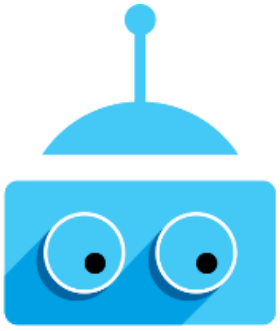

COM n PLAY
SCIENCE

COM'N'PLAY-SCIENCE RESEARCH ON LEARNING PHASE 1 – CASE STUDY REPORT SCIENCE MUSEUM GROUP

v. 1.1

19. November 2020

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PROJECT FACT SHEET

Acronym
COMnPLAY SCIENCE

Full Title
Learning science the fun and creative way: coding, making, and play as vehicles for informal science learning in the 21st century

Programme / Pillar / Topic
Horizon 2020 / Science with and for Society / Science education outside the classroom

Type of Action
Research and Innovation action

Grant Agreement
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Duration
36 months (1/6/2018 – 31/5/2021)

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€ 3,097,715.00

Overview
The project aims to help Europe better understand the new ways in which informal science learning is taking place through various coding, making, and play activities that young Europeans (children, adolescents and young adults) are nowadays increasingly engaged with, outside school and higher education science classrooms, beyond the formal boundaries of science education.

The project's main objectives are to:

a. Develop an appropriate conceptual and methodological framework integrating all aspects of the project into a unifying conceptual map.
b. Setup a European-wide community of stakeholders, including learners, educators, facilitators and policy makers from diverse fields, to contribute, guide and help assessing the conducted research.
c. Identify, pool and analyse diverse existing coding, making and play-based practices taking place outside formal science classrooms which bear some promise for informal science learning.
d. Conduct in-depth learner-centred participatory empirical research on selected practices.
e. Gain a deep understanding of the impact that this kind of informal science learning has on formal science education, traditional informal science learning interventions, young people as learners and citizens, as well as, on society.
f. Communicate and disseminate the messages and outcomes of the project widely, and enable the exploitation of the findings of the research through the development of relevant guidance for practitioners and recommendations for policy development and further research.

The main results stemming from the project include:

- An online inventory of all the identified and pooled practices, appropriately categorized and annotated in the light of the findings of the research, available to stakeholders and the public.
- A set of community building methods and tools for everyone wishing to get involved in community building linked to the project.
- A Web-based game promoting and supporting the continuous prolonged engagement of learners and their facilitators in the field research.
- The COMnPLAY SCIENCE Knowledge Kit, a modular set of reader-friendly, practice-oriented publications, encapsulating the findings of the project.
- The COMnPLAY SCIENCE Roadmap for Europe, a detailed concerted account by the consortium, the stakeholder communities and policy makers of the potential for short-, medium- and long-term impact of coding, making and play-based informal science learning.
- Numerous public events (workshops, training seminars, conferences, contests, fairs), often combined with training activities (winter and summer schools).

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Web & Social media

Web Site: http://comnplayscience.eu
Facebook: https://fb.me/ComNPlayScience
YouTube: https://bit.ly/2Hq5FsK
Twitter: @comnplayscience
ResearchGate: https://www.researchgate.net/project/CoM-n-Play-Science

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1. Partner

Partner name: Science Museum Group (SMG)

Objectives: The objectives of this study were to identify:

- What are the learning opportunities and limitations of CoderDojo workshops?
    - What can we learn from the design of the workshops?
    - What are the opportunities to personalise and localise coding?
- What is the role of facilitators (mentors) in museum-based informal coding sessions?
    - What is the mentor's perception towards the Coder Dojo workshops and the families participating?
- What is the perception of the workshop from the mentor's point of view?
- What is the families' perception of the workshops?

Case selection: The activity we investigate with this case study is CoderDojo at the Science Museum, London.

The Science Museum is part of the Science Museum Group (SMG) which is a collection of British museums including the Science and Industry Museum in Manchester, the National Railway Museum in York, The National Science and Media Museum in Bradford and Locomotion in County Durham. The five museums of the Science Museum Group are a key national resource. With their unparalleled collections in the fields of science, technology, engineering, mathematics, and medicine, they are uniquely placed to draw people of all ages to engage with science in an inspirational and informal way.

The Science Museum Group's Learning vision is to enrich lives by igniting curiosity in science. With aweinspiring authentic objects, cutting-edge science stories and hands-on activities, the museums celebrate and showcase the past, present and future of science and technology. STEM engagement is at the heart of what SMG does, and the concept of science capital is used to shape the group's work providing researchbased insight into what influences and shapes people's engagement with, and attitudes towards, science. SMG informs, inspires, and encourages learning on-site, as well as through outreach and online. SMG ignites curiosity around STEM by assisting discovery through active participation and social interaction.

The CoderDojo workshop at the Science Museum are part of the CoderDojo movement and as their website states they believe that an understanding of programming languages is increasingly important in the modern world, that it's both better and easier to learn these skills early, and that nobody should be denied the opportunity to do so.

CoderDojo is a global movement of free, volunteer-led, community-based programming clubs for young people. Anyone aged seven to seventeen can visit a workshop where they can learn to code, build a website, create an app or a game, and explore technology in an informal,

creative, and social environment. The CoderDojo workshop focuses on peer learning, youth mentoring and self-led learning. It aims to help young people realise that they can build a positive future through coding and community.

2. Abstract

Contribution: This case study is looking into the CoderDojo workshops at the Science Museum to identify opportunities and limitations of science learning, the role of mentors in museum-based informal coding sessions and their perceptions, as well as the families' response to the workshops.

Methodology: Data for this case study was processed using qualitative analysis and collected using a mixture of methods. The primary source of data was interviews with eight mentors (facilitators) and five families that participated in the workshops. Data from workshop observations were limited and informal discussions with museum coordinators of the workshops helped for further insight. This was because the case study took place during the COVID-19 pandemic and was conducted mainly remotely due to the closure of the museum and the general lockdown.

Findings: Findings showed that workshops created a positive environment that enabled children to shape the nature of their participation and follow their interests but also share their knowledge, progress, and results. Workshops allowed children to extend their experience at home or anywhere they wished by accessing activities online and see coding as a hobby. The current role of mentors was seen as tasked focused and didn't allow children to empathise with them. We note that their role could be enhanced by sharing their wider identities as programmers to strengthen their connection with children and further their science engagement.

3. Method

The study represents qualitative, exploratory research. The methods used are supported by sociological and technological qualitative research methods and are heavily based on the Deliverable 1.2. of the COM'n'PLAY SCIENCE project called "Research Instruments and Tools".

3.1 Overview and context

When the study was done: March 2020 – June 2020

Where: London, UK

Setting: The CoderDojo workshops are one-off coding workshop that take place at the Science Museum the second Saturday of each month. There are two separate 90 min workshops on the day, one in the morning at 11.30am and the other one in the afternoon at 2pm. The workshops first started in July 2018. Workshops are advertised as free for all and open for all,

and participants can book them through the Science Museum website on a first-come-first-served basis. However, there are limitations to that as families, if they want to join, are asked to bring their own laptops as the museum has limited resources and cannot provide laptops to all participants. Participants can book as many workshops as they want if there is availability.

Maximum number of participants is 50 for each workshop, this includes adults and children. The workshops while addressed on the museum's website that are for young people, accompanied adults needed to remain in the space due to museum's safeguarding policies. Parents are encouraged to sit together with their children, help during the workshops and have an active role facilitating activities.

The workshops take place at a non-formal setting, in a multi-purpose room of the Science Museum. The space is arranged so that participants can work individually or collaboratively if they prefer. The tables are arranged across the space, and each table is allocated a specific coding language (Scratch, Python, HTML, Minecraft and BBC Micro:bit) to encourage children working on the same language to sit together and potentially offer help to each other. Tables are set up so that beginners can sit near the paper resources and more experienced participants can sit near complex projects at the back (Figure 1). Children are free to move and interact with other participants on their table and of other tables.

Both workshops for this case study took place on 14th March 2020. Due to the COVID-19 pandemic we were only able to observe two CoderDojo workshops before the museum's closure. This also influenced the number of participants for each workshop we observed and in particular the newcomers as families that were less familiar with the workshops preferred not to join. Museum staff reported that workshops are usually fully booked**.**

Type of activity: Coding

Science capital focus: We examined the CoderDojo workshops from the perspective of science capital to further our understanding of CoderDojo, to reflect on the SMG's ongoing work and to further consider how science capital approaches inform the museum's role in children and families' science learning. We used the concept of science capital (science-related qualifications, interest, literacy and social contacts) to better understand how children engage with the coding workshops and how their engagement might be supported. Using the lens of science capital to inform our observations of workshops will enable us to help ensure that these learning experiences are inclusive for a diverse range of families, support more people to engage with science and make sure science is for everyone. SMG's central learning principle is to develop science capital in individuals and society by using reflective practice to critically think about the visitors' experience and how it could extend learning beyond their visit. Science capital research identified eight dimensions of science capital that affect a person's connection and relationship with science. These dimensions create practical guidelines that reflect SMG's values, mission and vision and help us understand what these influences are and how they build varied experiences. The dimensions that we tried to identify have to do with the language used, the science content knowledge, pre-existing skills, use of everyday examples, the people we relate to, confidence and ownership, positive reinforcement, promoting science talk and extending the experience.

3.2. Participants

Participants:

Children: 11

Accompanied adults: 9

Facilitators/Coding mentors/Volunteers: 8

Museum staff: 1

Researchers: 2

Age of participants:

Children: 7-14 years

Accompanied adults: 35 – 45 approximately

Gender:

Children: 6 Female, 5 Male

Facilitators/Coding mentors/Volunteers: 3 Female, 5 Male

Museum staff: 1 Female

Researchers: 2 Female

Language: English

Background of participating children: Children varied in the coding experience they had before they joined the workshops. The families with children 12+ were very experienced, they had done coding at school and they also had experience from other coding clubs. On the other hand, families that joined the workshops with children under the age of 10 had very little to no experience.

Children attended the CoderDojo workshop in family groups. The families were from London and the Greater London area. All children were accompanied by at least one adult and some also had a younger sibling with them.

Most adults in the family groups did not have any coding experience and because of this, 3 out of 5 families said that they usually do not help their children and prefer to observe them. In most families that joined the workshops there was an adult with work-related coding or science experience in the family environment. In most cases that was the father.

Background of facilitator(s): The CoderDojo workshops were run by volunteer coding mentors. They all had experience in software engineering, either from professional experience or personal interest and worked in or had retired from coding related jobs. Among the jobs were software engineers, website developers and consultants. It is also worth noting that

some volunteers felt that they needed to improve their coding knowledge by taking courses or doing some reading in their own personal time to further their knowledge on coding or learn a new coding language.

• 5 out of 8 coding mentors interviewed were Science Museum volunteers before they joined the workshops.

• 2 coding mentors had volunteered in other coding clubs before they started volunteering at the Science Museum.

Most of them became coding mentors because they wanted to be role models for young people and inspire them to do coding; wanted to share their enthusiasm about coding with children, triggering their interest by exposing them early on to science and coding. All felt that coding is a useful skill for young people to have.

Selection process: The CoderDojo workshops at the Science Museum are open to anyone aged seven to seventeen. As it is stated on the website, the workshops are also open to all abilities, from total beginners to programming masters. Participants weren't pre-selected or recruited. They were families that had booked the workshops on the day of the observations. Families when asked during the interview commented that joined the CoderDojo Science Museum workshops because they were free and don't pose a financial threat for them. The Science Museum's reputation and the location were also crucial in families' decision to join.

All families interviewed had been regular museum visitors before they joined the workshops. They had Wonderlab: The Equinor Gallery annual passes and had been to various museum activities such as the Garden and the Fly Zone. This also came across in the science capital survey - respondents noted that they visit museums regularly. Therefore, it is safe to think that workshop participants reflect the museum's visitors. Science Museum's visitors' profile is calculated using the UK's National Statistics Socio-economic Classification. It is an eight-class classification that provides an indication of socio-economic position based on occupation; 1 show those in higher managerial and professional occupations and 8 those that never worked or are long-term unemployed. According to the latest annual audience profile report of SMG's Visitor Insight team (2018 –2019), visits consists of; 68% fall in the highest 1-4 classification while 19% are from the lower classifications of 5-8. Additionally, 51% were made by female visitors, 26% were made by visitors from a Black, Asian or minority ethnic background and 6% said their group included someone with a disability or long-term illness.

Participation at the CoderDojo workshops is usually initiated by the parents. Parents came across the workshop when searching for extracurricular coding activities for their children. Parents searched for coding workshops because they had noticed that their children had an interest in coding. They heard about CoderDojo at the Science Museum either through word of mouth, through advertising at the Science Museum and CoderDojo websites, when visiting the museum or via Science Museum's social media.

Socio-economic differences and the risks of disadvantage and exclusion: As it is mentioned above the museum cannot provide laptops to all participants and families which poses a risk of exclusion and puts limitations for families that would like to join. This also limits the number

of children that a family could bring as each child needs to have each own laptop. Even though workshops are free and open for all, the need of specialistic equipment can deter some families.

3.3 Procedure

Number of occurrences: We observed two sessions.

Duration: The duration of sessions varied between 1 – 1.5 hours. The first session lasted one hour as it was ended early by an evacuation alarm. The second session ran for the full duration of 90min.

Phases and schedule: The workshop began with a 5 min introductory session. The introduction had two parts; firstly, to gather everyone together and introduce the schedule of the day, the coding mentors to the attendees and to get children to introduce themselves. Mentors were introduced as experts in coding while children said their name and ages. Secondly, science museum staff went through the coding offer and the different levels – regular visitors could skip the second part and continue with the workshop.

The coding phase of the workshop had limited structure regarding the activities. It lasted 60min and participants were free to select programming languages and activities and do coding. The only limitation was that participants had to sit at certain tables depending on the programming language they had selected to work with.

The workshop ended with a 30 min show-and-tell session where children shared their projects with the rest of the participants; talked about progress and shared ideas and challenges.

The 2 workshops observed differed in structure due to lower attendance levels because of COVID-19. The first workshop started right way with a 60min coding session and skipped the introductory session. Also, the first workshop missed out the show and tell because of the evacuation incident. Participants in the second workshop were repeat visitors and preferred to skip the programming languages overview.

Group work / individual work: Family groups stayed together, as encouraged by staff and mentors and preferred to remain in their family groups during the workshop. Each child had their own activity that they completed individually. Children were not given specific roles or tasks and were free to select activities and coding languages. However, children in family groups that were familiar with a programming language helped their siblings, giving instructions and guiding them through the activities.

Type of facilitation: During the workshop's facilitators/coding mentors hovered between programming tables and mainly responded to children's requests. When children needed support, coding mentors sat with them to try and find a solution and support the children to undertake their tasks. Coding mentors also praised children for their performances when they showed proudly their progress.

Support was also given by other members of the family groups. This was either an adult of the group or a sibling/friend.

Special attention was given to new participants. These children had a brief conversation with coding mentors about the different languages on offer and how resources were categorized. Families that were not familiar with the workshops or activities spent a couple of minutes with a mentor to identify their knowledge level and preferences. Mentors asked about children's knowledge and what they would like to work on 'Are you familiar with Coding?', 'Have you got a project you are working on already?', 'Do you have a project in mind?', 'What experience do you have in coding?'. If they were unsure the mentors suggested things they might like to try. Some mentors compared activities with popular video games 'It is like Minecraft'.

Instructions to participants: Children were given very few instructions or no instructions at all and they were encouraged to follow the instructions found in the activities provided during the workshops and 'explore' the activities by themselves.

Use of research instruments: Data was collected through observations and interviews with coding mentors and families. Observations and fieldnotes were collected by two researchers during the two workshops and one researcher carried out phone interviews. A total of 8 coding mentors were interviewed out of 20 that that were contacted; two who were at the workshops observed and six who had been at previous workshops. While 5 families were interviewed out of 40 that were contacted; three families had joined the workshops observed and two who had been to previous workshops.

All interviews were conducted by phone or video call at a prearranged time. Each interview lasted 45 mins.

In the second workshop, science capital data was collected using a printed version of the science capital survey. However, due to low attendance levels only 4 surveys were completed.

3.4 Resources

The coding activities included making puzzles, quizzes, animations, websites, games, patterns and drawings.

What material was used, why were they chosen and how: During the workshops, participants used their own laptops and paper activities provided by the musuem.

The paper activities were provided for projects in different coding languages such as Scratch, Python, HTML, Minecraft and Micro:bit and were categorized by beginner, intermediate, advanced.

Children could also bring their code out into the real world using the Micro:bit hardware provided.

There was not any specialized equipment used in the workshops. The museum had 6 backup laptops in case there were any problems with the participants laptops and to accommodate any last-minute bookings. The museum had various cables for different uses and sizes that the

participants could borrow to connect any equipment/hardware they had brought for their project.

A large screen and a microphone were used during the show and tell for participants to share their work.

There were also 3 Code & Go Robot Mice for children to program sequences of steps for the robot to do.

How the materials were used: The printed activities provided instructions on how to connect to different programing software and instructions on how to complete the activity. Children were encouraged to return the paper activities at the end of the workshop. A link to a Science Museum website with all activities available was also provided. Families could also take pictures of the activities.

3.5 Data collection

What kind of data was collected and how much: There are observations and field notes from 3 hours of data collection and 9 hours of interviews with coding mentors and families.

Our data derives from the following sources:

1. Observations and researchers field notes of 3 hours of activities involving 11 children. During the introduction and show and tell sessions the researchers remained on the edge of the learning space. During the programming period each researcher selected a coding table to observe closely. All field notes were taken by hand. The researchers completed detailed initial reflections within the following days of the data collection. Then the two researchers discussed their observations and initial reflections and shared them with two researcher colleagues to gain further ideas and insights.

2. Structured phone interviews, each 45 mins in length with five families that had joined the workshops. Families interviewed had joined at least one workshop in the past 3 months of the interview. The museums booking database helped with getting families details. During the interview families were asked about their background information; including information about their children, how they found the workshops, the role of the coding mentors and the extend that the workshops support coding skills and how relevant are coding skills to children's life. Families that participated were given a £20 voucher.

3. Structured phone interviews, each 45 mins in length with eight coding mentors. Coding mentors had volunteered in at least one workshop before the interview. They were asked about how they found the workshops, the relationships that they have built with the families and the extent to which they felt the workshops supported coding skills and if workshops were effective in communicating how coding skills are relevant to children's lives.

4. The science capital survey was also used on the second workshop. Printed copies of the science capital survey were given to the participants, however, due to low attendance we received only four completed surveys. The first workshop was interrupted due to evacuation and we were unable to collect any surveys.

5. Additionally, because of the halt of the workshops due to the COVID-19 pandemic, more detailed understanding of the workshops commenced with on-site and off-site informal discussions with museum staff members who coordinate the workshops. Coordinators gave an insight into the workshops, their structure and the dynamics between families and coding mentors and vice versa. Museum staff coordinate workshops, oversee the running on the day and are the point of contact for mentors and participants. They also present different

Why this data: Observations provide rich, qualitative data of the range of activities involving children, accompanying adults and coding mentors. These observations are not intrusive and do not require the video or audio recording of children. Interviews allow a deeper understanding on how families and mentors perceived and dealt with the workshops. The same open-ended questions were asked to all interviewees. Interviews weren't recorded..

3.6 Data analysis

Data from interviews were processed using qualitative analysis; each set of data was analyzed to identify patterns and behaviors and then coded. Similarly, for the observations that were also examined using an observation template and prompts that correlate with the science capital survey. Also, SMG's science capital informed Audience Engagement Framework was used to draw out and interpret findings. The SMG's Audience Engagement Framework helps identify best practice and highlight opportunities for improvement to provide experiences where science is inspiring, interesting, and enjoyable. Four core elements of a science engagement experience are defined; (1) Hook: An experience needs a hook to help capture people's attention and help them make personal connections with it. (2) Inform: should provide content at an appropriate level and link/built on audience's existing knowledge. (3) Enable: gives audiences the opportunity to interact with the experience's content themselves. (4) Extend: an experience should encourage people to continue exploring and make science connections in their everyday life.

4. Results

Based on the observations of the two workshops and interviews held with both families and coding mentors we identified the types of facilitation and general structural characteristics of the CoderDojo workshops whilst also investigating how families and mentor's perceived and dealt with the workshops.

Overall, everyone involved responded positively to the workshops, they stated that they enjoyed participating and found them a fun and enjoyable activity to do. Families highlighted that they enjoyed the exercises and the programming tasks and that the workshops were hands-on. Families also liked that the workshops helped them to have better awareness of the different coding languages, allowed them to share their coding projects and that they could learn from coding mentors and other participant's work.

4.1 Workshop's format

The atmosphere at the workshops was relaxed and informal. Children were absorbed in their tasks and the room was mostly quiet. This is likely to be because there were not as many children in the workshop as normal due to COVID –19. The second workshop though was a bit louder and participants more talkative as it was busier, and most children were younger (7-10). Children were very task-focused, they were seated with their laptops alone not interacting or engaging with their surroundings, however it was clear that they seemed to enjoy working and playing with their creations. We observed a couple of instances where children were engaged with the robot mouse and BBC Micro:bit and played together with a family member or a mentor, laughing about what they managed to program.

Workshops have a high track of repeat participants – some families have joined more than 10 workshops in the 18 months that the workshops have been running in the museum. Families and mentors commented that this is because children visit the workshops in their free time, and they are not part of their schoolwork. This could also be because they can work on their own projects, make their own decisions, and build on them over time, and because they can access the activities online themselves. Therefore, they associate CoderDojo as an activity that they can do during their free time outside school environment and consider it as a hobby.

There were times that the format of the workshops caused a level of uncertainty for first time participants whose only reference point was a classroom setting. However, children adapted quite easily to the new environment and enjoyed the informal set up and the chance to work on their own and make their own decisions. To this helped the support of the mentors as well that explained them how it works and helped them settle. The workshops encouraged children to continue to work on their own projects as they get more and more familiar with the programming languages.

4.2 'Show and tell' sessions

The show and tell sessions were proven to be the highlight of the workshop. They provided an opportunity for parents and mentors to see the children's work; it was a source of pride for them. We observed parents were clapping and cheering for their children when presenting their work. Parents also commented on the excitement children had after the show and tell sessions and that they were feeling proud and satisfied. It is worth mentioning that at the beginning and during the 60min of programming it was not clear for the researcher why children had joined the workshops. However, their intentions were made clear during the show and tell session. Children's excitement grew drastically, and the anticipation and enthusiasm were obvious. Children could reflect on their work, provide their own thoughts, and share with everyone in the workshop what they had done, the task they had completed, the challenges they faced and where they succeeded or failed. They could show off their work and receive praise.

Families said in their interviews that children found the show and tell useful as it was an opportunity to share their product with others and get inspired by other projects at the same time. They also serve as discussion points for their children at home; they talk about the

activities they saw and how they can develop their own project. Families commented on the importance of all children sharing their work no matter their progress. Even though it was observed that some children new to the workshops were initially shy to participate. Mentors and parents encouraged them to participate explaining that the purpose of it isn't to provide a final product and that they will be able to continue working on their projects, but to share their progress, thinking and future steps. Families found that this helps their children to process their activities and have a better understanding of what coding can do and why they do the activities. Parents said that the show and tell session is one of the reasons why they chose to come to the workshops.

4.3 Facilitation during the workshops

Mentors wandered from table to table and asked if children were alright, checking on their progress and whether they needed help. 'I am just walking around, let me know if you need help' or 'What are you working on?'. At times, mentors assign tables between themselves, depending on the volunteers available and the preferred coding language. Doing this makes it easier for them to help children and focus their attention but also manage facilitation. This adds to the comments some volunteers had that the parent's involvement must be emphasized and the need to participate when joining the workshops. With their involvement mentors thought that workshops would run better because the numbers of mentors available on the day aren't enough to give one on one support to every child. They noted that this will also manage parents' expectations on the level of facilitation provided during the workshops.

Coding mentors tend to see themselves mostly as helpers; they mainly respond to children's requests and act as observers moving around, rarely intervening. Coding mentor's interaction with children was mainly about the coding activities, troubleshooting Wi-Fi issues or getting them setup with the programming software. They noted that they usually spend more time with newcomers to set them up with the workshops and the activities rather than with children that are familiar with the workshops. At the same time, coding mentors tend to not share any of their personal coding related experiences and interests with families and children and when museum staff introduce them tend to just share their name and no other information. Asked about this they thought that families would not be interested in their experiences and that families joined the workshops to learn.

4.4 Children's behavior

Families and mentors noted that they feel that children are task-focused and prefer to be left alone to focus on their activities and would not want to engage with the mentors.

When communications occurred, children preferred to chat with members within their family group, either a sibling or a friend. Observations and interviews showed that participants rely as well on their peer's support with the activities. This was particularly noted with children on the same language table that had chosen the same activity or with children that were using the same programming language. Coding mentors said that children preferred to ask their peers for help rather than the volunteers. This might be because children feel more confident

sharing their ideas and work with a friend/sibling or someone with a similar age and experience. There was not any distinction between girls' and boys' engagement and coding mentors felt that in many cases girls that join the workshops are more settled and determined about coding than the boys.

4.5 Families' respond to the mentors

Families were pleased with the mentors during the workshops. They found mentors friendly, helpful, approachable, available, supportive, and discreet in their approach. Adult participants reported that the mentors had tried their best to help and come up with solutions. Regular participants mentioned that they felt that they had built a relationship with coding mentors that they usually have short chats and they were able to recall some names. On the contrary, children did not appear to be interested with the mentors other than their knowledge of programming. Parents noted that their children were usually very focused on their activities and did not engage with anything else. This could also be because the workshop approach was to provide task-related support and mentors did not share their own interests and science backgrounds/stories which could have helped children to empathize with mentors and engaged with them. It is worth noting that coding mentors did not feel that they had built relationships with the families joining and that their interactions were purely around coding. Families see mentors as coding experts and tended not to question their expertise, knowledge, and qualifications. They are pleased with the museum's justification that they are coding experts during the initial introductions 'I will introduce you to the coding mentors, the experts!'.

4.5 Communicating coding skills

Interviews showed that families and mentors felt that workshops are effective in communicating coding skills because they get to learn through play 'You can make a crazy witch or anything you like', 'Learn by trying things, like playing Lego', 'Make things fly'. Parents commented that the playful nature of the activities helps them to have fun and enjoy the workshops and maintains their engagement 'Just a fun time for the family, a little bit competitive'. In addition to the variety of coding languages, activities, and levels and with the workshops allowing them to engage with anything they wanted while they did not require a finished product/activity for them to be successful 'Definitely not a course, learn by trying things, there isn't a target, it is up to you', 'Allows them to be creative, try different things, unlike school is not formulated'.

Observations also showed that mentors at times use everyday examples to explain activities and phenomena that occur at the workshops. For example, in order to help a child understand how BBC Micro:bit function, a mentor used the frequencies and colours of the traffic lights. Everyday examples also appeared through various activities for instance, activities guiding children to make a website, a card or build a dice. However, when asked, families and mentors did not think that the workshops made explicit links to how coding skills are relevant to the children's everyday lives. Mentors argued that workshops focus more on challenges and tasks of the activities and the different codes and they do not focus

on how what the children learn applies to their everyday lives. Moreover, they thought that children are invested in the games and activities, and that links to everyday life is not something that they are interested to learn.

Interviews showed also that workshops were also successful in increasing mentors' and parent's existing coding knowledge. Also, parents with little prior knowledge reported that they developed a better understanding of what coding is and where applies in the wider world.

4.5 CoderDojo activities

The activities at the CoderDojo workshops are presented using engaging ways such as animations, unique design, vibrant colors, cartoonish characters, games, and avatars. While the content was delivered using text, videos, audio, graphs, pictures and animated pictures, and slides. Many activities also provided a story line or a scenario for users to follow. These allowed activities to suit a variety of different needs and abilities. At different levels activities also link and build on participants existing knowledge and understanding such as mathematics (geometry, spatial sense, patterning, measurement, numeration) but also basic computing.

Finally, activities are not restricted to the workshops, they are all freely available online and children are encouraged to continue engage outside of the workshop and access the activities online themselves. The museum provides them with a link to all activities. This also serves those who prefer to do their own projects and identify themselves what they want to do and in their own time.

5. Lessons learned

In the workshops we were able to identify some aspects of the science capital principals. The setup of the workshops and the wide range of activities on offer allowed children to be imaginative and creative. Being open-ended, having a trial and error approach and letting children choose the programming language and activities of their liking or even do their own projects and work at their own pace enabled children to shape the nature of their participation and follow their interests. Also, children had the opportunity to share their knowledge and experiences with others during the 'show and tell' sessions and be cheered from their families and other participants that it was rewarding and created a positive reinforcement. Besides, children could extend their experience afterwards accessing the online activities in their own personal time at home or anywhere they wished. This was also an environment that no gender inequalities were identified, and all children -no matter gender or age- were able to coexist and engage.

Coding activities were found to be very engaging for children. They enabled children to grow and make them relevant to themselves while providing an opportunity to develop a unique product that could be shared. They were built on challenges and encouraged competition; there were steps and tasks to follow in a gamified environment but at the same time allowed changes, self-discovery, and self-expression. They had various stimulus to convey the different tasks and capture children's attention. This environment appeared to be crucial in maintaining children's interest in the coding activities. They were easy to start with and follow at their own pace, but open for children to build and tailor to their needs and ideas. Activities were proven to fit well with the four principles of the SMG's framework

Opportunities to develop science capital informed facilitation As mentioned above the research showed that during the workshops at times some science capital principles were applied. However, often there were opportunities to build on science capital dimensions that were missed or could be further refined. Key to this is that mentors do not see themselves as role models and don't recognize the importance of their personal experiences and knowledge and the value they bring to the workshops, even though families see them as experts and they are introduced as experts by the museum. Acknowledging the value of their personal experiences, professional or non and sharing them with children would have possibly changed the interaction they had with children; how children perceive them but also how often and why they interact with mentors.

Also, mentors' approach when interacting with children was mostly task-focused, providing fast answers for their programming issues. Mentors rarely built on children's previous knowledge and experiences or make connections to their everyday life. There were times that mentors were observed interacting with children, especially with newcomers during introductions, using questions to try and learn about their interests, coding knowledge and likes in order to be able to suggest activities and programming languages, however, these interactions were brief and limited.

5.1 Limitations

The study was conducted during the COVID-19 pandemic. The Science Museum closed on 18 March; the last workshops were on 14 March. The researchers could only observe two workshops and attendance at the workshops was lower than usual and participants were those who frequently engaged with informal learning activities and spaces such as museums. The rest of the research was conducted remot

4. Reflections for the next phase of the project

This case study has deepened our understanding of how facilitation is perceived and delivered during the CoderDojo workshops in parallel with participants engagement. To reflect this, future research will focus on how changes in facilitation can improve science engagement. Based on findings of the case study a training course will also be developed for mentors. From this work we hope that we will provide guidance to encourage mentors to share their science interests and backgrounds with participants and further science engagement.