Adult Learning through Tinkering

A toolkit for informal science learning educators working with disadvantaged and underserved communities

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Contents

Introduction

This toolkit is based on work taking place through the Erasmus-funded "Tinkering EU: Addressing the adults"project[1]. A key aim of the project is to bring innovation to the way informal learning (IFL) educators work with adult groups and their families and to support them in developing inclusive Science Technology Engineering and Maths (STEM) learning programming with and for disadvantaged or underserved communities (DUCs). It is reaching out to adults who may not currently identify with STEM learning, who have relatively low levels of confidence with STEM and who are less likely to choose to participate in science-related social, cultural, or training opportunities. In this way, it is targeting adults who are likely to have low levels of 'science capital'. (Archer, Dawson, DeWitt, Godec, et al. 2015; Archer, Dawson, DeWitt, Seakins, et al. 2015).

This document is aimed primarily at Informal Learning (IFL) Educators[2] working with adult learners from DUCs, who wish to:
i)   Exploit the inclusive nature of Tinkering to create engaging and relevant STEM learning experiences for adult learners and their families.
II) Better understand how and why collaboration and co-design with community organisations can help develop more inclusive programming in STEM learning for adults.

It can also serve as a useful reference for community leaders and adult educators wishing to collaborate with the IFL sector to explore the use of Tinkering with the adult groups that they serve.

In this toolkit we aim to provide inspiration, ideas, and approaches that IFL educators and community leaders can use to help them to work more inclusively with adult learners and their families in STEM learning, especially when it comes to working with DUCs It also provides a rationale for using a co-design approach for developing Tinkering programming for adult learners through examples from recent local partnership projects.

The ideas contained in this document come from IFL educators and community leaders who have worked collaboratively to co-design Tinkering activities for underserved adult learners. The organisations involved and their community partners are included in appendix 1. These practitioners reflected on the process of working collaboratively with each other and on the outcomes for the adult learners who took part. Their reflections explore aspects of collaborative working practice and programme design that could help support more inclusive STEM learning experiences through Tinkering. The approach underpinning the process of reflection that this document drew upon is based on an action research and reflective practice model, thus supporting the professional development of the IFL educators involved.

A note about Tinkering as an inclusive approach for STEM learning and engagement

This toolkit does not provide a detailed background on the inclusive nature of Tinkering pedagogy. Such a background provides a starting point for practitioners wishing to explore more equitable ways of working with adult learners from DUCs using Tinkering. Key elements of Tinkering pedagogy that contribute to it being inclusive are:

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1 "Tinkering EU: Addressing the Adults. (2019-1-NL01-KA204-060251), funded with support from the Erasmus+ Programme of the European Union. http://www.museoscienza.it/tinkering-eu3/
2 Practitioners working in education, learning and community engagement roles in science centres, science museums and informal learning settings which could include libraries, Makerspaces, botanical gardens and zoos.

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- ▶ The way it connects with the personal interests and experiences of the learner, helping them to feel that science is relevant to their lives.
- ▶ The fact that it encourages the learner to explore playfully at their own pace.
- ▶ Its low language demand and the fact that there is no pre-requisite STEM knowledge or technical scientific theory.
- ▶ The way it creates more equitable power-relations between facilitators and learners: the learner has control over the direction of their learning and, in many cases, collaborates with the facilitator and others in the workshop.

For a more detailed background on Tinkering as an inclusive approach, there are useful resources which summarise the outcomes of previous European Tinkering projects which have demonstrated the effective use of Tinkering with broad-ranging audiences in informal science settings[3] and the inherently inclusive nature of Tinkering pedagogy for learners who may not feel that science is 'for them'[4].

Toolkit overview

Section 1

Section 1 provides a brief overview of the approach and methods used in "Tinkering EU: Addressing the adults". This aims to contextualise the tools that were developed to:

i) Support adult learning practitioners less familiar with Tinkering to explore the ways in which it can support learning and engagement in STEM (Tool 1).

ii) Support practitioner reflections around the use of Tinkering in the context of equitable learning (Tool 2).

iii) Support practitioner reflections about the benefits of working collaboratively across the informal learning and community sectors to co-design Tinkering programming for adult learners (Tool 3).

iv) Gather feedback from adult learners taking part in Tinkering sessions (Tool 4).

These tools are provided to help you embark on a similar process of partnership work and co-design with a local community organisation.

Section 2

Section 2 draws together insights from practitioners and adult learners involved in the project, summarised as five key messages for museum educators wishing to explore the use of Tinkering pedagogy with adult learners, focusing on disadvantaged and underserved adult audiences.

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3 "Tinkering: Contemporary Education for Innovators of Tomorrow" (2014-1-IT02-KA200-003510): http://www.museoscienza.it/tinkering-eu/

4 "Tinkering: Building Science Capital for ALL" (2017-1-IT02-KA201-036513), funded with support from the Erasmus+ Programme of the European Union: http://www.museoscienza.it/tinkering-eu2/

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Section 1:
Project approach

1.1
Project methods

The broad approach adopted in "Tinkering: Addressing the adults" is summarised in figure 1 which also shows the points at which different tools were used to capture the ideas, thoughts and reflections of the different stakeholders involved in each local project.

1.2
Project approach in-brief: partnership and co-design for supporting more equitable Tinkering programme development

1. Participating IFL organisations identified a target adult audience currently underserved or underrepresented in their visitor profile. At the same time, they reflected internally as a team on their current situation in relation to provision for that target group.
2. Participating IFL organisations reached out to community partners who might wish to collaborate on a Tinkering programme that would be co-designed with the community partner. The community partner served as a 'bridge' between the science museum and the adult learner participants, helping to support recruitment and provide deep insights into the needs, experiences, motivations, and interests of the target audience. For the community partners, this was an opportunity to explore the role that Tinkering could play in supporting the adult learners they work with.
3. IFL staff already familiar with Tinkering methodology worked closely with community leaders from the partner community organisation and Tinkering experts to draw together initial ideas for Tinkering themes and/or activities that could work with the target adult group.
4. The IFL staff and community leaders continued to meet to collaborate on the design of the Tinkering activity/activities.
5. The Tinkering activities were tested with the adult groups and further refined for wider use.
6. The informal science learning staff and community leaders reflected together on the process, the sessions, and on the impacts for the adult learners.

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Each ISL organisation identified a target DUC audience and sought **partnership** with a community group or organisation already working with adult learners in that DUC.

IFL staff reflected together on their current situation in relation to inclusive practice for programming for adult learners from DUCs (Equity Compass Tool).

Initial meetings were held to discuss:
▶ Tinkering pedagogy as an inclusive approach for STEM learning.
▶ The background, needs, motivations and assets of the adult learners.

A joint collaborative planning and design meeting was held involving Tinkering experts, IFL educators and the community leaders from the community organisation.

The community leaders and IFL educators worked together to fine-tune ideas for a **co-designed** Tinkering activity for the target adult learners.

The co-designed Tinkering sessions were piloted with the adult learners.

Community leaders observed the Tinkering sessions **(tool 1)** and reflected on what they had observed **(tool 2)**.

Adult learners completed a short evaluation form at the end of the session which was translated into learner's own language **(tool 4)**.

A joint reflective discussion meeting was held between the IFL educators and the community leaders to reflect on the process of working together/co-design **(tool 3)**.

Fine-tuning was undertaken and programming was then prepared for a wider roll-out with a larger group of adult learners.
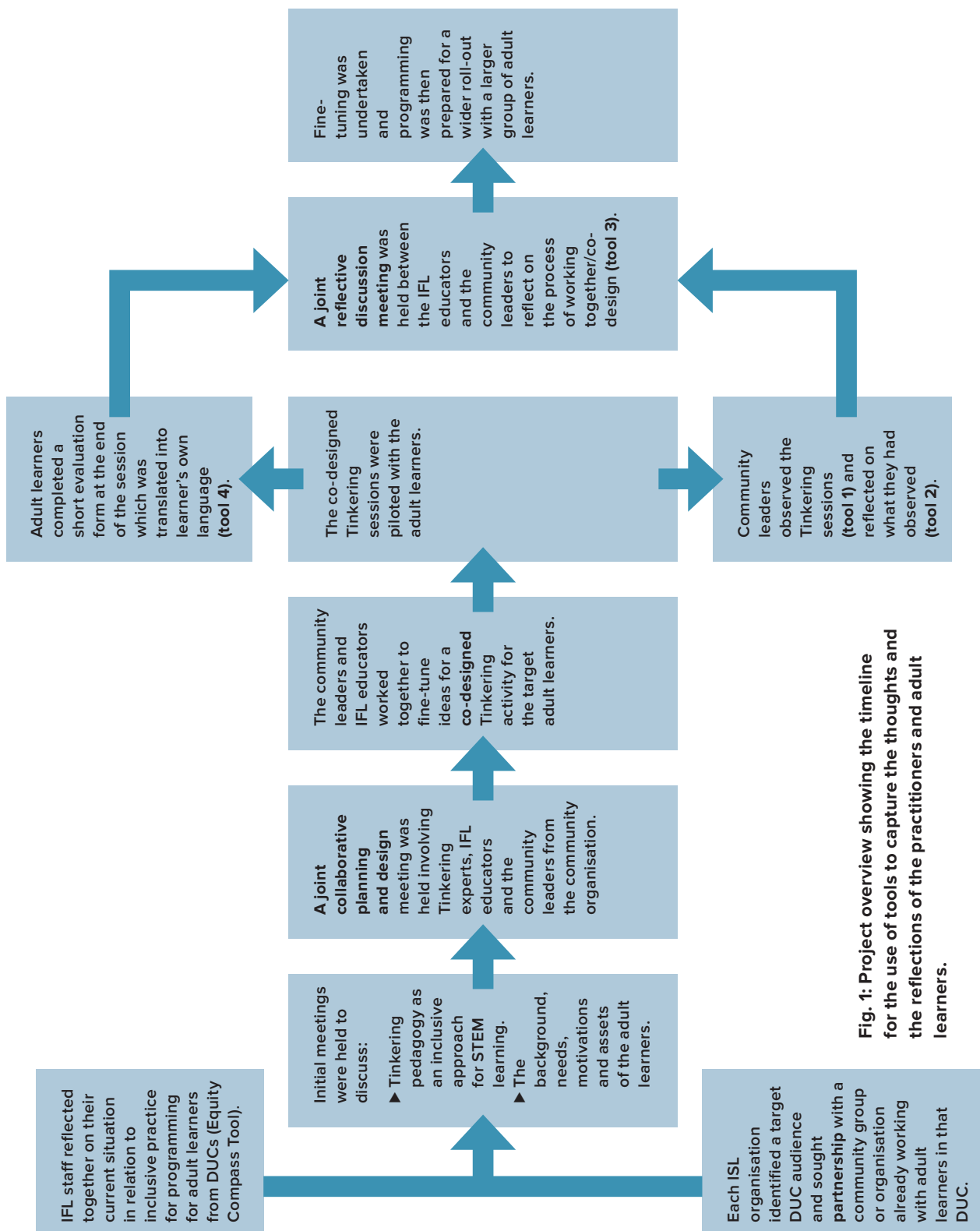
Fig. 1: Project overview showing the timeline for the use of tools to capture the thoughts and the reflections of the practitioners and adult learners.

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1.3
The tools

At key points in the project, a set of tools were used to capture the thoughts and reflections of the participating practitioners and adult learners. The four tools, which are described in this section, aimed to gather thoughts and reflections from the different types of stakeholders involved in each local co-designed Adult Learning Tinkering project. They helped capture data about i) the potential impact of using a Tinkering approach with underserved audiences and ii) the potential benefits of using a co-design approach. These benefits might be for the informal science learning practitioners and the community leaders themselves, their teams, their wider organisations, the adult participants and/or the wider sector.

Tool 1: Observation tool
This tool can be used by community leaders (CLs) who accompany their adult groups when the adults are participating in Tinkering. It aims to support the CLs to make observations about learning moments they see during the Tinkering workshops. It provides a set of observation prompts that relate to the Tinkering 'learning dimensions' (skills and behaviours)[4] in non-technical language that should not require any prior knowledge or training. The most easily observed of the Tinkering learning dimensions are included in the tool to help introduce and highlight these to practitioners less familiar with Tinkering pedagogy.

Tool 2: Reflection tool
This is provided here on paper but was administered in our project using online software. This reflection tool can support community leaders to reflect on the use of Tinkering in the specific context of the adults that they work with, after they have observed Tinkering 'in action'. It includes questions that touch on both skill acquisition and the inclusivity of Tinkering for these adults.

Tools 1 and 2 are designed for use by community group leaders who accompany a group to take part in a Tinkering workshop, and who have regular and ongoing contact with the adult learners. The community leader will need to know the group of adult learners well to get the most out of these tools.

5 For more detailed information on the Learning Dimensions of Tinkering visit: **https://www.exploratorium.edu/tinkering/our-work/learning-dimensions-making-and-tinkering**

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1 1

Tool 1: Observing Tinkering

Tinkering develops many different dimensions of learning which are shaped by the personal interests and experiences of the learner.

Use this recording sheet to note down your observations as you watch your group Tinkering. What learning do you see happening? Do you see any of the learning dimensions listed here? You might notice other things that interest or surprise you about how or what is being learned.

LEARNING DIMENSIONS

- Teamworking
- Communicating with others
- Sharing ideas
- Identifying a problem
- Observing
- Asking questions to help solve a problem or pursue a goal
- Using materials in creative or new ways
- Working through frustrations and developing workarounds
- Teaching, showing or helping others
- Testing things out / testing ideas
- Setting their own goals or following their own idea
- Participating actively
- Expressing pride / ownership / joy
- Making connections with personal interests and experiences
- Being creative

Take some time during the session today to observe one or two participants or groups closely for around 5 minutes. Observe interesting things that participants do or talk about.

Observation 1

OBSERVATION PROMPTS

- Are they working alone or with others?
- What tools/materials are they using?
- Are they trying to solve a problem?
- What do they discuss?
- Can you tell if they are engaged/ interested? How?
- Do you see anything happening from the Learning Dimensions?

Observation 1

OBSERVATION PROMPTS

- Are they working alone or with others?
- What tools/materials are they using?
- Are they trying to solve a problem?
- What do they discuss?
- Can you tell if they are engaged/ interested? How?
- Do you see anything happening from the Learning Dimensions?

Thinking about learning and/or skills that you observed, note down any three things that most interest you about what is taking place:

Make a note of anything that surprises you or which you did not expect to happen.

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Tool 2: Reflections after observing Tinkering

Think about the Tinkering you observed. In what ways do you think the experience benefitted the participants. List what you think are the top THREE benefits.

1.

2.

3.

To what extent do you think the adults felt comfortable, at ease and welcomed?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (Please circle) |

Not at all   A lot

If you think they did not feel comfortable, explain why not?

To what extent do you think the adults could relate to and engage with the workshop? In other words, to what extent do you think they felt it valued and linked to their interests and was 'for them'?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | (Please circle) |

Not at all   A lot

If you think they did not relate or engage, explain why not?

Would you involve your group(s) in something like this again?

Yes   No   Maybe   (Please circle)

Please include any comments on this if you have any:

Would you recommend this programme to others working in the same sector as you? ould you involve your group(s) in something like this again?

Yes   No   Maybe   (Please circle)

Please include any comments on this if you have any:

What were the three most interesting things that you noticed about what or how the adults were learning during the session?

1.

2.

3.

Now that you have observed Tinkering and got to know a little bit more about it, to what extent do you think Tinkering could help to develop the following 21st century skill areas for adult learners? Please indicate on the 1-7 scale for each skill area:

Creativity and divergent thinking
- Using a wide range of idea creation techniques such as planning, sketching, brainstorming.
- Developing unique strategies, tools, objects, or outcomes.
- Creating new ways to use materials or tools.
- Setting personal long-and short-term goals and planning ways to achieve these

0   1   2   3   4   5   6   7
Not at all   A lot

Ingenuity, inventiveness, innovativeness
- Using or modifying others' ideas or strategies to create something new.
- Demonstrating originality and inventiveness.
- Coming up with novel solutions and possibilities when faced with problems or obstacles.

0   1   2   3   4   5   6   7
Not at all   A lot

Communication and collaboration
- Incorporating input and feedback from other people (e.g. peers or a facilitator) into their work.
- Developing, implementing and communicating new ideas to others effectively.
- Being open and responsive to new and diverse ideas.

0   1   2   3   4   5   6   7
Not at all   A lot

Problem solving, critical thinking and strategic thinking
- Posing or identifying problems to solve.
- Coming up with solutions or methods to try to find solutions.
- Elaborating, refining, analysing, testing, and evaluating ideas.
- Planning steps for future action.

0   1   2   3   4   5   6   7
Not at all   A lot

Courage, resilience and taking informed risks
- Persisting to find solutions or workarounds.
- Viewing failure as an opportunity to learn – getting stuck and working to become unstuck.
- Trying something new or never (personally) attempted before.
- Trying something where there is a lack of confidence in outcome.
- Becoming comfortable with a process of small successes and frequent mistakes.
- Persisting toward a goal in the face of setbacks or frustration.

0   1   2   3   4   5   6   7
Not at all   A lot

Lifelong learning
- Striving to understand e.g., exploring confusion and/or obstacles to build new understanding.
- Using or connecting their work with prior knowledge and experiences
- Employing what has been learned during explorations.
- Complexifying thinking/understanding by engaging in increasingly complicated and sophisticated work.

0   1   2   3   4   5   6   7
Not at all   A lot

Tool 3: Joint-reflection tool

This tool can help with the planning and delivery of a joint-reflection meeting between co-designing partners to explore the impact of the co-design process on themselves, their teams/organisations, and the target-audience. It provides some contextual information about co-design and two reflection exercises. The first reflection, which is for the individual practitioner, forms a preparation for a subsequent joint meeting where co-designers then reflect together. By reflecting personally (on your own), and then jointly with your co-design team, you can clarify the benefits and challenges of working in this way, as well as identify ways the process could be improved for future work.

Tool 4: Adult participant validation form

The adult participant validation form is a short evaluation and survey-style form designed to be completed by the participants at the end of a Tinkering workshop. In our case, the form was translated into native languages. The form is designed to be light-touch and not onerous to complete. It asks for feedback and includes questions that touch on skill acquisition and the inclusivity (or not) of the Tinkering session for these adults. The inclusion of a range of skill areas with examples of those skills can serve to prompt participant reflection on their learning. As an alternative approach, the workshop facilitator could lead a group discussion about the skills that participants have developed during the workshop as part of a workshop plenary.

Tool 3: Reflecting on the process of co-designing Tinkering

Informal Learning organisations want and need to become more relevant to and representative of the communities that they serve. Working with community groups to conceive and design their programming can be a powerful way to help achieve this. When working with community groups, there are different levels of participation that vary in terms of the level of ownership by the community group:

Contributory	The relationship is mainly at the level of consultation. Participants might make a limited contribution
Collaborative	The organisation works with others to produce something, but staff make critical decisions and remain in overall control.
Co-creative/ co-designed	The community defines the goals of the project, working with the organisation to implement them. The organisation may facilitate skills development to help participants, or input expert advice but the community is supported to make critical decisions to meet their needs first and foremost. The relationship between organisation and participants is driven by core ideals of equality and reciprocity (helping and learning from each other with mutual benefit).
Hosted	The organisation hands over a space or resources to a community group to implement their own projects and work.

Increasing levels of ownership and decision-making by the community group or organisation.

When organisations with complementary aims come together to share knowledge, perspectives, ideas and skills, there can be many mutual benefits for all stakeholders involved. Co-creative or co-designed practice between informal learning institutions and third community organisations allows **knowledge to be shared across professional boundaries**. It involves a process of **mutual learning**. Through this process of mutual learning, greater understanding and respect can be achieved. Mutual learning is also important for maintaining trust in sharing information and knowledge effectively within and across the co-design team.

Co-design can impact not only the design of a specific programme to make it **more inclusive for the end-users**, but it can also impact working cultures and practices of the organisation more widely. It can help informal learning institutions to become **better at listening** and to become **more representative and responsive** to values, experiences, motivations, wants and needs of underserved audiences.

How can a co-design process help the co-designers?

A co-designer is anyone who is actively involved in the co-design process, which could be end users, staff, and volunteers. In our project it has been the science education staff and the community organisation staff. Positive outcomes can include:
- Increased confidence and engagement.
- New and stronger professional connections and relationships.
- Improved access to information.
- Stronger leadership or convening skills.
- Greater knowledge and expertise on a particular issue and/or the co-design process.

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How can a co-design process help the end-users/target audiences of the programme?

The end-user is the adult learner This toolkit is based on work taking place through the Erasmus-funded "Tinkering EU: Addressing the adults", prepared in the pilot phase of the project in anticipation of a wider roll-out of Tinkering events aimed at underserved adult learners taking place from January-August 2022.

How can co-design help the wider organisation and/or the wider sector?

Co-design can improve the way programmes are designed and delivered to make them work better for ISL and museum audiences, the organisations involved in the co-design process and the wider sector. Specific outcomes for your organisation might include:
- Improved knowledge of target audiences' needs and responsiveness to those needs.
- Smarter decision-making.
- Better ideas.
- More effective cooperation between people and organisations, and across disciplines.
- Stronger support for innovation and change.
- Improved relationships between organisations and target audiences.

Reflective thinking to strengthen impact

Now that you have spent time working collaboratively to co-design Tinkering, it is useful to reflect on the way in which you worked with your partners. This will help you to better understand the impact of working in this way on yourselves and the target-audience. By reflecting personally (on your own), and then jointly with your partner organisation, you can clarify the benefits and challenges of working in this way, as well as identify ways the process could be improved for next time.
Aim to do these two reflection exercises as your co-design work is coming to an end and, ideally, no more than 2-3 weeks after it is finished.

Exercise 1: Personal reflections

Use the following questions to gather your own reflection. Note down some answers to the questions to bring to your joint reflective discussion.

- *What expectations or hopes did you have for this project before it started? Do you think these have been met? Please explain why or why not.*
- *What do you think you have learned from working collaboratively with the partner organisation?*
- *How did you, as a collaborator, make decisions jointly and/ or share expertise?*
- *How did the process evolve as you got to know each other better? For example, did your role in the co-design process stay the same or did it evolve or change in nature?*
- *Do you think outcomes have been improved for the target audience of the Tinkering programming? If so, in what way? If not, why not?*

Exercise 2: Joint reflective discussion

Use your personal reflections from the questions above to now reflect together on the key benefits, opportunities, and challenges of working together in this project. Use the following discussion prompts to help structure your reflective conversation.

- *What did you learn from each other?*
- *What were the benefits of making decisions jointly and sharing expertise?*
- *How has your professional relationship with each other evolved as the relationship has developed?*
- *In what ways do you think the co-design process improved the outcomes for the target audience of the Tinkering programming?*
- *Do you think this way of working has affected the way your organisation will work in the future? If so, how?*
- *If you were to embark on this process again, is there anything that you would do differently now in terms of the process of co-design, based on what you have learned during the process?*
- *What do you think have been the main challenges and opportunities of working in this way?*

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Tool 4: Participant Feedback

1. Did you enjoy the workshop today?

     0   1   2   3   4   5   6   7   (Please circle)

Not at all   A lot

2. Did the workshop feel interesting and relevant?   Yes   No   Maybe

3. Would you recommend this workshop to others?   Yes   No   Maybe

4. Did you do any of the following today? (Tick as many as you think apply)

Critical thinking and problem-solving

- ☐ Identifying or working through problems
- ☐ Testing out ideas or solutions
- ☐ Coming up with questions or ideas to find solutions

Courage, resilience, and empowerment

- ☐ Trying things out even though they might not work
- ☐ Persisting even when there were setbacks or frustrations
- ☐ Becoming more confident to try new ways of working

Communication and collaboration

- ☐ Talking about your ideas or explaining things to others
- ☐ Teamworking
- ☐ Teaching, helping or supporting others
- ☐ Practising language skills

Creativity and inventiveness

- ☐ Exploring materials and tools in new or playful ways
- ☐ Using personal experiences and ideas as inspiration
- ☐ Coming up with new ideas or ways of working

5. Is (Polish/French/Italian/German/Dutch) your first language?   Yes   No

6. Do you think that taking part in Tinkering workshops could help people develop their language skills?   Yes   No

7. What would or could have made the experience better?

8. Is there anything you would like to tell us about your experience of taking part?

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Section 2:
Key messages for embarking on co-designed Adult Tinkering projects with disadvantaged and underserved community audiences (DUCs)

This section of the toolkit draws together and summarises the insights gathered from the tools outlined in section 1 and presents these as a guide for planning and developing learner-focussed, community-centred Tinkering projects with adult learners. We hope that this guide can help other organisations wishing to work in a similar way to exploit the inherently inclusive elements of Tinkering pedagogy whilst at the same time, creating highly tailored workshops for adult learners that link to their existing interests, develop existing skills and talents, and introduce new skill areas.

Message 1: Don't be afraid to have difficult conversations within your team or organisation from the start

Central to the success of community-focussed work that bridges informal STEM learning and working with underserved audiences is the motivation and willingness of the organisation to:

▶ Be self-reflective about their current situation in relation to equitable working practices in STEM learning.
▶ Create opportunities that enable a process of change of practice at different levels of the organisation – which could start from the bottom up or the top down.
▶ Learn with and from the community sector through effective partnerships that encourage two-way learning.

In the case of "Tinkering: Addressing the Adults", the five participating informal science organisations all differed in terms of their experiences of working with unserved adult learners, but all, from the outset, were highly motivated to create more inclusive ways of working with these audiences. In the initial planning stages of their project, each organisation met with their internal organisational stakeholders to reflect on their current situation in terms

of inclusive practice and to create a roadmap for next steps. This highlighted 'areas of challenge' that the informal learning practitioners aimed to explore further, either within their own organisational structures or with the community partner organisation they were partnering with.

Examples of areas of challenge identified by the informal learning practitioners from their internal early reflection meetings:

"How can we develop even deeper and more meaningful relationships with our community partners as part of moving toward a more co-creative way of working? And, in working in this way, how can we learn to better match our programming to the needs and interests of the participants?"
  NEMO Science Museum

"How should we deal with tensions that arise when thinking about delivering Tinkering with an intention of 'building skills' or filling a 'skills gap' whilst avoiding a deficit way of thinking – we should be developing activities that draw upon the participants' existing interests and skills and not assuming their lack of participation/ interest is due to lack of skills. We need to reflect on our own processes and how we can make them more relevant i.e., we need to work from the assumption that it is us that need to change and grow and that our adult audiences bring assets that can help and enrich our own practice."
  ScienceCenter-Network

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"How can we build sustainability into the project work so that it can be continued in some form via the community groups we are working with?"
  Copernicus

"Are we seeing a situation of an equitable and inclusive approach (Tinkering) being potentially constrained by an environment that has tendencies to be exclusive e.g., due to entrance fees, other cost, lack of expertise etc. What do we need to do more widely in our organisation to help ensure the success of projects like these?"
  Museo Nazionale Scienza e della Tecnologia Leonardo da Vinci

Recommendations: Before embarking on partnership work, create an opportunity to reflect together as a team on your current working practices in relation to the audience you wish to work with. Think about what areas of challenge exist. You may not be able to resolve these straight away, but don't be afraid to share and discuss these challenges with your community partner as the project progresses to help surface possible challenges and opportunities for learning how to overcome them. You might like to use a planning and reflection tool such as 'The Equity Compass' (http://yestem.org/tools/). Our teams used this tool in the very early stages of planning their community engagement work to help them think about why some practices are more inclusive than others, and how they can better support participants' STEM agency through more inclusive practices.

Message 2: Avoid deficit thinking and work from an assets-based approach

If you are targeting an adult community that you have not worked with before and are underrepresented as visitors to your organisation, avoid making assumptions about their lack of previous participation. There might be barriers that have stood in the way. For example:

- **Social barriers:** limited income; lack of social support; lack of transport; unstable housing or homelessness; language or literacy barriers; personal preferences and beliefs about the necessity and value of ISLIs; physical or mental health issues or disability; day-to-day stress.
- **Structural barriers:** prohibitive costs; physical access issues; scheduling/timing barriers; lack of communication; hidden costs (food, extra costs for activities).
- **Relational barriers:** cultural insensitivity of the organisation; judgemental attitudes or behaviours; failure to engage communities as partners; lack of collaboration or personalisation.

Greater awareness of existing barriers can help you to put measures in place to break them down. You need to be wary, however, that this does not lead you to a deficit way of thinking in which you view lack of participation as stemming from the participants themselves (e.g., their lacking interest or ability to participate) as opposed to understanding how the culture and practices of your programming or wider organisational structures are responsible for reinforcing the lack of participation (Dawson 2014a, 2014b; Taylor 2017; Tlili 2008)Deficit thinking places blame and responsibility for non-participation on the individual. The individual is deemed to be lacking, for example, in desire or willingness to participate and therefore the assumption is that they need to be supported or persuaded to 'come on board' and 'reap the benefits' of what is on offer, as opposed to recognising that what is on offer, what is being

represented and how it is presented, is actually the root of the problem. By working with your community partners to develop a Tinkering programme collaboratively, you can shift the position of power from expert or transmitter of knowledge to equal partners and co-creators with the community that your wish to serve, and in the process learn from them. Working in partnership with local community development organisations at every stage of our project enabled the IFL institutions to actively listen to, learn from, and become more relevant to their target audience.

"As an organisation we were highly impacted by the experiences made during the pilot phase. It helped to deepen our focus on diversity, equity and social inclusion and strengthen our relationships to community partners such as Peregrina. Ideas for new projects and further long-term cooperation are already in the pipeline, such as hiring clients of Peregrina to work with our facilitation team in a project such as the Knowledge°Room – a pop-up science center in Vienna targeting especially vulnerable groups. The project's co-creation approach inspired new forms of collaboration with our external partners and led to the development of activities that we hadn't foreseen. The activity "Dyeing with natural materials" has already been implemented in the Knowledge°Room as part of our Tinkering portfolio and is now motivating children, youth and adults from all strands of life to engage with STEM in a meaningful and empowering way."
  ScienceCenter-Network

"It really felt like a collaboration. I felt you took us seriously and listened to our needs. We are always a bit careful about working with an external party, because a lot of them just want to 'use' our target audience. We don't want to damage the bond with the women, so it's nice to work with a party that takes this into account and is open to working on it and doing it as well as possible. You took us seriously and that makes it feel valuable for us to do this."
  Community Leader working with NEMO Science Museum

"At the beginning I had very low expectations, almost no expectations at all. It is usually so hard and difficult to establish an honest dialogue between the social sector and the cultural sector. Quite often institutions come to us, asking for some people to engage into activities. It often feels like they have to tick the "inclusion box" in their mission statement. I thought that this would have been the umpteenth project in which I had to bridge people from my community to the organization. Within the time, I realized that this project was different. My people were really engaged, respected, and taken into consideration as people and not users. I was deeply engaged myself, both at a personal and professional level: especially during the activities, I wasn't the tutor anymore, I felt myself as part of the group"
  Community leader working with Museo Nazionale Scienza e Tecnologia Leonardo da Vinci

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"[Our Community Leader] observed that the participants, especially the three women from Somalia, had a very skilled level of handicraft in various fields, that they work independently and creatively. Some of his students also have high skills in the STEM area (are engineers, etc.) but are treated like children from people in Austria due to not being proficient in German. [Our Community Leader] noticed a self-reflection moment of [The IFL facilitator] when she recognized that participants had a far higher skill level than expected and she celebrated their skills and successes."
  ScienceCenter-Network

Recommendations: Avoid perpetuating incorrect assumptions about the reasons for non-participation by your target group, which can shift responsibility away from yourselves as practitioners, your programme design, or the wider organisation. Don't ask your adult participants to assimilate into your existing programme structure. You need to reflect on how to re-align or reimagine your practice to become more inclusive, which means deeply valuing what you can learn from the community and what they can bring (their assets) to support, enlighten, and enrich your work. Ask your community partner:

- How do you view our existing programming?
- What are we getting right and what are we getting wrong?
- In what ways do you think our existing programme (or wider organisational structure) might currently serve to exclude this group or make them feel unwelcome?
- How can we better represent the adult learners' interests, skills, and experiences?

Message 3: Know that the process involves a significant investment in time and resources

Working in partnership with local community development organisations to co-develop programming takes time. This is because it involves forming new relationships, being open to feedback, new ideas and new ways of working. But by working collaboratively, you can really increase the impact of your work. You will learn from and with each other, helping to sustain relationships with your community partners and their clients and, in some cases, helping them to embed Tinkering methodology into the existing adult learning work of the community groups. But before you embark on a project to work in this way, be realistic about the time and resources both you and your partner can invest.

"For the community team, they now see how Tinkering can be another tool to support reflective discussion [with the adult learners] as to what skills they have used, how they could apply the learning and skills. The staff could see that the Tinkering workshop can enable broader reflective discussions around not just technical skills but more than that. For some, what made them feel it was 'fun' and 'enjoyable' was that they felt at ease because there was a peaceful atmosphere, that it was welcoming, and because they enjoyed making their 'weird creations' which were playful in nature. They found it funny, quirky, silly, light-hearted. And because we had small group numbers it meant [the facilitator] could connect with each person personally — he got to know the participants."
  TRACES

"…The most important measure of the good impact of this way of working for us is the satisfaction of the participants. During both pilot workshops, we had very positive reactions from the participants, and we saw that they liked this type of activity very much. On the part of the Foundation, we now have many more people willing to participate in these workshops than we are able to accommodate. It proves that thanks to close cooperation we were able to create a good offer for its beneficiaries. Our Partner is already declaring its willingness to continue cooperation on potential future projects of this kind. For us, the key learning is to work with a partner who acts as an intermediary between the end user and us. Earlier, we very often tried to reach out to potentially interested people directly with the offer of our various activities. As this project has shown, finding a valuable partner who can act as an intermediary is very valuable and significantly facilitates our work."

   Copernicus

"We all think we were able to take extra time for the R&D this year thanks to the covid lockdown. Usually it is not so easy to find time. It would be impossible to imagine doing that for each project. That said, everyone thought it was really precious to be able to connect before we did the activities. In this way we felt more confident about each other, and we all would like to find time to have this dynamic reproduced in future projects."

   TRACES

"The more we started working together, the better the relationship developed because we looked together at what works with the target group and what doesn't. For example, the subject of the workshop and by adding an example to the workshop."
  **Community Leader working with
  NEMO Science Museum**

"[Our Community Leader] would like to develop a relationship and wants to show up with the students every few weeks. We discussed possibilities of regular cooperations, dedicated sponsorship from the wissensraum, using the wissensraum".
  ScienceCenter-Network

"This process needs time that is not always easy to find. Some partners would not want to do it if we do not know each other well at first. We established a very strong confidence relationship. The workshops were relevant. We all explored something outside our comfort zone, and explored the comfort zones of each partner and that is very refreshing."
  Community Leader working with Traces

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"On their way back home after the test of the activity, some women were already planning another visit to the Museum (the second of their lives!). I had seen these women under a new light: not just mothers concerned for their families' primary needs or difficulties. What I saw for the first time were women enjoying a moment of wellbeing. For a while they left the role of "mothers" to be just adults enjoying a leisure experience".

Community leader working with Museo Nazionale Scienza e Tecnologia Leonardo da Vinci

"We have been asked not to conclude our collaboration at the end of the project. The community leaders asked us to bring Tinkering in their communities, spreading it not just with a small group, but with them all. They've already imagined different scenarios to do so".

Museo Nazionale Scienza e Tecnologia Leonardo da Vinci

Recommendations: Be mindful that this way of working requires investment in resources and takes time. Be realistic about the time you and your partner have for discursive meetings, reflection, and planning. Avoid tight deadlines and give yourselves the space and time to go on the journey together.

Message 4: Be a responsive listener in a two-way learning process

The IFL practitioners reflected that they needed to be responsive listeners in the conversation, asking questions to gather a clearer picture of the needs and experiences of the group. While you may need to kick-start your work by providing insights in Tinkering methodology for the community leaders, remember that your current ways of working and thinking about how to programme Tinkering may not be the best fit for this group. Stepping back from the detail of your own practice and taking time to really listen and understand the situations of the adult participants you wish to reach will help you to unpick those elements of your existing practice that may create barriers or issues for the target audience. In this way you can start to build up ideas that can make your session more relevant, representative, and engaging for that specific community group.

"As a team we took the time to listen and take the ideas of the community partners. We were intentionally answering/asking questions more than we were suggesting ideas. We took the time to listen to each other and the ideas of the CL were the one that led the creation process."

TRACES

"I allowed myself to share insights. I saw that [the IFL practitioner] was much in restraint and questioning during the research and development process. I loved that it was possible to share intuition, and to feel confident to do so. Everyone was involved according to their expertise."

Community Leader working with Traces

"From the beginning, our community partner shared the opinion that the target group would prefer an output-oriented activity. Ideally the activity would lead to an object or experience the participants can be proud of, which they would later share with their family and friends as well as have feelings of empowerment by trying out new skills. Our partners believed that the women would prefer putting things together, over taking things apart, and that it would be nice if they had something to show at the end of it."
  ScienceCenter-Network

"The co-design process had a big impact on us. I didn't perceive museum staff as the experts that led the work by imposing their rules. I felt valued and part of a joint and mutual process of knowledge."
  Community leader working with Museo Nazionale Scienza e Tecnologia Leonardo da Vinci

"We soon realized that our expertise in Tinkering wasn't enough. If we really intended to make an impact with this group, we should have relied on our partners' expertise. They were the real expert in those adults' needs, expectations, and assets. You can't design an activity without considering and reflecting who you are addressing to".
  Museo Nazionale Scienza e Tecnologia Leonardo da Vinci

Recommendations: Your community partner is a window into the adult community you wish to serve. Facilitate a two-way learning process by becoming a responsive listener throughout the co-design process. Your community partner might be able to support you to consult directly with the participants to seek their ideas, opinions or wishes on ideas that are generated for the programme. Ask your community partner:
- What are the current lived experiences of the adult participants?
- What challenges could they see arising if you were to try your existing Tinkering approach with the participants?
- Are there particular skills that the participants would like to develop?
- What skills, interests and experiences do the participants bring with them that the session could be based around?
- What themes might most interest the group?
- What would most motivate the adult learners to come to a Tinkering workshop? What could put them off or prevent them from participating?

Message 5: Be prepared to 'Tinker' with your Tinkering methodology

The IFL practitioners involved in our project were all experienced in Tinkering pedagogy. What many of the practitioners began to realise, however, as they became more involved in the process of collaborating with their community partners on the activity design, was that they needed to be flexible and responsive to ideas that stretched beyond 'classic' Tinkering methods. Rather than tweaking existing 'tried-and-tested' Tinkering activities, several organisations found themselves developing completely new activities that they would not have envisaged doing without the input and ideas of

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their community partner. And while many characteristics of classic Tinkering methods were retained in the workshops developed, the IFL practitioners reflected that they had a lot to learn from the community partners to develop more relevant programming that really chimed with the interests and experiences of the adult participants that wished to engage.

"The testing really gave us an insight into how you can work with this group [Stichting Studiezalen]. We had two testing activities the day after each other. The language barrier in the first group was bigger than we anticipated but we managed to let them all have a good experience anyway. We changed a few things for the workshop the next day, so it was more suitable for people who understand less Dutch."
  NEMO Science Museum

"We collaborated closely with [name anonymised] from The Tinkering Studio during his stay in Vienna in autumn 2020. During several informal meetings we discussed suitable Tinkering activities for our target group and talked about the advantages and disadvantages of using computational Tinkering within this context. However, after several online meetings with Peregrina, the focus on computational tinkering was abandoned as our community partner didn't agree that this would be the best possible choice for their clients. They stated that the activities shouldn't require any special materials that their clients wouldn't be able to access in their daily lives. Together with our community partner, we discussed what kind of Tinkering

activities were more suitable for the target group and would better meet their interests as well as the jointly formulated goals for the collaboration (such as: the activity we're planning should induce feelings of empowerment). Another criterion for the designing process was that the activity could be easily integrated in the general educational program - also in the long run. In order to co-develop an activity, we conducted two R&D sessions, one of them facilitated by consultants from the Tinkering Studio. As a result, a completely new Tinkering activity was developed: Dyeing with natural materials."
  ScienceCenter-Network

"I do not think we would have developed a tinkering activity about weaving. In the subject choice and in the materials, our community partner, VrouwenVooruit, had a big impact."
  NEMO Science Museum

Recommendations: Adopt a collaborative, co-designed approach with the aim of creating bespoke sessions for your participants that really value their lived experiences. In this way you can support learners to feel that science learning is 'for them' and is relevant to their lives. Be prepared to throw out the Tinkering 'rule book' and look at your existing practice with fresh eyes.

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Useful resources from TinkeringEU

*A Practitioner Guide for Develo*ping and Implementing Tinkering Activities
http://www.museoscienza.it/tinkering-eu/download/
Tinkering-A-practitioner-guide.pdf

Tinkering and Science Capital: Ideas and Perspectives
http://www.museoscienza.it/tinkering-eu2/download/
TinkeringAndScienceCapital_LR.pdf

Tinkering as an inclusive approach for building STEM identity and supporting students facing disadvantage or with low science capital: Considerations from a reflective practice experience with teachers
http://www.museoscienza.it/tinkering-eu2/download/
TINKERING_03_FINAL_LOW.pdf

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Appendix 1:
List of participating informal science learning institutions and the community organisations they partnered with through the pilot phase of "Tinkering: Addressing the Adults".

Copernicus partnered with the **Foundation W secru Matki (Mother's Heart)** while developing the Tinkering activities Building cardboard furniture and Home garden.

- **Foundation W secru Matki (Mother's Heart)** is a non-profit organization/social inclusion charity which supports adults and families facing social or economic difficulty through educational and cultural activities, healthcare and health promotion and social assistance.

Museo Nazionale Scienza e Tecnologia partnered with two associations belonging to the network of **Caritas Ambrosiana**, a philanthropic organisation associated with the Catholic Church founded in Milan in 1963. The Tinkering activities tested were new versions of the Chain Reaction and Light Play.

- With its network, **Caritas Ambrosiana** carries out a range of initiatives to support people with social, health, community and welfare needs. Among them, MUST worked with adults in situation of economic, social, and cultural disadvantage, most of whom had a migratory background.

  The two local organisations involved were:
  PPP (Progetto Parrocchie e Periferie), which works aiming to create and implement strategies to develop active citizenship in the periphery, exploiting the social function of the parish and its educators; it covers four areas that cut diagonally the metropolitan area of Milan (Quart'Oggiaro, Baggio, Molise-Calvairate e Corvetto). QuBì Villapizzone implements social actions with positive fallout for the citizens of Villapizzone (suburban area northwest of Milan), with a specific focus on families and youngsters, trying to meet the needs of the younger generations and their families and the civic heed of the suburb as well.

NEMO Science Museum partnered with **Vrouwen Vooruit**, **Stichting Studiezalen** and **Tinkersjop** while developing the Tinkering activities Interweaving and Send a message.

- **Stichting Vrouwen Vooruit** is a non-profit organization, they aim to reach and support women (especially immigrant) from Amsterdam West and the surrounding area to participate (more) in society, so that they can (continue to) take steps forward in their emancipation, integration and development process.

- **Stichting Studiezalen** is a non-profit organization in Amsterdam. They seek to reach children, youngsters and adults and help them forward through a combination of Life Coaching, homework support and talent development, they offer a tailor-made approach.

- **Tinkersjop** is an organisation in Curaçao working with families, schools and adults to get them acquainted with STEM and give them the opportunity to develop knowledge and skills. The target group is diverse in age, but all come from a low economic and social background.

ScienceCenter-Network partnered with **Peregrina** and **PROSA** while developing the Tinkering activity Dyeing with natural materials and adjusting the activity Wishcards.

- **Peregrina** is a counselling centre for migrant women aged 16 and older. They offer advice and information in legal as well as social matters and help with all questions concerning careers and education. Peregrina offers German language courses for levels A1+ to B1 as well as basic education courses.

- **PROSA** offers basic and compulsory schooling courses for young refugees aged 15 and over. In addition to the courses, counselling by social workers and tutoring support by volunteers is offered.

TRACES partnered with **Service Pénitentiaire d'Insertion et de Probation (SPIP) du Val de Marne** and **Espace Dynamique d'Insertion Césame** while developing the Tinkering activities Popping Balloons and adjusting the activity Dismantling and merging electronic toys.

- **Service Pénitentiaire d'Insertion et de Probation (SPIP) du Val de Marne** is a public service in charge of giving access to culture and training to inmates in the Val de Marne French region. The targeted group will be detainees from the Melun detention center, all men, in long-term detention, average age 45 years.

- **Espace Dynamique d'Insertion Césame**. It is a place of training, experimenting, and exploring for youngsters (16-25 years old) in an underserved neighbourhood in Paris to help them build a better professional and social future. The targeted group are young adults that dropped out of studies and professional world in research for a new professional project.