to adjust it, the moderators orchestrated the discussion and gave their feedback, and the child would continue again with his explanation welcoming the advice, explaining the rationale behind the choices he made (even when questioned by the other participants), and so forth.

After being congratulated by all the participants, the boy then received his own Scratch beginner badge certifying his skills and creativity by presenting his game and reflecting on its development (Fig. 4.1.2.4).

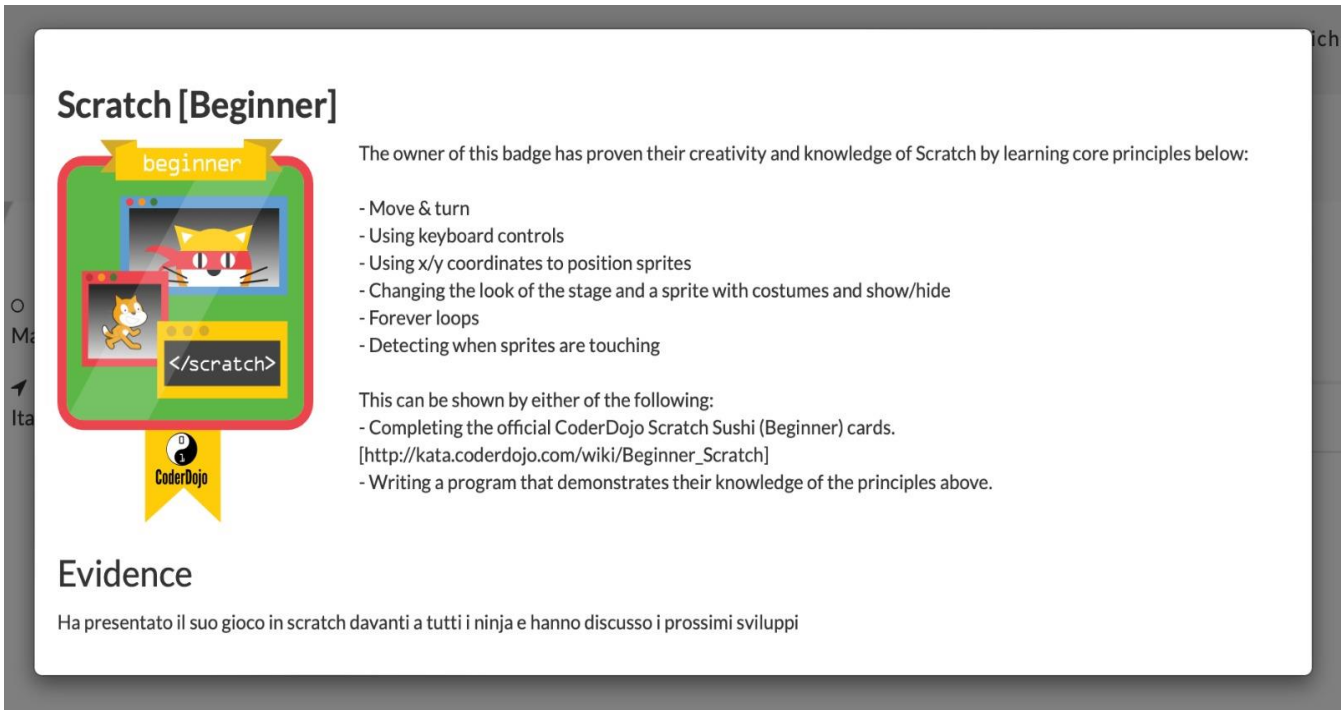


Fig. 4.1.2.4 - Scratch Beginner Badge

The workshop ended with the moderators thanking the two presenters and inviting the other participants to present their own works once the encounters will start again after summer.

Overall, this activity represented a first step towards implementing the curriculum of IT4 following what emerged from the children's consultation. It also allowed a redistribution of agency and power, with a less asymmetrical configuration in which children had the opportunity to both teach and learn something back from their peers, with the moderators acting as facilitators to orchestrate the process and provide feedback in turn.

We contend that this experience can be of help for these moderators but also educators in general in order to rethink their teaching styles towards a more flipped approach to learning, where children are treated as experts in their own rights who have something to say, fostering mutual reflections, collaboration, agency, but most of all metacognition with respect to one's digital skills and ways to improve them.

4.2 Technology and tools in Denmark

In terms of technology and tools for learning environments, it is not only important to acknowledge already established infrastructures in the learning environment, but also to make sure those infrastructures are flexible enough for adjustment when they work less optimally to avoid break-downs in the learning situations. An empirical example of the need for flexibility was how moderator A's (DK1 and DK2) intention and orchestration was highly supported by the room layout and physical materials, but not so much by the technology. The software environment for the technology was not designed for sharing between different groups. The participants physically gathered around one computer in order to collaborate with each other or to view code from different groups. How the workshop participants appropriated the pre-orchestrated setup of the spatial layout mostly aligned with the moderator's intention for participants to share and copy the physical materials and space as seen in DK1 and DK2. However, as this was not fully supported by the technology, this did not happen to the same degree with the digital materials.

Moderator B (DK4) had the intention of creating a learning situation where the task and tools would resemble that of a professional programmer. This came at the expense of the benefits of collaboration between participants and work towards a common outcome. With a digital outcome, such as a website, this is, however, not easily achievable as most tools are built for single use.

From the observations of programming workshops in the initial phase of the research, we found that there was a potential to also design the software for collaboration and for knowledge sharing. As Moderator A intended to facilitate copying and sharing between groups through the physical layout of activities, we decided together with Moderator A to develop a tool for teaching that enables the same with the digital materials.

However, collaborative production requires complex infrastructuring with, for instance, a shared web server, code repository, or tools for collaborative editing. For the co-design activities focused on technology and tools, we had the possibility to work together with moderator A (DK1&2), software developers and researchers in order to support moderator A's (DK1&2) needs for collaboration and knowledge sharing between groups in programming workshops in non-formal learning environments.

4.2.1 Tool and outcomes

In a two-month co-design process consisting of bi-weekly co-design workshops that included moderator A, the researchers, and a software developer, we prototyped a tool for teaching to better support moderator A's intention to also support sharing with the digital tools and not only the physical

setup. In the co-design workshops, we discussed and later tested different versions of the tool to develop further iterations.

The outcome of the co-design activities was a web-based tool that supports collaboration and sharing between groups in programming activities with the micro:bit. The tool consists of two main parts: an adapted version of MakeCode, the commonly used software for programming the micro:bit for the participants and a teacher's page that enables the moderator to administer groups and exercises and provides access to the groups' projects.

Student's page

The student's page consists of an adapted version of the MakeCode interface. The page is comprised of the normal MakeCode interface with the addition of an instruction view on the right side that contains instructions or additional information about the exercise authored by the moderator such as videos, images, and text. The participants can step forwards and backwards between the different steps in the exercise. Each step in the exercise is made up of the individual instructions on the side and prepared code and code blocks in the MakeCode interface. The moderator specifically wanted to try out preparing pre-selected coding blocks on the screen that the participants would have to assemble like a puzzle to create a functioning program. Additionally, participants can share code they implemented in a shared code library so that other groups and participants can access and reuse the code. The MakeCode interface is collaborative and can be modified by anyone that has access to the link.

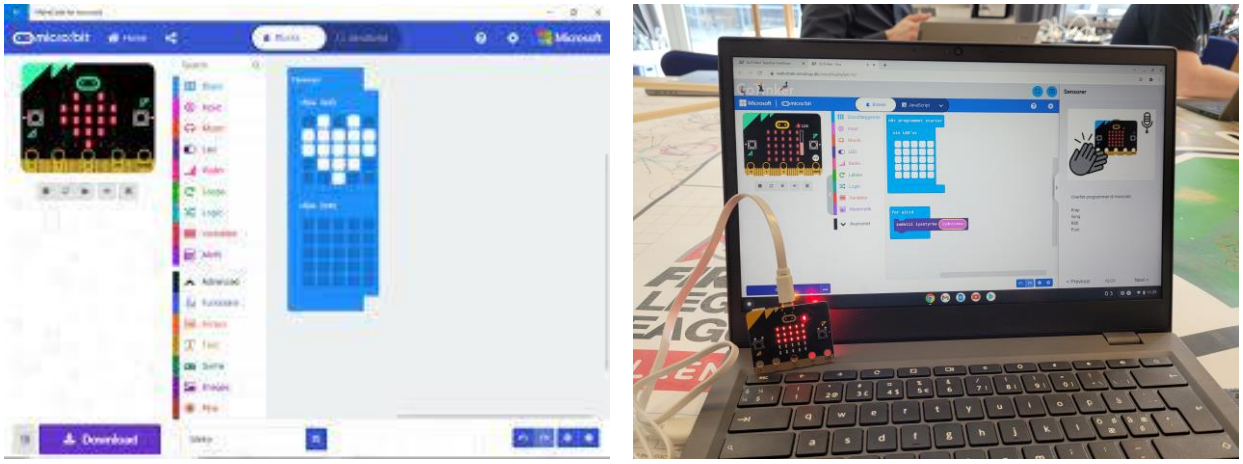


Figure 4.2.1. Left: screen shot of the original MakeCode from Microsoft. Right: CoTinker interface, with MakeCode included to the left, and teacher's instructions and code repository to the right.

Teacher's page

The teacher's page works as an overview for the moderator to manage the groups and the exercises. The moderator can create groups and access each of the group's MakeCode interface to share it on the projector with the rest of the class. For each of the groups, the moderator can see on which step of the exercise the groups are and also has the option to move all groups to the same step in the exercise at the same time.

To be able to work with the sensors of the micro:bit in a more collaborative way that includes all the groups, the moderator also has access to a sensor view that can display different sensor values of the micro:bits published by the individual groups on one shared page.

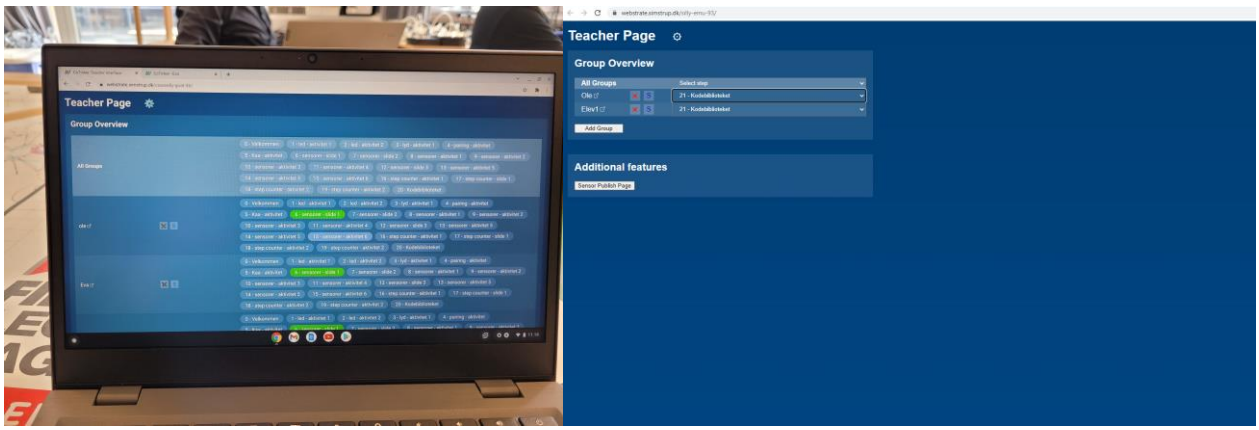


Figure 4.2.2. The teacher's page of CoTinker. For each group, it is possible for the moderator to see where they are, and what they are doing, and share their work. The teacher's page in action during a co-design workshop, right is a screenshot of the teacher page.

Exercises and teaching material

The moderator developed a number of exercises for the micro:bit and the tool we developed. The exercises all revolved around exploring the different sensors of the micro:bit such as sound, light, and accelerometer.

This included an exercise with the light panel and sound to create patterns on the micro:bit, exploring the sound sensor by visualizing a graph with the sound level over time, and creating a step counter with the accelerometer.

Pilot tests and future work

We piloted the tool that was developed in the co-design process in one workshop with the researchers and in another workshop with five high school teachers for the moderator to get didactic feedback. In further iterations one of the main points of feedback from the moderator was to create an authoring tool that would enable teachers to create their own exercises. In the current tool, the developer needs to implement the suggested exercises from the moderator which makes the development of exercises tedious, also with respect to enabling other people to use the tool and prepare their own teaching material.

In the workshop with high school teachers, the teachers were particularly interested in the possibility to add instructions to the student's page as this would minimize shifting between multiple applications at the same time as this can disturb the teaching flow and cause breakdowns.

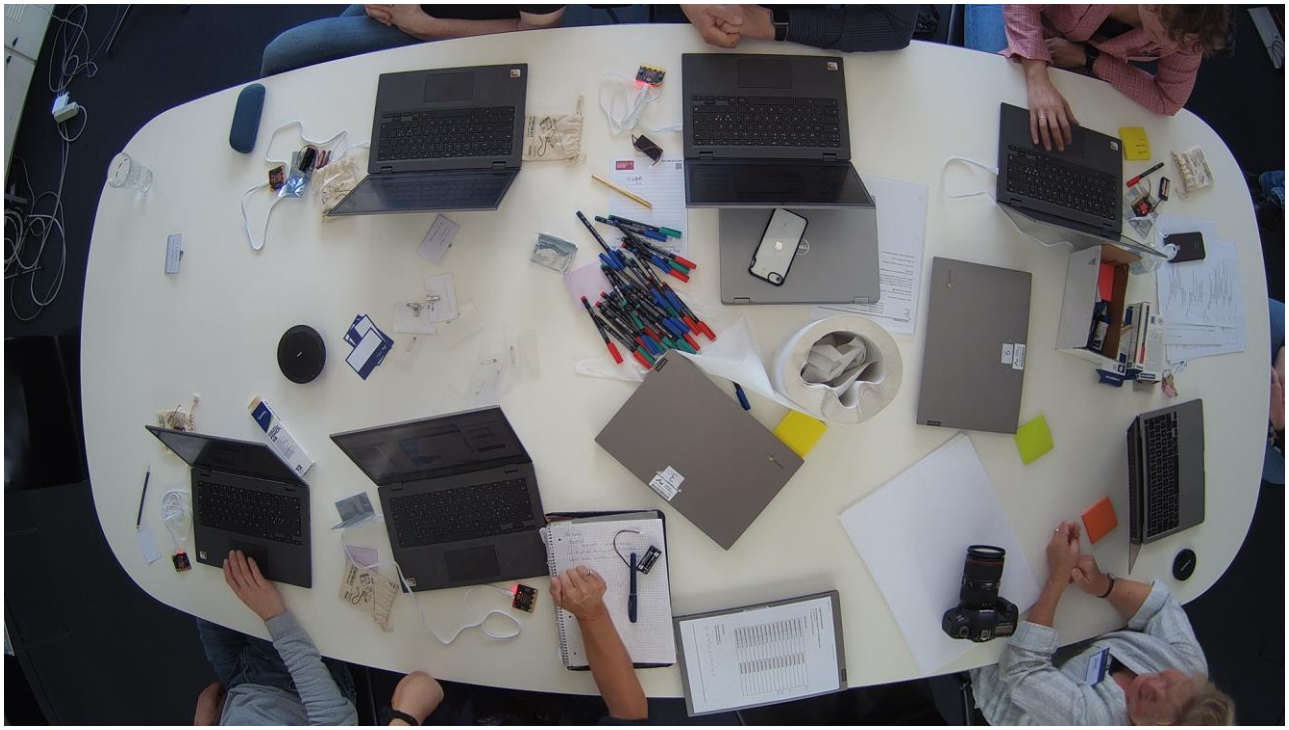


Figure 4.2.3. The workshop with high school teachers. Each of the teachers was trying out the tool together with the micro:bit while the moderator was giving instructions.

In our co-design process, we explored one way of enable sharing of digital materials between participants which we identified as an important aspect to support in workshops based on our previous observations and interviews. The tool has currently not been tested in a real workshop or teaching scenario, so further steps would include testing the tool and materials prepared by the moderator with children to draw more cohesive conclusions on how the tool would be appropriated in a workshop scenario.

4.3 Policy in Belgium

The Belgian researchers developed a co-design workshop during which children are stimulated to create their own non-formal learning activity related to digital skills. The goal of this co-design workshop is to find out what children want and need in activities to acquire digital skills and from there on to suggested evidence-informed policy recommendations.

The first co-design workshop was the BE5 session. At the intended starting hour, there were no children present. Eventually, the children started showing up one by one. This tardiness became an indicating factor for the entire workshop. The community centre where this co-design workshop took place, offers after-school activities without a strict structure. The children are allowed to come and go as they wish and they can choose which activities they want to join and when they would rather "chill out". During this co-design workshop, the children expected the same level of freedom. They walked in when they wanted and they sometimes left during sub-activities of the co-design workshop. Whenever they did not like a certain task, they either walked out or they would watch videos on YouTube or TikTok on their smartphones. Because of these expectations of the children, it was impossible to keep them focused on the co-design workshop for the entire duration of the session.

Approximately 20 minutes after the intended starting time, the workshop started. The researcher introduced herself and explained what the workshop would entail. The children could ask questions and were specifically interested in whether their input would have real impact. The children were enthusiastic and eager to start the session. The researcher had displayed all available crafts materials on a table prior to the session, and this seemed to spark the children's interest in the workshop.

Most of the children already knew each other, but since there were some newcomers, the researcher decided to play the introduction game with them. The children liked this a lot and asked to repeat the exercise a couple of times. Afterwards, the children were divided in two groups. They could choose their own group, which resulted in a group with only boys and a group with all the girls and one boy. In this report, we will refer to the former as the boys only group and to the latter as the mixed group. Since the organiser asked right before the start of the workshop to reduce the session from three to two hours, it was decided to not give the children any roles as this explanation would take away time from more important activities. However, it was indicated that children could ask the other team questions and that curiosity was encouraged.

The first sub-activity was the mapping of everything related to digital skills, technologies and activities that the children could think of. The children were encouraged to work together as a group, but most children started working on their own or in pairs. The boys only group showed interest in the extra questions in the envelopes, but the mixed group did not want to use these questions. Instead of writing on the large A3 papers as suggested, the mixed group started crafting. This resulted in a creative display of their answers. When asked to think about digital technologies, the mixed group answered: TikTok (3x), games, Netflix, hacking (2x), text messages, music, chatting (2x), famous, pressure, hate and abuse. The girl who wrote 'abuse' positioned this very central on a decorated paper with a crying face. When the researcher asked her what she meant with this, she indicated that children can be bullied online, especially in the comment section of TikTok. One girl made a drawing of the earth on a Styrofoam ball. She explained that this globe depicted the widespread use of social media.

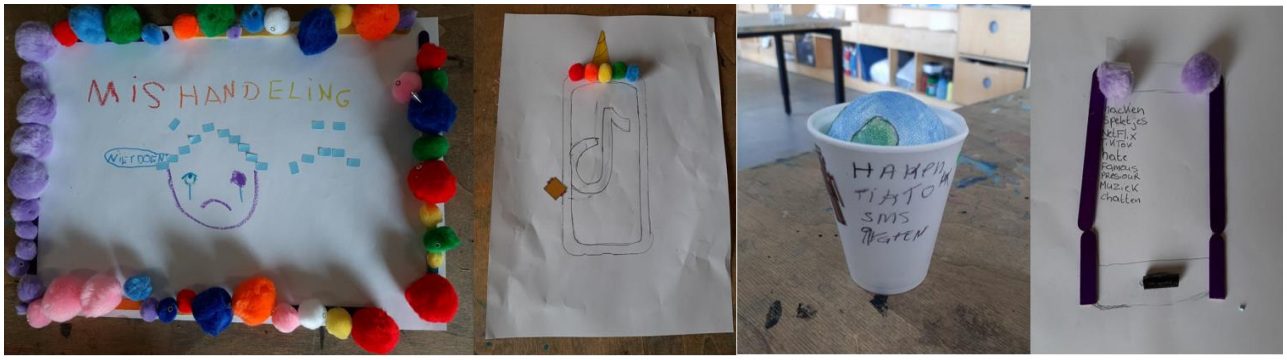


Figure 4.3.1: Mapping of digital skills and technologies – Mixed group BE5

The boys only group worked on the A3 papers and wrote down what they could think of. They also cut out icons and they glued the extra questions to the paper. When asked to think about digital technologies, the boys answered: PlayStation, television, smartphone (2x), Netflix, Amazon Prime, Stremio, games, game consoles, Nintendo Switch, computer (2x), headphones, Facebook, TikTok, Snapchat, Instagram, YouTube, computer mouse, USB stick with virus, watching TV and movies, organising your work, making money, learning to hack, hacking, making crash codes, scamming people, hacking accounts and selling them, and hacking online banks. Additionally, the boys group also glued some of the extra questions to their papers and answered them, resulting in repeating certain answers. These were their questions and answers:

- “What objects do you think of when it comes to digital technologies?”: computer
- “What do you need to know or be able to do in order to be able to work with digital technologies?”: learning to hack
- “What could you need digital technologies for?”: hacking
- “What do you need in order to use digital technologies?”: computer, USB

When asked why they focused a lot on hacking, the boys replied that this seemed fun to them and an easy way to become rich.

After this activity, the researcher introduced the new organisation “Digikids” of which the children could be the ‘boss’ and create their own activity. The researcher showed them the visuals of the social media accounts of Digikids. Then, the researcher explained how the personas work and read out loud the information on these personas. The groups could choose which persona they wanted to work with. The boys group chose Maxime, a high-SES persona. The mixed group chose Sam, which is an upper-middle class persona. Nora, the low-SES persona, was not chosen even though this persona resembled the SES of the participating children. The children could choose the gender of their persona. Maxime quickly became a boy, and Sam became a girl to all members of the mixed group, except for one girl who thought Sam was a boy. The mixed group afterwards joked about Sam being transgender. The children clearly had difficulties with empathising with the personas. The boys only group did not try to fill in the social media profile of Maxime and only jokingly changed the number of followers to 10 million. One boy filled in the friendship book in a serious way. He answered for example that Maxime’s biggest wish is to become a multibillionaire so that he can donate money to the poor and that if he could shop one minute for free, he would go to MediaMarkt (a Belgian technology store). The boy answered that Maxime wants to become a hacker. The other boy did not take the task serious, answering things as “my favourite subject in school is hitting children”, “my favourite hobby is dying” and “I am 100 years old”. The mixed team took the task serious, but struggled with it and barely answered anything. They indicated that Sam wants to become a doctor and would go live by herself if she would win one million dollars. One girl made some drawings of a dog and a sister on the social media profile page. During this activity, the children’s attention decreased. Some children started running around and others started watching videos or TikToks on their smartphone.

The second part of this activity questioned what the children wanted their personas to know, feel and be able to do such that the invented activity would suit the persona. In the boys only team, only one boy continued with this activity. On the paper with the brain, he wrote that he wants Maxime to know how to hack. He also wrote “computer, USB, setup, making smart plans”. On the paper with the muscular arm, indicating the skills the persona needs to acquire, the boy wrote: “hacking, planning, brain, computer, smartphone, tablet”. When asked how he wanted Maxime to feel, he only answered “happy”. The boy filled all of this in in about a minute, clearly trying to finish as fast as possible. After finishing this task, he joined the other boys that were running around. The mixed group indicated that they want Sam to know the difference between fake and real, how to be safe online, how to make movies and anime and how to hack. They also wrote down the words “smart”, “stupid” and “help”, but they could afterwards not explain why they had written this. On the page with the muscular arm that symbolised the necessary skills, the mixed group wrote: “TikTok influencer, being able to film well, good quality, being funny, good talents, super smart, hacking, programming, being good with computers, and intelligent”. They wanted Sam to feel happy. As the children became noisy and inattentive, the researcher decided to give them a small break. After the break, the children unfortunately were not able to provide answers as to why they had written certain answers.
Since the organiser asked to shorten the workshop, the researcher decided to group the activities after the break due to time restrictions. The children could design their tool and make the time schedule at

the same time. The researcher also made the children aware that there would be a presentation moment later. The boys only team made a timeline for an activity that lasts between 09:15 and 16:15. In the morning, the boys planned 'taking over accounts' and 'making viruses' as activities. After the lunch break, they planned 'selling USBs with viruses' and 'selling accounts'. The boys indicated that they do not need or want to invent a new tool for their activity, so they drew a computer and a USB stick instead. The mixed team made a week schedule. They indicated that Sam goes to dance class on Monday after school and has computer class on Tuesday between 16:00 and 18:15 and on Friday between 15:00 and 17:00. On Thursday, Sam practices for a computer test and on Wednesday, Saturday and Sunday, Sam has nothing planned. The mixed group thus called their Digikids activity a "computer class" and it should occur twice a week according to them. They indicated that this class lasts two hours and the participants learn how to hack. They also did not want to craft a tool, so they simply wrote down that a computer and smartphone are needed for the activity.

The co-design workshop ended with a presentation moment. Since the children were not able to present their ideas in a coherent way that made it clear for the other group, this became more a sort of Q&A session during which the researcher asked questions about what the groups had done. The researcher also encouraged the other children to ask questions. When the boys only group explained that they wanted to create an activity in which they hack accounts and sell them, the mixed team asked them why they wanted to hack. One girl even said that hacking was bad and reacted disapprovingly, even though the mixed group also created a hacking activity. This discrepancy was later clarified. One of the boys of the boys only group responded that by being able to hack, you can sell accounts and make money. The girls in the mixed group then wanted to know what kind of accounts would be hacked. The boys group clearly had not thought about this before, but then answered hesitatingly that they would hack PlayStation and Roblox accounts. When one of the boys answered that Maxime learned how to hack from his father when his mother wasn't home, this caused some commotion and the children became distracted. The children seemed to find it very funny that a child would learn this from a parent. After resuming the Q&A, the researcher asked the mixed team whether Sam and Nora would like the hacking activity that was created by the boys only team. The girls responded that Sam is a sweet person and therefore would not like the activity. The group couldn't answer if Nora would like it or not. The boys didn't think about how they would provide the necessary materials. They acknowledged that their activity wasn't accessible to children without their own computer, but they did not anticipate a solution.

During the presentation of the mixed group, they explained the week schedule of Sam and the computer class they created. Although they previously decided that they would teach how to hack, they now framed it as learning how hacking happens so that children learn to protect themselves against hackers. It seemed as if they realised now that expressing their disapproval of the hacking activity of the boys only team made their own activity choice seem hypocritical. The mixed group now decided to learn how to hack in an ethically responsible way. During the Digikids activity, participants would learn how to use and fix a computer and how to remove viruses. The boys only group indicated that Nora and Maxime would like this activity. When someone asked whether Sam was a boy or girl, the response was made that Sam is transgender which led to hilarity and uproar in the boys only group. As the attention of the children was fading, the researcher tried to quickly ask them what they thought children in general would need to improve their digital skills. The children indicated they want better and free WiFi and that each child needs its own laptop to make homework, especially once children go to high school. The children repeated their strong wish to learn how to hack, either to earn money or to protect themselves. After this, children started going home and left the room abruptly.

After the co-design workshop, the organiser told us that the children did not express their own ideas or wishes. The children were allowed to choose their own persona, and they chose the high SES and upper-middle class SES personas. The organiser phrased it like this: *These children are rarely questioned in studies like these. Now they finally get the chance to express what they want, but they imagine being someone that is high SES. Now they still haven't told you what they want, they have told you what Maxime and Sam want. (BE5, organiser)* As this remark hit home, it was decided to change the research protocol as to not make the same mistake again. The personas were used with the goal of letting the children focus on different needs and wishes, but it backfired in not prioritizing the perspectives of low SES children. The researchers therefore decided to no longer work with personas in the next co-design workshop.

The second co-design workshop (BE6) was organised in collaboration with a community centre that provides after-school activities to children who live in a disadvantaged neighbourhood. Upon arrival of the researcher, no children were present. The local organiser had to go find the participating children as they were still playing outside. This caused the workshop to be delayed and we had to shorten the length of the workshop from 3 hours to 2 hours. Since the organiser did not keep in mind the mutually prearranged age restrictions of the study, 9 children participated of which only 3 children were eligible for participation. The other 6 children were allowed to join, but their responses were not reported.

After the researcher introduced herself and the study and after she gave the children the possibility to ask questions, the workshop started. Since all children knew each other prior to the workshop and due to time restrictions, the introduction games were skipped. The different roles were also not applied during this co-design workshop, but the children were encouraged to ask questions. During the mapping exercise, the children wrote and drew on A3 papers what they could think of when asked about digital technologies. Since the drawings weren't always clear, the researcher asked for clarification. The children gave the following answers: bitcoin, television, games, Apple, 5G, WiFi, crypto, computer chips, Facebook, e-mail, viruses, websites, phones, Nintendo Switch, Samsung, gift cards, hashtags, Roblox, music boxes, computers, consoles, PlayStation, Instagram, social media, computer mouse, keyboard, monitor, microphone, apps, YouTube, Snapchat, Tesla, iPhone, smartwatch, Fortnite, Minecraft, Google, voice chat, a like button, hacking, programming, and coding. When another child asked how they knew so many things, one boy answered that he had a lot of time to think about it.

Next, the researcher explained to the children that a new organisation called "Digikids" was created and that they could be "the boss" and invent the activities and tools for the organisation. The personas were no longer used during this co-design workshop. Since the six children that were not eligible for the study had by now stopped participating in the workshop, it was observed that the three boys also lost their focus and attention. Therefore, the researcher decided to focus on the most important subtasks. The boys decided to invent an activity that happens on Wednesday afternoon after school and during school holidays that starts at 12:00 and ends at 16:30, with a break at 14:15. The activity would focus on computer skills and therefore the children crafted a computer. When they were done with crafting, the boys wanted to quit the activity. The researcher invited them to quickly explain first what they had crafted before leaving the co-design workshop. The boys answered this: *It is a gaming computer for children who would like to game but that are afraid of viruses. It's an extremely secured computer that is really safe and easy to use for children. You only need a few cables and a mouse and you receive the computer like this in the box. You only have to press one button to start. The keyboard is also super easy and good and soft for your fingers. There is a manual for children so that they can know, if they want to game, which letters they have to use and what the buttons do. The computer is*

not free, but we want to make it cheap because it really comes in handy for children. (BE6, participant) When asked if children need their own computer to participate in the Digikids activity, they replied: *No, they don't need to have it. But if they would like to game a lot or become an influencer, then yes... They would need it. But if you don't have much money, we can sell it to you for €50 if you have parents with financial problems. Or you can rent it. But if you have enough money, it costs €250. (BE6, participant)* Without the instructions of the researcher, the children immediately thought of payment issues and ways to make sure that the computer was accessible to all children. By focusing on making it impossible to have viruses, the children paid lots of attention to safety. After this explanation, the children wanted to quit and the co-design workshop quickly came to an end.

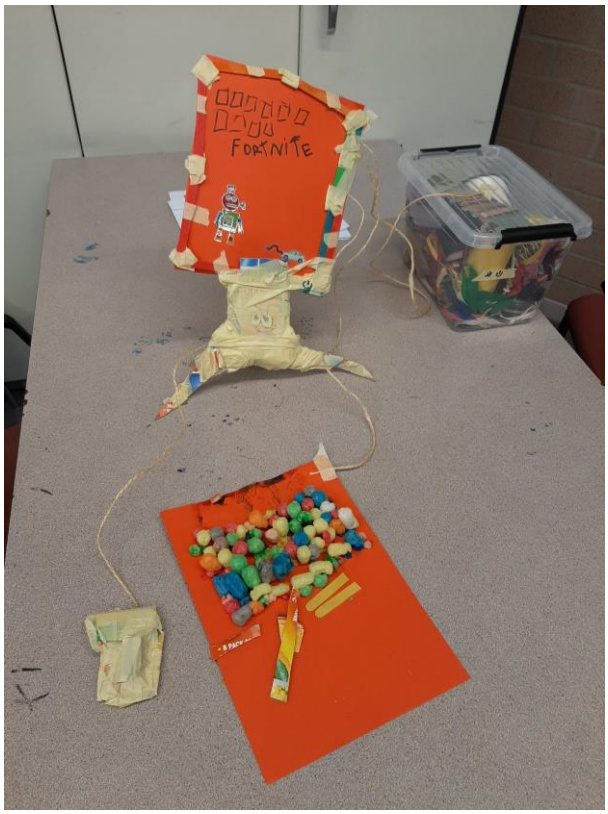


Figure 4.3.2: Designed technology - BE6

Through our co-design sessions, we learned that for organisers and policymakers it is important to understand that an inclusive format in the context of non-formal learning is one with many degrees of freedom for the child. That is, it should be an accessible format where one can quickly 'get in and out', where there are not too many structural dependencies in the sequence of activities. There must be room for slowness, but also speed when activities succeed each other quickly and when both the more learning-oriented activities as conceived and facilitated by the moderators alternate with relaxation and play that the young people themselves choose. There must be a space for a programme, but also an openness to serendipity. It is also important for organisers and policymakers to keep social goals in mind alongside the learning goals, as they reinforce each other. For example, it is important to take time for the young people to get to know each other, before they can be expected to suddenly work together nicely on a learning project. One cannot simply skip the time and energy one has to put into these social activities, and it is especially important if young people are joining for the first time or do not know each other yet. In terms of content, it is interesting if the digital competences that are acquired are close to the needs and interests of young people. For example, it is important for

low-SES young people to know how to repair computers, deal with viruses - assuming that they often have to work with inferior hardware and software-, but they also benefit from reflections on how to use these skills in a world in which they hope and dream to acquire skills to achieve 'quick wins', such as hacking or being an influencer in order to earn money quickly. Our advice for policy recommendations and to the organisers and moderators of such workshops is therefore to allow a certain open-endedness, so that children can appropriate and fill in the projects in the light of their own future selves.

Additionally, policymakers should focus on prioritizing extensive collaboration between the organiser and external stakeholders. The organisation should become embedded in the social fabric of the city and/or youth work since this improves the learning activities. When an external stakeholder such as the city provides infrastructure such as rooms and materials, the activity becomes accessible since the participation cost is reduced and the location becomes more approachable. More available resources and materials also keep the children interested and motivated to attend activities. Cities that own materials can also lend these to local schools, which stimulates visibility of the offered activities and workshops. Participating in non-formal learning activities about digital skills should ideally be offered for free, on an accessible location and with materials provided by the organisation or an external stakeholder. Furthermore, appointing a staff member of the city to follow-up the activities, improves the collaboration with organisers and makes the activity more accessible. This appointed staff member can especially focus on reaching the predetermined target group and promoting the activity. The collaboration between organiser and stakeholders is therefore crucial to assure inclusion and accessibility.

4.4 Conclusions

With a different focus on teaching, tools or policy, the three co-design activities were all child-centred: including children's voices directly or indirectly, as mediated by moderators and organisers, as during the co-design workshops in Denmark.

When children were given direct voice, such as in the co-design workshops held in Belgium and Italy, they engaged in future talk, imagining ways to apply their programming skills to everyday life contexts. Italian children seemed to adhere more closely to the dominant social construction of programming skills as a requirement for a successful inclusion in their labour market (a finding mirroring English children's entrepreneurial motivation to attend the summer camp DigiCamp to learn designing and programming games, as in the words of its founder reported in Livingstone & Blum-Ross, 2020). This is not surprising, given that the children and young people participating in the co-design activity in Italy are participants of the local CoderDojo. In fact, they reported attending CoderDojo's session to pursue a career in IT, as software and/or game developers. Conversely, the children and young people involved in the co-design sessions in Belgium were attendants of youth centres located in socially deprived areas or aimed at more vulnerable children. Accordingly, they envisioned different future scenarios, where digital skills acquisition and practices are associated with online safety and security (e.g., learning how to protect the computer from viruses). Several Belgian children also hinted upon their future professional role and the importance of the acquisition of digital skills for economic reasons, but they did not echo the dominant discourses and rather reflected non-traditional roles and competencies, such as becoming an influencer, the importance of hacking and repairing. Together, findings from the co-design sessions held in Belgium and Italy corroborate a finding of the observation phase: namely, that digital skills learning and practices need to be adapted to children and young people's lived experiences and everyday contexts. The findings of the co-design

sessions in Denmark point in a similar direction, suggesting that the digital learning environment should be designed in relation to, and adapted to the digital skills practices of children and young people.

More specifically, in terms of the teaching style, the Italian case study has shown that giving children a voice would help moderators of digital skills initiative in non-formal settings, and educational practitioners more generally, learn about the educational experience of children and how to adjust their teaching style accordingly. For example, if organiser and moderators aim to engage a diverse range of children in terms of age, gender and socio-economic background, involving children in peer-mentoring, or designing different programming paths centred on different software and programming languages could be solutions to render the workshop suitable for both newbies and more advanced programmers. Flexible and child-centred workshop structures, along with child-centred teaching style, would allow diverse children and young people to be included in programming and robotics workshops.

Moreover, the Danish case study has shown the importance of tools and software in shaping children's and young people's digital skills learning and practices. Indeed, most digital learning environments are not designed to foster collaboration among the participants. Therefore, moderators' and organisers' attempts to design a collaborative learning experience through the material organisation of space and the structuring of the activities assigned to the participants are compromised by the lack of supporting digital tools. Working with a moderator and software engineers, the Danish team managed to extend the CoTinker web-based framework to support moderators' needs for collaboration and knowledge sharing between groups in programming workshops in non-formal learning environments.

Finally, the Belgian case study also points to the value of promoting child-centred digital skills initiatives: more specifically, an inclusive format entails different degrees of freedom for children, avoiding too many structural dependencies in the sequence of activities so that children can step in and out of the activity at their own pace. Balancing social and learning goals is also important, in order to help children familiarise with each other, the context and the activity itself. Moreover, findings from the co-design sessions conducted by the Belgian team also emphasise that opportunity for organisers of digital skills initiative to cooperate more extensively with various stakeholders in order to improve the accessibility and the inclusivity of digital skills workshops.

5 Concluding remarks

In this report, we have presented the findings of our research activities examining children's digital skills practices in non-formal learning contexts. In what follows, we briefly list the most important findings and recommendations for research, policy, and practice.

Digital skills

Most workshop are informed by a narrow definition of programming digital skills as an individual achievement, which is intrinsically beneficial for children and young people. While children themselves may have appropriated the dominant discourse on programming skills as a gateway to the labour market, this framework is a barrier for many children and young people.

To foster the inclusivity of programming digital skills workshops in non-formal learning contexts, it is crucial that the digital skills practices are close to children's and young people's interests and needs. Children —especially those from under-represented groups, including girls and children from lower socioeconomic status— should be given a voice in the design of programming digital skills workshops, so that they can participate in activities that are suited to their own lived experiences and future talk.

Teaching style and workshop format

One-fits-all solutions and "open doors" workshops that aim to include a diverse range of children and young people often fail in their goal. More tailored approaches, designed to meet the needs and experiences of specific groups of children and young people, are more successful provided that the degree of formality is also flexible. More specifically, we have observed that vulnerable children and young people are more likely to participate when the workshop structure leaves degrees of freedom for the child to enter and leave an activity at their own pace.

Child-centred teaching styles, that adapt digital skills practices to children's and young people's own interests, competencies, and experiences, are also a way to ensure more inclusive and engaging non-formal learning environments.

Equally important is the re-framing of digital skills as a social accomplishment, rather than an individual achievement. Our observations and co-design sessions suggested multiple complimentary strategies to achieve this goal. Focusing on the teaching style, we have observed how child-led activities and peer mentoring can indeed support digital skills acquisition as a social practice. Organisers and moderators should not think of learning goals as independent from, and even conflicting with, social goals: rather, learning and social goals complement and reinforce each other. Organisers and moderators should aim at a balance between spontaneous and more guided interactions among children, child-led and moderator-led activities, formality and flexibility of the workshop structure.

Tools and digital learning environment

Collaborative activities can represent the means to counter the dominant understanding of programming skills as an individual achievement, foster inclusivity and integrate learning and social goals. Yet, collaboration among children is often hindered by the digital learning environment and

tools, which compromise organisers' and moderators' strategies to foster collaboration through teaching style, activity structure and material organisation of the space. Conversely, in order to design situationally appropriate learning technologies and activities that integrate with current practices, it is important to understand the implicit and explicit social and material structures that constitute the activities and interactions with technologies.

Therefore, designing collaborative digital learning environments and tools is a crucial step towards inclusivity.

Policymakers, practitioners and researchers

A further critical aspect we observed is the need for more systematic and regular collaboration between different stakeholders —organisers and moderators, policymakers and local authorities, researchers, children, and parents to ensure more inclusive digital skills practices in non-formal learning contexts. We would recommend stakeholders engage in co-design practices, to organise programming digital skills initiatives that are centred on children's and young people's interests, competences, experiences and (future) needs.

Acknowledgements

The authors thank the reviewers for their critical reading and useful suggestions that helped improve and clarify this report.

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Appendices

1 Appendix 1: Observation protocol

Activity (Date, Time, Place)

Description of the Activity:

What to look for	Guiding questions	NOTES
Space and tools	• How is the space organised? • What kind of equipment are children provided with? • Does the space allow for children to cooperate? • Are there barriers and/or facilitators to children's participation?	

Children	• How do children approach the tasks? • Do they work autonomously or in group? • Is there a team leader? Do children take on a specific role? • Do children look involved in the tasks? • Do children look like they are having fun? • Do children ask for teachers' support and help?	

Moderators	• How do teachers interact with children? • What teaching style do they adopt? (e.g. cooperative, traditional, practical etc.) • Do teachers interact equally with all students or more with someone in particular, and if so why does this seem to be the case? (E.g. so not to leave a specific child behind, etc.) • Do teachers look like they're enjoying the task?	
Procedure	How is the activity structured? What's the order of activities? How long do they take? What are the different sub-activities? How many children and how many teachers are there?	

Participation	Do power differences exist between participants? Have the power differences ben deliberately negotiated? • Who makes decisions? Why? • Do all participants understand reasons for decisions? • Are there occasions for all participants for critical reflection on the process and the outcomes? • Are there occasions for evaluation for all participants, on both individual level as well as on group level?	
Competences	What kind of responsibility children have / do not have? Why? • Who defines the goals for the activity? Are children allowed to take part in defining the goals? Why/ why not? • Do all participants understand the goals? • Do children have all information they need? How can they get it? • Does everybody get a chance to contribute? Do all participants listen to each other? • Do children's activities have real impact? • Do children learn something? Does this learning build on top of previous knowledge/competences? • Does the work process support children to initiate future projects by themselves? • Does the project result in tangible outcomes?	

Other	Anything else worth noting	

2 Appendix 2: Interview guide

Equipment needed:

- Audio recorder
- Informed consent
- Observation field notes (as stimuli)
- Pen and paper/computer

Topic	Questions
Introduction	Introduce yourself and other researchers (if any). Thank the participant for their time. Ask them if they have any questions.
Start of the interview	Is it okay if I turn on the audio recorder?
Role of the actor in the context and goals/philosophy of the activity/ies	Ask questions about what the role of the interviewee in the context of this specific educational activity is, e.g.: • How would you define your role? • What types of activities do you generally carry out with children? • What target do you want to reach and why? • Why do you believe these activities are relevant? What are you trying to accomplish? • Are there other areas you think should be covered when teaching children digital skills? If so, what, and why? • Other
Questions about children's background	Ask questions to gather information about children who generally attended these courses: • Can you tell me about the gender and age balance of children participating in these activities? • Do you have any idea about their socio-economic background? • How involved are parents in their children's participation to these activities? • Do parents report particular reasons for having their children participate to these activities and do they have particular expectations? • Other
Questions about children's participation and digital skills	• How would you describe children's participation to the activities? • Do they tend to work mostly on their own or to ask for their peers' support? • Are these children familiar with technology in general? • And are they familiar with the type of activities you propose? • How good do you feel children are at using technology? • How often are you asked for help and what kind of requests do children have? • Do you see any improvement or change in their technology use or confidence after your activities? • Have you ever noticed any difference between children according to their age or gender?

	• Have you ever noticed any difference between children who appear to be more digitally skilled than others?
Activities and space	• How, if at all, do you organize the space where the activity takes place? • Is there a rationale behind space organization? If so, what? • What about the objects used during the activities? How do you choose what to use and why? • What kind of practical implications do you believe these activities may have for children in their daily life and in the future? • Do unexpected events ever take place that makes you adjust the activities? If so, could you provide some examples? • Are children ever involved in the choice of activities or in the direction to take?
Questions on things observed	Ask situational questions based on what you observed during the activity. These questions may also be asked at the beginning of the interview to break the ice. You can also use occurrences you observed to provide examples or back questions during the previous (or following) phases of the interview.
Anything else?	• Is there anything else you'd like to give your opinion on or that I forgot to ask a question about?
Concluding the interview	Thank the participant. Emphasize the confidentiality of the information given. Clarify that the participant may also contact the researcher afterwards in case of further questions.

3 Appendix 3: Observation procedures by country

Observations in Belgium

The Belgian team of researchers conducted four observations across Flanders, the Dutch-speaking region of Belgium.

Due to the COVID-19 restrictions, all observed workshops were postponed and took place in February 2022. The workshops lasted between two and three hours.

We observed four local sections of CoderDojo Belgium, which is an organisation that aims to organise free programming workshops for children aged 7 to 18 years on a regular basis. CoderDojo Belgium was founded in 2013 in collaboration with Telenet, a cable broadband services provider. Telenet now still provides second-hand laptops for each regional CoderDojo section. This means that every section has a certain number of laptops at its disposal that can be used by children that are not able to bring their own device. CoderDojo Belgium aims to make their sessions accessible to all by providing laptops and free participation.

Two CoderDojo workshops took place in a building owned by the municipality, one of which was in a rural area *(BE1)* and the other in the suburbs of a big city *(BE4)*. Workshop 'BE4' was a CoderDojo4All workshop, which is a special section of CoderDojo Belgium that focuses on inclusion by targeting underprivileged low socio-economic and/or immigrant youths.All participating children in that workshop had an immigrant background. The two other workshops took place in the city centre, one in a library *(BE3)* and the other in a science and technology museum for children *(BE2)*.

The parents and children were informed in advance of the researchers' presence during the workshop. Both the parents and children received an information letter with the aims of Task 6.1 of the ySKILLS project and signed an informed consent, in which they gave permission to observe the children during the workshop. The informed consent could be sent via e-mail to the researchers prior to the session, or it could be signed on paper on the day itself before the start of the observation.

During the observations, the researchers collected field notes without interacting with the participants. However, sometimes the children themselves came to show something or ask questions to the researchers. The researchers filled in the observation grid that can be found in **Appendix 1**. The organisers of the workshops were sometimes asked for clarifications, but the activity was never interrupted by the researcher's presence or activities. The field notes that were taken during the observation were later analysed according to the common coding scheme.

Observations in Denmark

The Danish team of researchers conducted observations in a total of nine workshops on programming for children and adolescents in non-formal learning contexts in East Jutland.

Two of the workshops, were organised only once, DK2 and DK3. These two workshops took place at the University during the autumn holiday and were part of a larger 'IT camp for girls', organised by the computer science department at the university, for high school girls who might be interested in studying IT at the University in the future.

The DK1 activity was a series of five workshops wherein the same children participated each time. It took place during evenings in a university lab but was organised by an external organisation named Co-coders. The Co-coders college – DK4 workshop was a workshop series that toured around in various high schools in the East Jutland area in Denmark. The workshops took place in various high schools after school hours. The researchers observed two of these workshops in two different cities. Both DK1 and Co-coders college – DK4 workshops were organised by Co-coders, an organisation devoted to increasing interest for programming and new technology. Co-coders started in 2017 with organising programming courses for women but has since then expanded as to target group and type of activities, however still with a focus on increasing interest for and competences in programming.

All of the nine workshops were attended on a voluntary basis, free of charge, and with some cake or sandwiches provided. The workshop participants were recruited by the organisers.

The participants, and for the younger children also their parents, were informed about the researcher's presence for doing observations, about the type of data collected, and for what purpose. This information had previously been sent to the organisers, and for the DK4 workshops an informed consent letter was shared with the responsible at the high schools by the organisers.

During the observation, one or two researchers were present and collected field notes without interacting with the participants. Researchers filled in the observation grid for each dimension in the observation grid as relevant. When possible, the researchers had informal conversations with the facilitator before, after, or in the breaks of the workshop to clarify the plan, if anything was unclear, and for short reflections of the workshop.

Observations in Italy

The Italian team of researchers conducted three observation sessions. The selection of the workshops was highly conditioned by the COVID-19 restrictions in place. For example, while the researchers had already started a collaboration with a network of public libraries in a town in Lombardy, all of their digital education activities, including programming and robotics workshops, had been suspended. Similarly, (usually expensive) activities organised by for profit FabLabs and Makerspaces, or activities organised by associations aimed at promoting digital skills in disadvantaged areas, were postponed or cancelled.

All the workshops observed were free of cost, but the location (a public library, a youth club and the campus of a business school) and the area (town in a metropolitan area/middle city/–large city respectively) allowed for some variations in the background of attending children.

Parents and children were informed about the presence of the researchers during the workshop by the organisers, who shared an invitation letter and the informed consent form to all registered children. The invitation letter explained the aims of the ySKILLS project and Task 6.1 in particular, informed parents of the scope and nature of the observations and provided the contact of researchers for further information. Additional information was provided directly by researchers before the workshop, when parents accompanied their children. Informed consent forms were either returned in a digital copy through organisers or signed on a paper copy by parents before the workshop.

During the observation, the researcher collected field notes without interacting with participants. Particular attention was paid to the epistemic dimensions outlined in **Appendix 1**. Researchers filled

in the observation grid for each dimension as relevant, adopting a descriptive/interpretive approach (Denzin & Lincoln, 2000). Occasionally, researchers would interact with the workshops' moderators in quiet moments if some clarification was needed or to get some information about children's background, without disrupting the activity.

4 Appendix 4: Interview procedures by country

Interviews in Belgium

All participants in the Belgian interviews received an information letter and informed consent prior to the interview. The informed consent was either given by sending the signed form via e-mail or by giving consent orally and having this consent audio recorded.

The interviews lasted between 15 and 45 minutes, were audio recorded and later transcribed and analysed using the coding scheme.

In three cases, BE1, BE2 and BE3, the interview with the organisers was conducted online via Skype for Business within two weeks after the observed workshop. In general, the interviewed organisers knew about the practical details such as registrations and had considerable experience with CoderDojo. The interview with the organiser of the CoderDojo workshop in the science and technology museum (BE2) was carried out with the lead coach (the main organiser) even though this coach was not present during the observation due to being quarantined with COVID-19. Although this coach could therefore not provide answers about the observed workshop, the interview with this coach did provide a lot of useful information about the organisation of CoderDojo workshops in general.

As for BE4, the interview was conducted face-to-face immediately after the observation. Since the organiser was unavailable, this last interview was conducted with a volunteer of the BE4 workshop who was not aware of the practical organisation of the activity. The latter organiser did not speak Dutch as a native language but wanted to give it a try. However, after a while we had to switch to English because the language barrier was too big. As his understanding of the English language was also rather limited, this last interview was cut short. Therefore, there will be a limited number of citations from the BE4 interview in the discussion of the results.

Interviews in Denmark

Two of the organisers were recruited for semi-structured interviews by one of the researchers. One organiser (A) was responsible for six of the workshops; five workshops of DK1 and one with DK2. The second organiser (B) was responsible for the series of DK4 workshops which was observed twice in different cities (see **Appendix 3**). The third responsible organiser (DK3) was invited but was not able to participate in an interview.

The two conducted interviews took around 60-100 minutes, were audio recorded, and later transcribed for analysis. One interview was conducted face-to-face, the other online over Zoom. The interviews took place around three weeks after the observed events and were conducted in English as the interviewer was not a native speaker.

Interviews in Italy

The initial contact with organisers of programming initiatives, which were already highly informative for the researchers, were followed up by interviews conducted online within two weeks from the observation of each workshop.

All the three organisers interviewed belong to CoderDojo (even though the Lego WeDo activity-IT3-observed was not organised by CoderDojo but by another youth centre as part of the International Children's Day events). These organisers also served as moderators.

Additionally, we also interviewed two moderators of the two first observed workshops (IT1 and IT2, see **Appendix 3**), selected based on their specific role in the activity.

For the third workshop (IT3), we only interviewed the organiser since the moderators were high school students volunteering to moderate the activity as part of their education (they were all students in an education curriculum high school). The young moderators, in fact, had not received any prior training for the workshop and were not usually involved in the organisation's activities.

All the interviews were conducted online on Microsoft Teams in November 2021 and lasted between 40 and 60 minutes, with a mean length of 51 minutes.

5 Appendix 5: Co-design procedures by country

Co-design in Belgium

In Belgium, a co-design workshop aimed at 9- to 18-year-old children and young people was developed. With these co-design sessions, the Belgian researchers aimed to find out how children and young people themselves would design activities around digital skills in non-formal learning settings. The workshops focused on what they find important and what they consider to be facilitators and barriers to participation in such activities. Instead of starting from the point of view or the expectations of (adult) researchers, the aim was for the children and young people themselves to be able to organise a workshop that suited their needs and wishes. These findings were later compared with the existing infrastructure and discussions with stakeholders to create policy implications.

To recruit participants, the organisers of the local CoderDojo divisions that participated in the observation and interview phase were contacted again. The BE1 and BE4 (the CoderDojo4All division) organisers initially agreed to also participate in the co-design workshops. Both organisers worked for the municipality and could therefore recruit participants, either via CoderDojo or via other initiatives of the city. This collaboration would mean that children who live in a high-SES area (BE1) and children who live in a low-SES area (BE4) would participate. The SES was assumed by the housing prices of that area. However, the priorities of the contact person of BE1 shifted as he became responsible for managing the reception of Ukrainian refugees in his municipality. Therefore, the collaboration with BE1 was cancelled. Additionally, a local community centre with a children's department consented to participate. This community centre organises after-school activities for children who live in a disadvantaged neighbourhood of a city in Flanders.

The first co-design workshop took place at the end of March 2022 after school on a Wednesday. We will label this co-design workshop as BE5 since the organiser and location stayed the same as BE4, but the children and the activity changed. Since the organiser recruited children in the community centre, not all children who participated in this co-design workshop had previously participated in a CoderDojo4All (BE4) workshop. Therefore, the label BE5 fits better. The organiser recruited participants via flyers (that he made himself) given to children between 10 and 12 years old that regularly attend activities in the local community centre. Nine children (ages 10-12), five boys and

four girls, participated in this co-design workshop. They all had an immigrant background and none of them spoke Dutch as their native language. The researcher provided snacks and drinks to thank the group for their participation.

The second co-design workshop took place on a weekday during the Easter holiday in April 2022 at the community centre of a disadvantaged neighbourhood of a bigger city in Flanders, Belgium. This workshop is labelled BE6. The organiser invited the researcher a week before the co-design workshop to introduce herself to the children and to recruit participants. This recruitment phase happened right after the children got out of school, which might be the reason why the children paid only limited attention and were not very interested. In the following days, the organiser further tried to invite children to participate in the workshop. Eventually, nine children showed up during the co-design workshop. However, even though the activity was aimed at children and young people aged 9 to 18, four participating children were too young to participate in our study (aged around 6 years old). Moreover, two of them even suffered from a mental and learning disability. Two of the other participants were refugees. They were siblings and did not speak any Dutch or English, which made communicating very difficult. Therefore, only three (all boys) out of the nine participating children were observed. The other six children could join the activities, but they stopped rather quickly. All children lived in apartments owned by social services, an indicator of their low socio-economic background. All children had an immigrant background. The researcher provided snacks and drinks to thank the group for their participation. Children who participated in the Ramadan could take their snacks home.

Informed consent was given by the parents to participate in the co-design workshops and to make audio recordings. During both sessions, the researcher made field notes and audio-recorded the presentation moments. These recordings were later transcribed.

Both co-design workshops were intended to last three hours, but eventually took two. The organiser of BE5 asked right before the start of the workshop to limit the time to two hours. The second workshop, in the community centre, stopped after two hours because the children no longer wanted to continue.

As for the research protocol, we had to be flexible to respond to situational demands, including the organisers' last-minute requests and children's attention span and interests. Consequently, the actual protocol deviated from how it was originally designed. The original protocol can be found in **Appendix 6**. Differences between the original protocol and the actual course of action are further explained in the results section.

The BE5 and BE6 sessions started with an introduction during which the researcher introduced herself and what the study would entail. The children were given the opportunity to ask questions. Even though most children already knew each other, an introductory game was played to make the children feel at ease.
Due to time restrictions in both co-design workshops, it was decided to not use the different roles as originally intended.
Then, the actual co-design workshop started. The researcher explained that the children would do a mapping with their group in which they had to write down everything they could think of when it comes to digital skills. It was emphasised that there were no right or wrong answers. The children were given large papers, scissors, glue, coloured pencils, markers, and papers with icons on it. These

icons provided very broad examples, ranging from icons of concrete tools to icons of activities, people, professions, objects, etc. Several children cut out these icons and glued them on their mapping papers. Some children also made drawings or crafts of their answers. The researcher provided envelopes with help questions that the children could ask for when they were out of inspiration.
The researcher walked around constantly to help groups who had difficulties in understanding the task, who were stuck or that became distracted.
Afterwards, the children were instructed, via different sub-tasks, to create their own ideal digital skills workshop. The researcher explained that a new (fictitious) organisation will be founded: "Digikids". The children were then given the task of imagining the question: “What if you were the creator/boss of Digikids? How would you then organise the activities?”
There were several sub-tasks:

1. Originally, the researcher intended to give the children personas that they would have to keep in mind while designing their workshop. The first sub-task was then to become familiar with the different personas by envisioning their social media accounts and answering questions from friendship booklets. However, during the BE5 session it became clear that the children (who were from a low SES background themselves) preferred the high SES personas. The BE5 organiser afterwards mentioned that it is a pity that low SES are often ignored in academic research, and now that they had the chance to have a voice, they were asked to pretend to be a high SES person and to only keep in mind high SES needs and preferences. As this was a striking remark, it was decided to not work with personas in the BE6 co-design workshop.
2. The children were asked the question: “If you were the boss of Digikids, how would you make the activities?” To support this, the facilitator asked the questions, “What do you want children to be able to do?”, “What do you want children to know?” and “How do you want children to feel about it?” The children were given a large sheet of paper with an icon of a muscular arm, a brain and a heart on which they could write their answers. In the BE5 session, the participants did this exercise with their persona in mind. In the BE6 session, the participants could answer these questions based on their own wishes and needs.
3. The researcher asked the children which materials Digikids would need to organise a good activity. The researcher encouraged the children to base their answers on the previous task and thus to focus on which knowledge, skills and attitudes they would like their persona (BE5) or themselves (BE6) to acquire. The children were encouraged to think out-of-the-box and could invent their own technologies or tools. The children were given different crafting materials so that they could craft or draw the technology or tool themselves.
4. The researcher asked the children to design the planning of their ideal activity. The researcher helped them to think about sub-activities, time schedules, breaks, frequency, …

The co-design sessions ended with a presentation of their invented activity. The organiser and researcher were present. During the BE5 session, time was running out and the children were not paying much attention anymore. The presentations were therefore rather short and not many questions were asked. In the BE6 workshop, the children wanted to quit rather abruptly. The researcher could convince the children to quickly explain what they had created, but it was not a real presentation.

The results of the co-design sessions were later compared with discussions with stakeholders and previous observations in order to formulate policy recommendations.

Co-design in Denmark

In Denmark, it was decided to focus the investigation on the tools and technologies. Based on the empirical results from observations of workshops and interviews with moderators, there were two major insights that had an impact on this choice. Firstly, the workshops formats and teaching style were very different, even for workshops intended for the same target group. This became especially evident in the difference between the workshops DK4 and DK3 based on individual work, and workshops DK2 and DK1 which were based on collaboration. The second insight was that the software was designed for individual use, and not for collaboration and knowledge sharing, something that was especially evident in moderator A's workshops DK2 and DK1 where there was a potential for the software to better support the moderator's intention. These findings will be further elaborated below, but introduced here in order to situate the co-design with a focus on tools and technologies.

The Danish ySKILLS team joined forces with the CoTinker research project, which specialises in developing new technologies for informatics teaching (https://cctd.au.dk/projects/cotinker/). Together, we went into a longer co-design process with different actors in order to develop and test a new digital learning tool for facilitating programming workshops in non-formal learning contexts. The participants in a series of one hour co-design workshops were the two ySKILLS researchers, one researcher from the CoTinker project, facilitator A, and a software developer hired by the CoTinker project. The focus of the co-design was to scaffold collaboration and knowledge sharing of programming through software.

For two months, the group held bi-weekly co-design workshops. In the workshops, a new iteration of the prototype tool was presented, tested and discussed, and we concluded with a list of next steps. For each of the workshops, the ySKILLS researchers mainly took part in observations and facilitation, took notes, and asked clarifying questions. In the later meetings, the ySKILLS researchers took the role as testers, as the new prototype tool was piloted by moderator A. The workshops took place in facilitator A's Lego lab at the university, the same lab that the workshop series DK1 took place. To be as realistic as possible, we tested the prototype on the same type of Chromebook computer that all children in the municipality have at schools.

The tool that was developed is a new approach within the CoTinker framework (https://cctd.au.dk/projects/cotinker/), which is a web-based, modular toolkit for developing collaborative and flexible learning environments in informatics. The focus of the teaching was on the micro:bit (https://microbit.org/) and its various sensors. The BBC micro:bit is a pocket-sized computer that introduces how software and hardware work together. It has an LED light display, buttons, and sensors and many input/output features, a built-in microphone and speaker, and a power button. To program the micro:bit, a computer, phone or tablet with internet access is needed to load the Microsoft MakeCode or Python code editors. The micro:bit is commonly used in both formal and non-formal learning environments in many different countries. In Denmark, sponsored by the national broadcasting network, all children are introduced to the micro:bit in fourth grade (https://drultrabit.dk/).

The new CoTinker tool developed in the co-design workshops built onto the MakeCode code editor and incorporated exercises and instructions authored by the facilitator A. Additionally, there was a teacher view, a control panel, where the moderator can create groups, see where the groups are, show and share the work between groups, etc. The facilitator was especially interested in the teacher view, because with this view, he could share the code from each of the groups on the shared screen, instead

of people have to walk over to that group. This was to facilitate learning better, and to help the children share knowledge, inspiration, solutions, and problems with each other.

The tool was planned to be tested with girls aged 12-13 years old in 3x2h workshops in May-June 2022. The facilitator designed the activities, and the invitation for the workshop series. The university network was used to recruit child participants. Unfortunately, too few participants volunteered, why it was decided to run the pilot in a different setting.

The tool was piloted by the facilitator in a workshop with a group of five high school teachers in informatics, in order to get didactic feedback for further development of the tool. The workshop took place in a meeting room at the university. The room was chosen due to that it has built-in recording equipment, both video and sound. The participants had given their consent prior to the workshop that the video and sound could be used for research purposes. There were five participating high school teachers, the facilitator, one developer, and four researchers. The participants were provided with one Chromebook computer each, the same type of computer that all school children have in the municipality.

In the workshop, the facilitator started out by presenting the tool, and went through several exercises that they developed for the micro:bit. The teachers had no previous experience with micro:bit. After completing a few exercises, the participants provided feedback and ideas for further development.

Co-design in Italy

The approach to co-design in Italy was focussed on facilitating moderators' reflexivity around teaching styles and the future development of new learning activities through a direct consultation of children and a subsequent activity, carried out in a second moment, informed by this consultation.

All three actors participating in the first observational phase of the research were asked to take part in the co-design, but due to several constraints and feasibility, this part was carried out with the Youth Center's organiser/moderator, who is also an organiser and moderator of a local CoderDojo (different from those who participated in the first phase of the research, henceforth called IT4). While partly of convenience in nature, this choice was also motivated by the fact that IT4 had interrupted all activities and contacts with its participants ever since the first lockdown measures took effect in February 2020 and was about to restore their laboratories with children and young people. On this occasion, along with the moderators, we deemed it appropriate to organise a children's consultation to give them voice in terms of what they would like (and would not like) to do and achieve now that IT4's meetings were back after the long hiatus. We understood this consultation, along with the moderators, as an opportunity to embrace an approach that, following Tangen (2008), sees children not only as "becomings" but as "beings" and recognises their voices as an expression of insiders' epistemology that meets that of "outsiders", whether it be the moderators themselves or us as researchers. In this process, our role was to facilitate children's expressions of desires, ambitions, and requests for change and or improvement to provide mentors with first-hand information to rethink their teaching styles in a participatory, co-design fashion. Our approach was not directive, as we do not believe that there is a right or wrong teaching style per se, but both the researchers and the moderators valued the opportunity to foster reflexivity by recognising children as competent actors who bring an active value to a process of co-design and co-research to rethink teaching styles and activities (Clark, McQuail, & Moss, 2003).

To notify participants of our presence and intention to conduct this co-consultation to give them voice in terms of the directions they wanted these new encounters to take, both a message on the official website of the local CoderDojo and an email to its members were sent by the organiser. The meeting took place on April 2022, and the consultation was conducted within the time allocated for the whole workshop, but before any activity took place. A total of 11 participants were present: three sixteen-year-old boys, a fifteen-year-old boy, three ten-year-old boys, two nine-year-old, a boy and a girl, an eight-year-old boy, and a twelve-year-old boy.

For the consultation phase, children were first approached by the organiser/moderators who explained why we were there and what we were doing. During the explanation, it was emphasised the importance for them to learn from participants' ambitions and desires to co-design the future activities and get food for thought in terms of their teaching styles by hearing from children directly. The researchers then introduced themselves and asked children a series of questions, with the former being aimed at understanding why they were there and what they would like about these activities, and the others to gain information on what else they think could or should be done. The consultations took approximately 45 minutes. Every participant was invited to voluntarily respond to each question. To differentiate the different needs that participants could have, they were asked to indicate their age when answering. The following question list was adopted as a guide to be implemented as needed according to children's answers:

1. Can you please tell me why are you here today?
2. And can you tell me what do you like the most about the activities you do here?
3. Is there something you would like to do but did not get a chance to do here so far, or that you feel you should do more?
4. Is there anything you would change in the ways these activities are organised?
5. Would you like to conduct an activity for your peers? And if yes, how would you do that?
6. Now, please think of a person of your age who has never done anything like the things you do here before. How do you think she/he could be encouraged to participate? Is there anything you believe the workshop could offer to get her/him involved?

As we will highlight in section 4.2, children's diverse and rich answers were transcribed and shared with moderators, as a stimulus to rethink and reflect on their teaching styles in terms of approaches used and further developing their educational activities.

Following this first phase, we came back for the next encounter, taking place more than a month after, to conduct a participatory observation of a co-designed activity. During this time, consistently with what emerged from the consultation, the organiser and moderators from IT4 reached out to their participants inviting them to volunteer for presenting something they have been working on related to coding and programming to the class, to both conduct part of the encounter, teach something to the other participants, the moderators and the researchers, and get a badge in return as a token of appreciation recognising the role they played during the workshop.

Such an activity, see also section 4.2, was used as a strategy to start translating into practice what emerged from the consultation, to foster participants' engagement by reconfiguring the roles within the learning contexts. In an educational asymmetrical relationship, in fact, flipping and reconfiguring the social roles played by the actors can distribute agency and give children responsibility, a sense of trust in their ability to demonstrate their skills, learning cooperatively through peer tutoring, enabling metacognition, foster reflexivity for peers and educators, as well as inspire others to do the same (Christenson, Reschly, & Wylie, 2012; Hartman, 2001; Steinberg & Cazden, 1979). A total of six

participants, all boys, participated in the co-designed workshop: an eight-year-old, a twelve-year-old, a thirteen-year-old, two fifteen-year-olds, and a sixteen-year-old.

6 Appendix 6: Original protocol co-design workshops Belgium

Disclaimer: This is the protocol as how it was originally created. During the actual co-design workshops, changes were made and flexibility with the protocol was needed. A description of the changes can be found in "4.3 Policy". Below, an asterix (*) indicates that this part of the protocol was not adopted in the co-design sessions.

Observer:	Organiser:	Session number:

Date:	Time:	Duration:
Location:	Target group:	Number of participants:

<u>Subject</u>: Co-design session on digital skills

1. Starting situation

The researcher (henceforth 'facilitator') recruits participants for the co-design sessions through organisations that have worked with her in the past. Two co-design sessions will be organised, but each organisation will only participate in one session. The focus is on participants between 9 and 18 years old. Since they are minors, the informed consent of both parent and participant requires special attention. Together with the organisation, a strategy will be developed to obtain this informed consent. It is especially important to emphasise that audio recordings will be made of the various sub-tasks, but mainly of the presentation moment. We do this to be able to form a good picture of the motivation and motives for certain choices and decisions made by the participants. There will be no video recordings or photographs of the participants. However, pictures will be taken of the room and the tinkered objects. However, no participants will be visible on these. Throughout the co-design session, the researcher will observe the participants and take notes.

In cooperation with the organisation, we hope to be able to recruit participants and have a space at our disposal. Furthermore, we have no expectations towards the organiser and we, as researchers, will take full responsibility for the co-design session. So in principle, it is not even necessary for the organiser to be present, although it would be nice if the organiser could play 'audience' during the presentation moment. This could even be an interesting learning moment for the organiser to get to know the wishes of the target group better and to get possible ideas for future activities.

There will be breaks throughout the activity. The researcher will provide snacks and drinks for all those present, including the organiser(s) and the young people who do not feel like taking part in the research.

2. Positioning of the subject

The research focuses on digital skills of children and young people in non-formal learning environments. With these co-design sessions, we try to find out how children and young people themselves would design activities around digital skills. We focus on what they find important and what they consider to be facilitators and barriers to participating in such activities.

3. Schedule of the activities

Timing / Duration	M / L / C[1]	*Content, work formats, media and other resources, instructions, (didactic) questions*
10’	M	Introduction: The researcher introduces herself and the study. The children are told what will happen during the session and what the aim is. The children are given the opportunity to ask questions.
10’	M	The researcher makes the children stand in a circle and asks them to introduce themselves briefly (e.g. name, age, grade, hobbies). Afterwards, some short introductory games are played in which the children have to rank themselves without using words, e.g. height, age, house number, birthday. The children are not allowed to talk or make sounds, but they can make gestures. The children are then divided into groups. If there are too few children, there is one group.
10’ *	M	Each group gets a role, e.g. material master, time keeper, journalist,... and an explanation of what the role entails. The researcher provides stickers with icons that visualise the different roles. In this way the children can put the sticker on and show the others what their role is. Each group gets a 'spokesperson'. Throughout the activities the researcher may ask this child for an explanation or clarification of what the group is doing and why they are doing this. In each group there is also a child who gets the role of 'journalist'. If the child does not understand this term (even after referring to, for example, Karrewiet), this child is called the 'chatterbox'. This child may occasionally leave the group to ask the other group questions about what they are doing and why they are doing it. In this way it is also less obvious that the researcher comes to ask questions from time to time, because a climate is created in which it is considered normal to ask questions to each other. At the same time, it allows the researcher to get an idea of the meaning the children give to the activity, without disturbing the activity. If there are too few children and consequently only one group, the role of 'journalist' is dropped. The children themselves have a say in who will take on which role. The researcher emphasises that each role is equally important. * *This part of the protocol was not adopted in both co-design sessions.*
15’	L	The researcher explains that the children will do a mapping with their group. The idea is that the children map out by means of a mapping or brainstorm what they think of when it comes to digital skills. It is emphasised that there are no right or wrong answers. The children are given large papers, scissors, glue, coloured pencils, markers, magazines from which they can cut and icons. The icons will give very broad examples, ranging from icons of concrete tools to icons of activities, people, professions, objects, etc. The children may cut out the icons and stick them on the papers if they recognise and think of them and find them relevant for the activity. The children receive magazines to get extra inspiration. They may also write and draw extra ideas. Any association may be noted. The researcher provides envelopes with questions for help. Whenever the children have no inspiration, they can open a new envelope. This will always contain a card with a question of varying complexity, such as: ▪ "What objects do you think of when it comes to digital technologies?" ▪ “What objects do you know that are connected to the internet?” ▪ "What do you need to use digital technologies?" ▪ “What do you need to know or be able to use digital technologies?” ▪ "How can you become digitally proficient? What do you need to learn? What do you need to practice?"

		▪ "For which professions do you need to be proficient with digital technologies? What do you need to be able to do?" ▪ "What dangers do you think are associated with digital technologies? What do you need to be able to do to handle them safely?" ▪ "What might you need digital skills for?" ▪ ... The researcher is constantly walking around to help groups who are having difficulties understanding the task or who have gotten stuck. If the groups are focusing too hard on one aspect, the researcher can help them think about other forms of digital tools or skills.
95'	L	The researcher explains that a new (fictitious) organisation will be founded: "Digikids". The children are then given the task of thinking about the question: "What if you were the creator/boss of Digikids? How would you then organise the activities?" There are several sub-tasks: 1. The researcher shows the children some pictures of the fictitious Digikids website and social media channels (e.g. Instagram, YouTube, Facebook,...). Then the researcher gives each group a persona with a description of a (fictitious) first participant of Digikids. This persona is based on insights from actual empirical data, but the individual in itself does not really exist. It is therefore an archetype for a participant in the activity. In the description, information such as name, age, family situation, which digital tools this child has at home, etc. is provided. The children are then given some blank templates of social media channels such as Instagram and Facebook. They are now allowed to try and think for themselves what their persona would look like by drawing a profile picture or cutting it out of magazines. With the information the children already received about the persona in mind, they also come up with an appropriate 'bio' for on social media. The researcher also provides some blank pages from a friend's book. If the participating children are too young or have difficulties imagining what a bio on social media might look like, they are encouraged to think further about their persona by filling in the questions in the friend's booklet. (15') 2. The researcher instructs the children to think about the question: "If you were the boss of Digikids, how would you make the activities to fit persona X? To support this, the researcher asks the questions, "What do you want X to be able to do?", "What do you want X to know?" and "How do you want X to feel about it?". The children are given a large sheet of paper with an icon of a muscular arm, a brain and a heart on which they can write their answer. (15') 3. The researcher asks the children which materials Digikids would need to organise a good activity for persona X. The researcher encourages the children to base their answers on the previous task and thus to focus on which knowledge, skills and attitudes they want persona X to acquire. The children are encouraged to think out-of-the-box and they may invent their own technologies or tools. The children are given different crafting materials so that they can craft or draw the technology or tool themselves. (30') 4. The researcher asks the children what they think the planning of the ideal activity for persona X would look like. The children are encouraged first to think about what sub-activities they would like. Then they should think about how long they want each sub-activity to last. If the children have difficulties imagining this, the researcher can help them by asking if they would like, for example, a break in their activity and what the participants would do during that break, if they would like to organise a joint start moment, if there is a show moment at the end, if there is one big activity or alternating

		tasks,... Finally, the children are given a large roll of paper with a timeline on which they can indicate how they would plan their activity and which sub-activities would be organised. (20') 5. The researcher tells the children that a presentation moment will follow in which each group will present the work it has made to the other groups and the people from CoderDojo/the municipality/the library/the parents/... The children are given time to prepare for this presentation moment. They are free to choose whether they entire group wants to present or not, but the researcher encourages each child to play a role in the presentation. Those who feel comfortable doing so can present their work through role play or drama. If the groups are uncomfortable with this or there is a lack of time, they can also do an artifact walkthrough where they show and explain the things they have made. (15')
30'	C	The co-design session ends with a presentation. The people from CoderDojo/the municipality/bib/the parents/brothers and sisters/... are invited to this. The children explain to the other groups who their persona is. After all groups have explained their persona, the groups show one by one using a role-play, drama or artifact walkthrough how their activity for persona X would look like and how the activity would go. Afterwards, the children also explain why they have organised their activity in this way. If the presentation is difficult, the researcher asks questions to help them with their explanation. The other groups may then ask questions. The child who is given the role of 'journalist' at the beginning of the session will now also be encouraged to ask questions. The researcher encourages the other children to become 'journalists' as well. After the presentations, the researcher asks the other groups if the activity they just presented would work for their personas. The researcher displays a point grid on a flipchart. Each group gets a score out of ten on how well the activity would fit their persona. The children also have to explain their score and thus justify why the activity seems to them to fit their persona or not. There is room for a group discussion in which they reflect on how the activity could be improved or what is still lacking to make it good for the other personas. If there is only one group (because the number of children present is low) the researcher asks questions to get the children thinking about the suitability of their activity for other archetypes of participants. The organiser and the audience may also ask questions.

4. Required materials

- Recording equipment
- Informed consent parents
- Informed consent children
- Informed consent organisation
- Stickers with icons visualising the different roles
- Large papers
- A4 papers
- Scissors
- Glue
- Coloured pencils
- Pens
- Ball point pens
- Icons that can be cut out (of technologies, activities, people, professions, objects,...)
- Magazines that can be cut out
- Envelopes with inspiration questions in
- Images social media channels Digikids
- Texts with descriptions of personas
- Empty social media templates
- Empty copies of a friends booklet
- Large paper with an icon of a muscular arm, a brain and a heart
- Craft materials (e.g. toilet rolls, egg cartons, string, sticky tape, wiggly eyes, coloured paper, etc.)
- Large roll of paper with a timeline
- Flipchart or large paper with a grid of points
- Permanent markers
- Snacks and drinks

(The materials will be provided by the researcher.)

[1] M = Motivational phase; L = Learning phase; C = Closing phase