Case study report

1. Partner

Partner name: ovos media Gmbh

Objectives: Is a virtual makerspace a valuable alternative activity to reach children at home, and does it present an attractive format to motivate participants to engage with science?

Case selection: The original second case study chosen by ovos would have been a Futurespace "experimental game". The case study partner Otelo conducts these sort of makerspaces regularly; however, due to the COVID-19 pandemic, schools in Austria were closed by mid-March 2020. The lock-down also led to a stop of all activities offered by Otelo. This is why ovos and Otelo discussed the potential of creating a Virtual Makerspace. This kind of workshop could reach children who were being home-schooled. Moreover, it could provide a research opportunity which has never existed as such, due to the COVID-19 situation.

2. Abstract

Background: Due to the COVID-19 pandemic, schools in Austria were closed by mid-March 2020. The lock-down also led to a stop of all activities offered by ovos' partner Otelo. This is why ovos and Otelo developed two Virtual Makerspaces. These kind of workshops could reach children who were being home-schooled. Moreover, they could provide a research opportunity which has never existed as such, due to the COVID-19 situation.

Research Areas/Questions: Is a virtual makerspace a valuable alternative activity to reach children at home, and does it present an attractive format to motivate participants to engage with science?

Methodology: The limitation of this study is, due to its virtual nature, not being able to observe the students at home as they disconnected in between the instructional and presentation workshops.

Contribution and Findings: A Virtual Makerspace does present a valuable alternative activity to reach a broad variety of children (both female and male) at home; however, it depends on the topics offered in the workshop. The threshold needs to be as low as possible (First Virtual Makerspace); when it becomes more specific and the keywords are more "scienc-y" (Second Virtual Makerspace), it will not attract as many children. In the second case, the children who already have medium to high science capital, will be motivated to join.

3. Method

3.1. Overview and context

When the study was done:

- Workshops: 9th/10th April (First Virtual Makerspace), 7th May (Second Virtual Makerspace),
- Preparation time (Otelo/ovos): 1st April – 8th April; 22nd April - 6th May

Where: Austria

Setting: non-formal / informal; all participants and facilitators were at home during the workshops, using their computers in order to access the Zoom online meetings as well as the COMnPLAYer app); Virtual Makerspaces with online instruction and (voluntary for the First Makerspace) presentation meetings

Type of activity: Making (First Virtual Makerspace), Coding & Robotics (Second Virtual Makerspace)

Science capital focus: Science capital is particularly addressed in section 4 of this case study.

3.2. Participants

Participants:

- First Virtual Makerspace: 17 children, at least 4-5 parents, 2 facilitators, 1 researcher
    - Quantitative study: 17 children
- Second Virtual Makerspace: 4 children, 1 facilitator, 1 researcher
    - Quantitative study: 4 children
    - Qualitative study: 4 children, 1 facilitator
- Quantitative study (survey overarching both workshops): 1 facilitator

Age of participants:

- **First Virtual Makerspace:** The invitation stated children from 8-13 but included children below eight years old if they worked together with their parents.

Female participants	5 (1), 8 (1), 9 (3), 10 (2), 11 (1)
Male participants	5 (1), 6 (2), 8 (2), 9 (1), 10 (2), 11 (1), 13 (1)
Participants in total	5 (2), 6 (2), 8 (3), 9 (4), 10 (4), 11 (2), 13 (1)

- **Second Virtual Makerspace:**

Female participants	11 (1)
Male participants	10(2), 14 (1)
Participants in total	10(2), 11 (1), 14 (1)

Gender: None of the children chose the option "I would rather not say my gender" – they chose either female or male.

- **First Virtual Makerspace:** The First Virtual Makerspace had nine male and eight female participants". The participants were all registered by their parents via email.
- **Second Virtual Makerspace:** There were three male and one female participant.

Language: German

Background of facilitator(s): attended a polytechnical (secondary) school and I realised that she wanted to work in this field (2013), has been working for Otelo since then.

Socio-economic differences and the risks of disadvantage and exclusion: as a whole, this case study does not look at these aspects as we were happy that so many participants registered, despite the COVID-19 crisis.

- **First Virtual Makerspaces:** Out of 17 participants, 11 children live in more rural areas. According to the facilitators from Otelo, the majority of these 11 children had already known the company Otelo before the project.
- **Second Virtual Makerspace:** all four children live in more rural areas of Austria.

Selection process:

- **First Virtual Makerspace**

An invitation (see a template of the makerspace here) to the First Virtual Makerspace was posted on both companies' social media pages. The age group was defined as 8-13 but younger children were also able to join in case their parents helped them. Considering that parents only had two full days to register their children, the number of participants was quite impressive (17). This might have been due to the fact that parents already had to look after and homeschool their children for four weeks at the time of the workshop. The workshop might have provided a welcome distraction to both parents and children.

- **Second Virtual Makerspace**

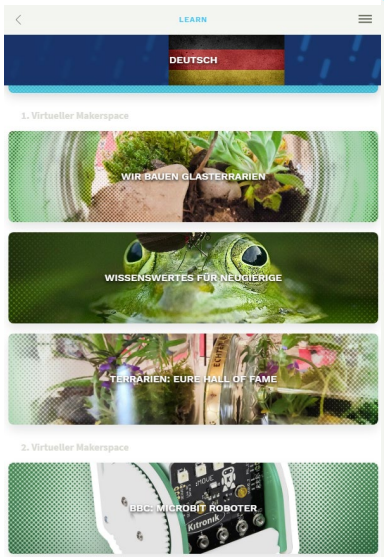
The invitation was sent to the parents whose children had participated in the First Virtual Makerspace. Moreover, it was posted on the companies' Social Media websites. Only four parents registered their children this time. The assumption is that this was due to a higher threshold (in the first makerspace, the only material needed was easy to gather) whereas this time the robots had to be sent by post and even though there was the option to send it back without paying this might have been a reason for parents to decide against registering their children.

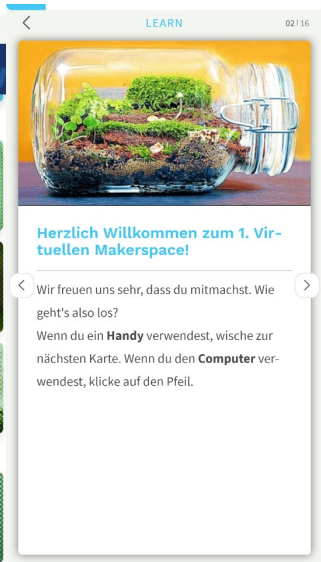
3.3. Procedure

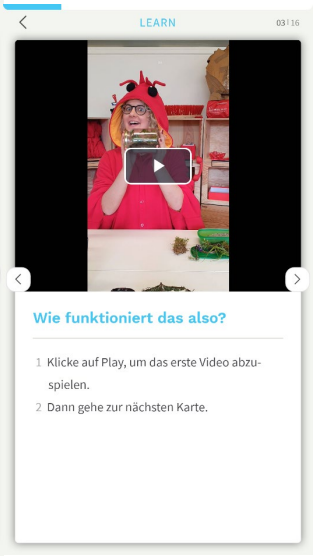
Ovos in partnership with Otelo came up with the concept of the Virtual Makerspace due to the COVID-19 crisis. The original plan had been to research the Otelo Digital Playground "Futurespace" from March to May; however, the lock-down in Austria resolved in the shut-down of schools and all activities such as the Futurespace. As pupils had to remain at home and received digital education, Ovos and Otelo realised something: At this point, children already had online home-schooling for four weeks and they had become accustomed to working digitally. The step towards creating a virtual (online) makerspace was consequently not a big one.

The First Virtual Makerspace: Building Glass terrariums

This workshop was organised within two weeks and set to the mornings of 9th and 10th April 2020. Children in Austria were on Easter holidays during the whole week. It was decided that the first workshop should have a low threshold for children to participate. This meant that they should already have most of the material at home or be able to pick it up easily. Otelo's suggestions to make "glass terrariums", using glass jars and filling them with stones, earth and plants, was therefore considered the most feasible. Otelo produced videos for an instructional step-by-step tutorial which ovos edited and uploaded to the COMnPLAYer app, adding fun pictures, emojis and additional content about science (hermetic spheres, biological circles etc.). Find screenshots from the COMnPLAYer app below and the link to the place in the app.


LEARN
DEUTSCH
1. Virtueller Makerspace
WIR BAUEN GLASTERRARIEN
WISSENSWERTES FÜR NEUGIERIGE
TERRARIEN: EURE HALL OF FAME
2. Virtueller Makerspace
BBC: MICROBIT ROBOTER


LEARN
02 | 16
Herzlich Willkommen zum 1. Virtuellen Makerspace!
Wir freuen uns sehr, dass du mitmachst. Wie geht's also los?
Wenn du ein **Handy** verwendest, wische zur nächsten Karte. Wenn du den **Computer** verwendest, klicke auf den Pfeil.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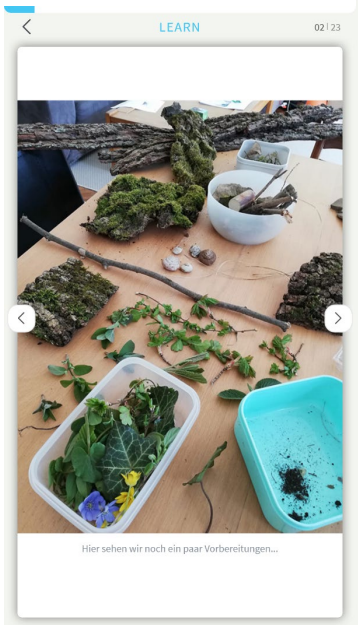
03 | 16
Wie funktioniert das also?
1 Klicke auf Play, um das erste Video abzuspielen.
2 Dann gehe zur nächsten Karte.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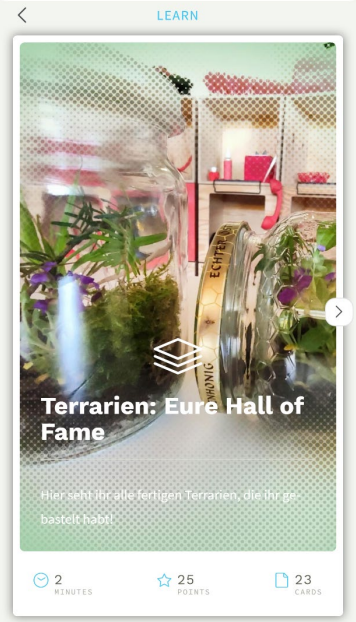
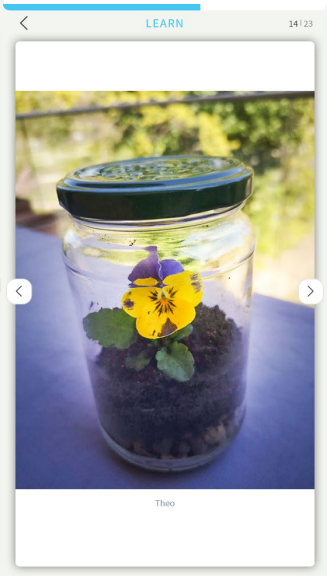
02 | 23
Hier sehen wir noch ein paar Vorbereitungen...


LEARN
Terrarien: Eure Hall of Fame
Hier seht ihr alle fertigen Terrarien, die ihr gebastelt habt!
2 MINUTES
25 POINTS
23 CARDS


LEARN
Wissenswertes für Neugierige
Wenn du dich für Naturwissenschaften interessierst, kannst du hier noch mehr erfahren!
10 MINUTES
25 POINTS
9 CARDS


LEARN
9 | 9
WIE FUNKIONIERT DIE HERMETOSPHÄRE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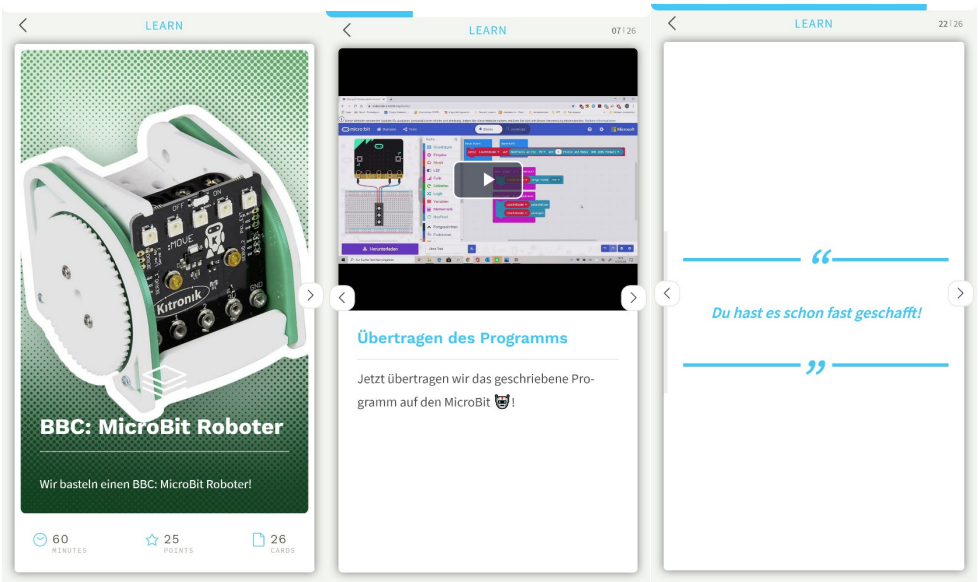
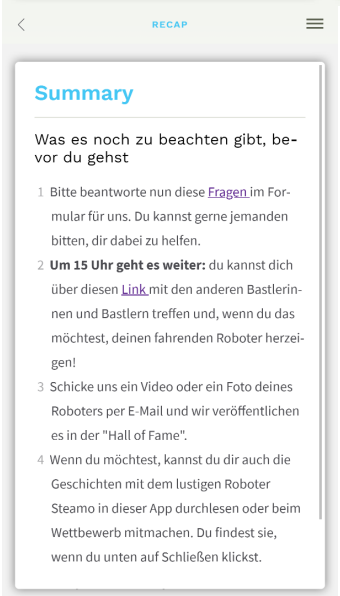
14 | 23
Theo

The Second Virtual Makerspace: Building and programming a BBC MicroBit robot

As the First Virtual Makerspace had been very successful, ovos and Otelo decided to organise a second online workshop. This time, the aspiration was to build something a little more advanced than a glass terrarium, consequently raise the age of possible participants from 8-13 to 10+, and perhaps add some coding to the process of making. Otelo suggested to team up with the company Conrad, an Austrian online shop for technology and electronics. The plan was for Conrad to send the material necessary to build BBC Micro:Bit robot to the participants who had registered. If the participants wanted to keep the robot in the end, they would have to pay 70 euros. The other option was to send the robot back at the end in which case they would not have to pay for it. In the process, Otelo took that sending process from Conrad. Once again, Otelo produced the video for an instructional step-by-step tutorial which ovos edited and uploaded to the COMnPLAYer app, adding designed pictures, fun emojis and the additional links to the online form for the participants to fill out after the workshop. Find screenshots from the COMnPLAYer app below and the link to the place in the app.





Number of occurrences:

There were two Virtual Makerspaces and each workshop was set so the children could finish their project in half a day.

Duration: Each instruction meeting took up to 15 minutes; the facilitator was available in the Zoom meeting for a few hours (2 hours in the first, 2-3 hours in the second); each presentation meeting took 15 minutes.

Group work / individual work: Participants worked individually – except for a few children who worked together because they were siblings living in the same household.

Type of facilitation: The facilitator gave the instructions about the step-by-step-tutorial in the instruction meeting. She was then present in the same Zoom meeting for several hours in order to answer questions if the children came back to ask them.

Throughout the workshop, the facilitator was eager to help with the questions. She treated the children in a friendly, encouraging and reaffirming way and acknowledged their attempts. For example, in the Second Virtual Makerspace, one participant said that something he had programmed was not working which had apparently worked before, which the facilitator jokingly referred to as the "Vorführeffekt" (= something does not work when presented even though it has worked before or vice versa). Seeing her smile as well, this apparently made the participant feel at ease again – he laughed.

During the presentation meetings, the main facilitator (there were two facilitators in the first one) also praised the children's results which made them smile and look proud.

In the Second Virtual Makerspace, we asked the facilitator to provide her observations of the children's reaction, which also indicates that her positive reinforcements and the space itself facilitated discussions – the children started being helpful towards each other:

"I had the feeling that from the beginning, the children were not shy to introduce themselves, to ask questions, particularly when something was not clear. In other workshops, children are often shy in the beginning and they rather try to help each other [than ask questions to the facilitators]. (This might be related to the fact that these children often know each other from before and that there are usually more participants than in the Second Virtual Makerspace workshop."

"What stood out to me is that the children, who had more experience with the Micro:Bit, were also very helpful towards the other children and also helped me out."

"What I also found interesting is that most children tried to solve their problems on their own and (according to them) did not ask their parents for help. Other parents supported their children for the whole workshop."

The (main) facilitator of both workshops was asked to answer the following survey questions:

- **How old are you?**
  22
- **With which gender do you identify most?**
  female
- **Do you work in the field of science and technology?**
  In parts yes, as we have to develop and build up our stations most of the time.
- **Do you work together with schools outside of the Virtual Makerspace?**
  Yes, for example for the Futurespace.
- **Do you take part in other projects in which the focus is on science subjects?**
  Yes (E-MINT, Futurespace, KET)
- **Which experiences do you have in the field of programming?**
  As I completed an apprenticeship as a production technician and worked as an apprentice trainer for two years, I know the programming basics. Before the workshop, I prepared myself programming the Micro:Bit once.
- **Which experiences do you have in the field of robotics?**
  Due to my apprenticeship in production, I got to know several industrial robots; I also work with learning robots in the Futurespace workshops.
- **Which experiences do you have in the field of making/crafting/creating?**

Since I started working for Otelo in July 2019, I have had several points of contact with these topics.

- **How long have you been working with programming/robotics/making outside of this project?**
  Since I went to a polytechnical (secondary) school and I realized that I wanted to work in this field (2013).
- **How many workshops have you led before?**
  Two virtual workshops, two robotics workshops with primary school children and the Futurespace workshop (several times).
- **What do you consider the biggest challenges of the Virtual Makerspaces?**
  I think that the biggest challenge is to get the children motivated so that they actually want to take part – maybe particularly those children who are usually not that interested into technology.
- **Please compare the two Virtual Makerspaces with each other.**
  The First Virtual Makerspace was more open because the theme of the workshop (glass terrariums) allowed it. Moreover, there were hardly any difficulties during the crafting process as not that much could go wrong. The target group was a different one and the first workshop was a bit more "chaotic" (than the second one). This was probably also due to the bigger number of children in the first workshop, compared to the second workshop.
- **Would you add anything to the two Virtual Makerspaces?**
  -
- **What effect could a workshop such as the Virtual Makerspace have on the future career of** participating students?
  I think that the workshops have the potential to promote or awaken the interest of children in science. The workshops will have different effects on different children but I think it important that all of them have the chance to take part.
- **Are workshops like the Virtual Makerspaces particularly appropriate to fascinate girls for science topics?**
  I think that the Virtual Makerspace was appropriate for all sexes and that perhaps some girls might be less shy to try out something new and just participate – especially, because they are at home and therefore they do not feel "observed" the whole time. Everyone can work at their own pace and comparing yourself with others is not happening during the workshop.
- **Do you think that shy/introverted children are more likely to open up or present something to others in a virtual workshop?**
  I have the feeling that most children find it easier in front of a camera than, for example, when sitting in a circle.
- **Do you feel that it is a more equitable room than in an offline workshop because not everyone can talk the whole time?**
  I think that this probably depends on the children and the workshop leader.

Instructions given to participants:

The workshop was set in the mornings (9 and 10 a.m.), with the online instruction meeting starting at 10 a.m. The researcher and one facilitator (two in the first one) were present together with the participants of the workshop. The (main) facilitator introduced herself.

Only in the Second Virtual Makerspace, which had a higher age group and fewer children, the facilitator asked everyone to introduce themselves as well and to state their former experience with a programming/robotics workshop.

In both Makerspaces, the facilitator then presented the COMnPLAYer app by sharing her screen. She showed the participants where they could find the topic that included the instructional step-by-step video of the Second Virtual Makerspace. She told the participants that she would be there and that they could leave the meeting and come back later should they have any questions.

The presentation meeting was set for the next day (1st Makerspace) and 3 p.m. on the same day (2nd Makerspace).

Use of research instruments: The research instruments used in both workshops were quantitative (survey). The First Virtual Makerspace was the playing ground for the Second Virtual Makerspace as we needed to see what worked and so the qualitative research methods (interview, observations) were mostly introduced in the second workshop.

3.4. Resources

The invitations were sent out as PDFs/Google Docs and contained the links to the COMnPLAYer app, the online survey forms and the zoom links. Videos filmed by Otelo and edited by ovos were uploaded to the COMnPLAYer app (German section). Zoom was used as the tool for the instruction and presentation meetings. The participants as well as the researcher and facilitators used their computers in order to access the online meetings, the app and (in case of the Second Virtual Makerspace) the programming platform https://makecode.microbit.org/. The MicroBit robot parts were sent to the participants of the Second Virtual Makerspace.

3.5. Data collection and
3.6. Data analysis

- **First Virtual Makerspace**
  - Quantitative study (PRE-WORKSHOP SURVEY; POST-WORKSHOP SURVEY)
- **Second Virtual Makerspace**
  - Quantitative study (PRE-WORKSHOP SURVEY; POST-WORKSHOP SURVEY)
  - Qualitative study: INTERVIEWS with children (a video was recorded of the presentation meeting and transcribed), OBSERVATIONS by facilitator and researcher during the online presence of the children.
  - Method of Triangulation: In the presentation meeting at 3 p.m., the children were asked to put the MicroBit robot in front of the camera or to share the screen with everyone and show their display. The interviews were recorded and transcribed, however, for reasons of readability, summarised further below.

In this second evaluation of the data, the method of triangulation was attempted. The reason for this was that after the interviews had been conducted with the four participants, it seemed obvious to the researcher that it might be interesting to complement the data received from the PRE-WORKSHOP SURVEY with the interview questions that were posed to the participants during the presentation because they might be interlinked. However, to keep a clear distinction, the words “interview” and “survey” will mark the transition.

- **Overarching survey** (Trainer survey) in order to get the insight from the facilitator who is used to conducting “live” makerspaces.

4. Results

4.1 First Virtual Makerspace

PRE-WORKSHOP SURVEY

The following 10 questions are part of the PRE-WORKSHOP SURVEY:

1. What gender do you identify with?

The First Virtual Makerspace had nine male and eight female participants (none of the children chose the option "I would rather not say my gender". The participants were all registered by their parents via email.

2. What is your age?

The invitation stated children from 8-13 but included children below eight years old if they worked together with their parents.

Female participants	5 (1), 8 (1), 9 (3), 10 (2), 11 (1)
Male participants	5 (1), 6 (2), 8 (2), 9 (1), 10 (2), 11 (1), 13 (1)
Participants in total	5 (2), 6 (2), 8 (3), 9 (4), 10 (4), 11 (2), 13 (1)

3. Are you interested in one or several SCIENCE subjects (mathematics, IT, science, technology)?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	4	2	2
Male participants	0	1	2	2	4
Participants in total	0	1	6	4	6

4. Does your school/your teachers promote your interest in science subjects?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	1	5	1	0	1
Male participants	2	0	4	2	1
Participants in total	3	5	5	2	2

5. How often do you participate in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school?

	Never	Rarely	Sometimes	Often	Very often
Female participants	4	3	1	0	0
Male participants	6	3	0	0	0
Participants in total	10	6	1	0	0

6. Have you had any experience in making / crafting?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	2	0	3	3	0
Male participants	3	1	4	1	0
Participants in total	5	1	7	4	0

7. If yes, where did you have this/these experience/s?

Two male participants wrote that they had had this experience at home; one male participant mentioned the “Da Vinci Lab”(the partner ovos worked with in the first case study). There were more comments from girls:

- Make pottery, crafting
- “Miba” summer school
- Analogue while drawing and crafting
- At home in the garden
- workshops, school
- During technical lessons and lego

8. Are you interested in making/crafting?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	1	1	6
Male participants	0	1	2	2	3
Participants in total	0	1	3	3	9

9. In future, would you like to do a job in which you can create something?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	1	2	2	3
Male participants	0	0	2	2	4
Participants in total	0	1	4	4	7

10. What are your expectations of the workshop?

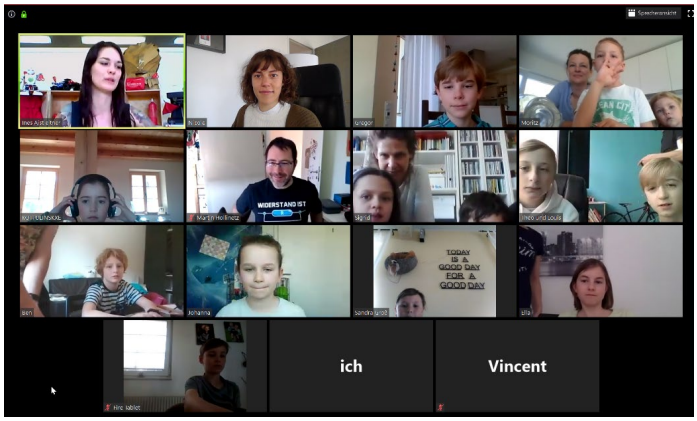
- Girls’ expectations were:
  - “entertainment and passion about creation
  - “to build a great aquarium with my dad”
  - “fun and experimentation”
  - “to learn something exciting”
  - “crafting together”
  - “having new experiences creating something”
  - “to be surprised”

- Boys’ expectations were:
  - “entertainment and fun with my sister and mum”
  - “having fun building an aquarium”
  - “building a nice aquarium”
  - “nothing in particular”
  - “to get an insight”
  - “to see what is possible virtually”
  - “uncertain”
  - “something good”

After the workshop

The children were asked to fill out the POST-WORKSHOP SURVEY form. Unfortunately, the number of responses was not the same as for the PRE-WORKSHOP SURVEY – only 12 out of 17 participants filled it out. This might have been due to the fact that the workshop presentation was set to the next morning (10th April). One reason could be that the children's motivation to present their results and/or answer questions about something they had done a day before decreased after a full day. As could be seen in the screenshots of the two online meetings (instruction (picture 1) and presentation (picture 2)), the number of people participating in the online workshop (excluding the facilitators) decreased from 17 on 9th April to 9/10 on 10th April.

The instruction online meeting (1)



The presentation online meeting (2)

POST-WORKSHOP SURVEY

12 children chose to take part in the POST-WORKSHOP SURVEY. As we had to split up the forms that were sent in, we split the questions in PRE-WORKSHOP SURVEY and POST-WORKSHOP SURVEY but, unfortunately, forgot to include the question "What gender do you identify as?". This is why the results below stem from all participants.

1. Did you like the Virtual Makerspace?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	0	1	11

2. Would you like to take part in a second Virtual Makerspace?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	1	0	0	3	8

3. Would you like to take part in other science projects (mathematics, IT, science, technology)?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	1	0	0	6	5

4. Were you able to use your knowledge in science subjects during the workshop?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	1	0	6	3	1

5. Have you learned anything new about making/crafting through the workshop?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	2	4	6

6. What has been particularly challenging in this workshop?

- "Hammering a hole"
- "Planting plants"
- "Searching for suitable material and animals in the garden"
- "Getting the plants into the glass"
- "That mum did not know how to use the app in the beginning"
- "Getting the plants into the glass and raise them up"
- "The choice when building"
- "Adding the ants to the terrarium"
- "Digging up the flowers"
- "Placing the plants in the glass"
- "The 3-year-old"
- "Searching for a worm"

7. How well did you find your way around the app?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	3	6	3

8. How well did the "Zoom"-meeting work?

	Badly	Not that well	Mediocre	Well	Very well
All participants	0	0	1	4	7

9. Did you manage to finish your project?

All participants said that they had finished the glass terrarium.

10. Will you participate in the presentation meeting tomorrow?

Nine participants said yes, three said no.

11. What would you do differently in a future workshop?

- Three participants said "nothing".
- "The host was logged out intermittently, no questions could be asked and one was excluded from the meeting and could not log back in again."
- "everything was great."

- "Choose a different room/space for the implementation"
- "Water the plants less; to make it lying down"

12. Is there anything else you would like to mention?

- "I really enjoyed it."
- "My result will be sent by email as there is no webcam available."
- "Thanks a lot for the interesting morning!!"
- "It was very interesting. THANK YOU"
- "That it was very cool."
- "Can we at some point make something with dinosaurs?"
- "I liked it and Zoom provides a good opportunity to exchange views."
- "I would like to have snails living in the terrarium as I only have worms in it. At least there are 5."

The Hall of Fame

The children were asked to send in pictures of their glass terrariums which most of them did. Ovos uploaded these pictures to the COMnPLAYer app "Hall of Fame".

4.2 Second Virtual Makerspace

PRE-WORKSHOP SURVEY

1. What gender do you identify with most?

There were three male participants and one female participant.

2. Did you take part in the First Virtual Makerspace?

	Yes	No
Female participants	1	0
Male participants	2	1
All participants	3	1

3. Are you interested in one or several SCIENCE subjects (mathematics, IT, science, technology)?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	0	0	1
Male participants	0	0	1	0	2
Participants in total	0	0	1	0	3

4. Does your school/your teachers promote your interest in science subjects?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	0	1	0
Male participants	0	1	1	0	1
Participants in total	0	1	1	1	1

5. How often do you participate in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school?

	Never	Rarely	Sometimes	Often	Very often
Female participants	0	1	0	0	0
Male participants	1	1	1	0	0
Participants in total	1	2	1	0	0

6. Have you had any experience in making / crafting?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	0	1	0
Male participants	0	1	1	0	1
Participants in total	0	1	1	1	1

7. If yes, where did you have this/these experience/s?

- Welios Wels, AEC Linz, EV3 ROBOTER at home
- Summer-Camp-4kids HTL/WY
- Miba, Otelo
- First Virtual Makerspace

8. Are you interested in making/crafting?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	0	1	0
Male participants	0	1	0	1	1
Participants in total	0	1	0	2	1

9. In future, would you like to do a job in which you can create something?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Female participants	0	0	0	1	0
Male participants	1	1	1	0	0
Participants in total	1	1	1	1	0

10. What are your expectations of the workshop?

- Girls' expectations were:
    - Fun and a functioning MicroBit

- Boys' expectations were:
    - To learn more about this topic
    - Cool experimentation
    - No idea

Method of Triangulation

The following participants, who were registered by their parents via email, took part (names have been changed due to GDPR): Ludwig (male, 14), Gustav (male, 10), Jakob (male, 10) and Sandra (female, 11).

a) **Sandra (female, 11)**

Asked in the first online meeting, she stated that her experiences with robotics and/or programming before the makerspace were programming a robot and using Scratch in IT lessons at school.

The PRE-WORKSHOP SURVEY results (summarised for better readability)

Sandra also took part in the First Virtual Makerspace. She stated that she is very interested in one or several SCIENCE subjects (mathematics, IT, science, technology). Her school/ teachers promote her interest

in science subjects. She rarely participates in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school. With regards to making / crafting, Sandra has had an average experience so far ("Miba, Otelo"). She is interested in making/crafting and would like to have a job in future in which she can create something. Her expectations of the workshop were "to have fun and a functioning MicroBit".

Interview after the workshop

Sandra was the first one of the participants that the researcher and the facilitator interviewed. She had experienced difficulties during the building of the robot (the MicroBit set that she was sent was faulty). According to the facilitator, this had, however, not been a problem for her:

"Sandra was very solution-oriented and relaxed. The fact that her robot could not be built due to a defect in the base plate did not spoil her motivation. I had the feeling that she was happy when Ludwig (14) helped her and she was also always ready to help when others had issues with their programming."

Despite the above mentioned issues, Sandra made a video of what she had already programmed with the lights. When asked whether she had worked on it herself or had any support, she said that she had done it herself while her mom was doing her job working from home in the other room. Sandra also stated that she enjoyed the virtual makerspace very much and would definitely join again if there was another one planned. The facilitator asked her whether she had experienced another workshop (at school or with friends) and if so, did she experience any differences not knowing anyone of the participants. Sandra said that she still enjoyed it and that it was a nice distraction of a "normal home-schooling day" to which she implied to as overwhelming due to the number of teachers.

b) **Gustav (male, 10)**

Asked in the first online meeting, he stated that his experiences with robotics and/or programming before the makerspace were programming with Scratch.

The PRE-WORKSHOP SURVEY results (summarised for better readability)

Gustav had also taken part in the First Virtual Makerspace. He stated that he is averagely interested in one or several SCIENCE subjects (mathematics, IT, science, technology). His school/ teachers do not promote his interest in science subjects well. He never participates in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school. With regards to making / crafting, Gustav has had not much experience so far ("First Virtual Makerspace"). He is not very interested in making/crafting and would not be very interested in having a job in future in which he can create something. He did not have any expectations of the workshop.

Interview after the workshop

Gustav shared his screen and presented the programming website https://makecode.microbit.org with which the children had programmed different parts of the robot. Gustav did not say much but showed the participants how he had programmed that the word HELLO was visible. He added that other than that the robot could "only" go around and show lights – which was, in his eyes, "not as much". When asked by the researcher, Gustav stated that he had set up the robot alone, that he had enjoyed it and he would take part in a workshop again.

c) **Jakob (male, 10)**

Asked in the first online meeting, he stated that his experiences with robotics and/or programming before the makerspace consisted in programming a lego robot.

The PRE-WORKSHOP SURVEY results (summarised for better readability)

Jakob had also taken part in the First Virtual Makerspace. He stated that he is very interested in one or several SCIENCE subjects (mathematics, IT, science, technology). His school/ teachers averagely promote

his interest in science subjects. He rarely participates in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school. With regards to making / crafting, Jakob has had a lot of experience so far ("Summer-Camp-4kids HTL/WY"). He is very interested in making/crafting but would not be interested at all in having a job in future in which he can create something. His expectations of the workshop was "some cool experimentation".

Interview after the workshop

Jakob's younger brother apparently had helped as he was visible next to him in the video. They shared their screen and showed a video of their robot going through a parcours of bottles on the floor. Jakob added that it had taken a few attempts but that they had finished it in the end. They had also programmed the robot to display the word "READY", a heart and colourful lights. When asked by the facilitator, Gustav stated that he had had help during this workshop, that he had enjoyed it and that he would take part in such a virtual makerspace again. He said that he had taken part in a summer camp of a Technical School where he had experienced programming. The facilitator asked him whether he preferred a virtual workshop to a workshop such as the summer camp during which he could be with fellow children. He said that he did not care and he loved both.

d) Ludwig (male, 14)

Asked in the first online meeting, he stated that his experiences with robotics and/or programming before the makerspace were: Lego Mindstorms robot and MicroBit at school

The PRE-WORKSHOP SURVEY results (summarised for better readability)

Ludwig had not taken part in the First Virtual Makerspace. He stated that he is very interested in one or several SCIENCE subjects (mathematics, IT, science, technology). His school/ teachers promote his interest in science subjects very well. He sometimes participates in activities such as coding labs/ future labs/ making labs/ Futurespace/ Robotics etc. outside of school. With regards to making / crafting, Jakob has had an average experience so far ("Welios Wels, AEC Linz, EV3 ROBOTER at home") He is interested in making/crafting and averagely interested in having a job in future in which he can create something. His expectation of the workshop was to "find out more about this cool topic".

Interview after the workshop

Ludwig preferred to show his robot directly on the camera (he held it up for everyone to see). He said that he had incorporated lights that flashed in the colours of a traffic light. He had also wanted to make the robot turn by 180 degrees but that had not worked out. Apparently, some things were not working as they should, such as that the lights should switch off after a few seconds. Asked by the researcher, he stated that he had really enjoyed it and that he would take part in another workshop – no matter whether it was a virtual or offline one. He said to him a workshop that was a little more advanced / that expands on the basics learned in this course would also be appealing.

In order to give a full picture, the results of the POST-WORKSHOP SURVEY are as follows.

POST-WORKSHOP SURVEY

1. Did you like the Virtual Workshop?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	0	0	4

2. Would you like to take part in a further Virtual Makerspace?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

All participants	0	0	0	0	4

3. Would you like to take part in other science projects (mathematics, IT, science technology)?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	1	1	2

4. Were you able to use your knowledge in the science field in the workshop?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	2	0	2

5. Did you learn anything new in the workshop?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	0	1	3

5a. If you learned something new, what exactly was that?

- "I improved the way I work with the micro controller and the PC"
- "Programming of Microbits"
- "That there are additional programming packages"
- "The way the robot is programmed"

6. What was particularly challenging in this workshop?

- "The dissimilar servos"
- "To calibrate the servos correctly"
- "Nothing"
- "The calibration of the servos"

7. How well did you find your way around the app?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
All participants	0	0	0	1	3

8. How well did the meeting in Zoom work?

	Badly	Not so well	Mediocre	Well	Very well
All participants	0	0	0	0	4

9. Did you manage to finish your project?

	Yes	No
All participants	3	1

10. What would you do differently in a future workshop?

- "Final presentation would be better in the evening"
- "Nothing. Everything was fine."
- "What is being delivered should be equivalent to the video - I had two different wheels and one step was not necessary ("washer" for installing the servos) which was very confusing; and the side panels looked different."

11. Will you keep your Micro:Bit robot?

	Yes	No
All participants	3	1

12. Is there anything else you'd like to add?

- "The screw for calibrating the servos was so tiny (despite the huge tool range in the house, no screwdriver fit) and it was difficult to adjust. As a whole, it was a fantastic workshop and I have a lot of joy with the robot."
- "It was very fun and I look forward to the next workshop"
- "Thank you for the great workshop □**"**

The researcher's observations

The children were not shy to re-enter via the Zoom link throughout the given available time of the facilitator and ask questions. Examples for these questions were "How do I find the Makerspace in the app again?" or "The robot already does something when I put in the batteries even though I haven't programmed it", "I'm having problems downloading the data", etc.

During the presentation at the end of the workshop, the researcher and the facilitator asked one child at a time, taking turns. The facilitator started asking the first child directly. When this was done, the researcher decided to ask who wanted to go next but the children seemed a little shy so she asked one specific child to continue.

Throughout the workshop, the facilitator was eager to help with the questions. She treated the children in a friendly, encouraging and reaffirming way and acknowledged their attempts and results. For example, one participant said that something he had programmed was not working which had apparently worked before, which the facilitator jokingly referred to as the "Vorführeffekt" (= something does not work when presented even though it has worked before or vice versa). Seeing her smile as well, this apparently made the participant feel at ease again – he laughed.

The lens of Science Capital

The facilitator did not directly mention opportunities for studying the topic of the workshop in the future; however, she referred to possibilities of future (Virtual Makerspaces). They did not link topic knowledge and skills to future jobs – the workshop had an explorative character. She introduced herself and her backgrounds very briefly – they did not explicitly explain their interest and experience in the topic to the participants of the workshops. The facilitator did not ask about people that participants may know working in the field or a related-field. She encouraged further activities relating to the workshop to be done later, specifically to try out different programming of the robot. Moreover, she sought to find out about the participant's interests outside of the workshop (see **Interview after the Workshop**).

To what extent are facilitators broadening what counts as science/coding/making? How could they broaden what counts?

The topic of coding should always be understood in the context of designing and automating processes. Societal demands and desires towards the design of life and experience are not only conveyed but also reflected. Otelo focuses in all its educational activities in the technical field also on social value and the resulting impact. Otelo's approach is that it is important to empower people to shape their own future, so that they are not shaped by technology of those who develop and market technology. In their mediation

formats Otelo rely on participative research and always involve potential target groups in the development of new formats. This results in a learning and development effect, both between teachers and learners. They are currently implementing this approach in various research projects with different target and age groups. Their programs range from kindergarten children to senior citizens. They also try to carefully use digital tools for teaching, but always reflect on how these tools affect their own lives and environment. Otelo is not a purely scientific institution, but was developed out of a civil society process to establish Citizen Science at a regional level. With their current 37 locations, they have an extensive "sensor network" that provides them not only with data about needs but also with important impulses for the integration of science and technology into the social environment. This has enabled Otelo to establish a network where citizens feel they are an active part of a research community.

Are there opportunities to personalise and localise making/coding with respect to participants interests and experiences? What could they do?

The format of the "Virtual Makerspace" offers the possibility to act directly in the living environment of the participants and to integrate this environment individually. In the case of children, the background and attitudes of the parents also become apparent because they are usually involved in the preparation of the programme. This is especially helpful in order to establish a personal relationship to life and in the reflection of what has been experienced/learned to find a path for their own further development. Otelo always bring the content into social and personal contexts. With the format of the virtual Makerspaces they are still at the beginning of a development and are currently working on the expansion of this format.

How do facilitators elicit contributions which build on participants own knowledge/experience, value these & then link these to formal/canonical science concepts? What could they do?

Otelo has been carrying out their participatory research programmes in various areas of social and technical innovation for 10 years. Otelo developed a concept of creating prepared environments for issues that have emerged from the community. Within these, new content and mediation formats could be developed. They also refer to these development environments as "Montessori Kindergarten for Citizens". By cooperating with partners such as the Science Center Network or various universities, they are also able to create new impulses that initiate and elicit new interactions and developments. This bottom-up approach enables the experience as active members of a research and design community.

How can incorporate more instances to celebrate and cement what children know, who they know, how they think and what they do. What could they do?

With its offers, such as the Virtual Makerspace, the Futurespace and also the KET (Kinder erleben Technik) program, Otelo always tries different dimensions such as professional potential, social impact or even impact on the own way of life. Cultural influences and barriers are also addressed and, if possible, integrated into the programs. Most of their pedagogical staff have pedagogical and technical training. Recruitment has mostly taken place through direct cooperation and through the teaching activities of their staff at pedagogical universities and the Kunstunversität-Linz (media design).

The involvement of parents in the preparation and implementation of the Virtual Maker Space and the sometimes necessary support of parents also leads to a reflection and deepening of the content in the family atmosphere.

5. Lessons learned

With regards to this case study, the format worked quite well for the setting. The surveys and interviews could have been more extensive and in more detail. Unfortunately, the surveys had to be split into two Google forms (due to the fact that the workshops were split into two sections). In the second form, the question about gender and age were not asked as they were in the first form.

The facilitator survey and observations by the facilitator and researcher led to interesting insights. Applying the Science Capital teaching approach during a Virtual Makerspace would prove useful to encourage participants of future Virtual Makerspaces even more and help them realise what counts.

Overall, the case study on the Virtual Makerspaces reinforced our perception of the success of providing online/virtual workshops, particularly in times of a pandemic. The trends show that the importance for children to find their way around digital tools will increase in the future and that jobs of the future might look different. The Virtual Makerspaces worked well with the participants as can be seen from the feedback in the post-surveys and interviews with the second group.

Making it more attractive to a broader audience may be easier if the virtual makerspace is offered through schools. A second level would certainly be to describe the workshop differently - by using a story or challenge - than simply writing up the content of the tutorial videos. That simply does not appeal to many kids of today.