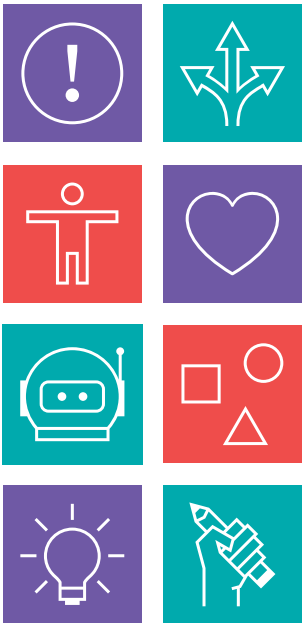
Design Principles and Methods Toolkit



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SCIENCE
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Design Principles and Methods Toolkit for Supporting Science Learning Outside the Classroom

Design for growth

Introducing the Design Principles and Methods Toolkit: What, Why, Who, How?

This document contains a set of design principles and a toolkit with methods for designing science learning activities that take place outside the classroom, in spaces such as science centres, makerspaces, museums, galleries, and gardens. The Design Principles and Methods Toolkit are aimed at science educators, coordinators and facilitators working in a diversity of contexts associated with science learning.

This toolkit hopes to aid the design and facilitation of meaningful science learning activities and programs, with an emphasis on nurturing inclusive science learning. To the best of our knowledge, to date there is not a similar resource available specifically focused on science learning outside the classroom. Thus, we hope that the Design Principles and Methods Toolkit will contribute to the professional development of those involved in non-formal science education by triggering reflection about pedagogical design and practice.

The Design Principles and Methods Toolkit builds on the knowledge and experiences of science education practitioners and learners involved in the SySTEM 2020 project, an EU-funded project that explores science learning in informal and non-formal settings across Europe, and has been generated through a co-design process. Based on the feedback and contributions of SySTEM 2020 partners, science learning outside the classroom is framed as an inter- and transdisciplinary field, in which arts and humanities are central.

The design principles provide general guidelines for designing science learning activities outside the classroom. They are intended as a starting point to aid and inspire

educators and pedagogical coordinators. The design principles included in the toolkit have been distributed in three thematic sections, corresponding to their intended design purpose: for everyone, for experience and for growth. While these thematic sections are not exclusive, they help identify entry points to the principles based on specific needs. The design for everyone principles relate to equity and highlight issues around access, diversity and inclusion in science education outside the classroom. Thus, we encourage the non-formal science education community to consider the design for everyone principles as the foundation for any activity they undertake. The Design for experience principles focus on facilitation practices, while the design for growth emphasise the importance of continuous learning and development for learners and educators.

The toolkit with methods for supporting science learning outside the classroom focuses on bringing the design principles into practice. For this purpose, we have included methods and tips from practice, but also a selection of cases that give the reader a contextualised understanding on adapting those ideas to specific localities and contexts.

The contexts in which people learn about science are extremely diverse. For this reason, the Design Principles and Methods Toolkit does not provide ready-made activities and solutions to replicate in other settings, as we acknowledge the need to respect subtleties in context diversity in which people learn about science. Due to this approach, the toolkit requires the active contribution of the reader to accommodate the principles and methods and adapt them to their unique context and needs.

Design for everyone

MAKE IT ACCESSIBLE
- Being approachable
- Accomodating diverse needs

EMBRACE DIVERSITY
- Showing the diversity of people who engage in science
- Fostering diversity among participants

BE INCLUSIVE
- Developing empathic understanding
- Making it meaningful

Design for everyone builds on the fact that people are diverse and that everyone should have opportunities to participate in science learning regardless of their personal or social circumstances. Supporting equitable approaches to science learning outside the classroom demands a special effort to ensure that science learning is accessible, diverse and inclusive.

Make it accessible

"You can't expect people disengaged with science to visit you. You need to take your education work out to where your audience is."

THERESA CROSSLEY, SCIENCE GALLERY AT KING'S COLLEGE LONDON.

Making science accessible means ensuring there are real opportunities for people to engage in science learning. For this, people need to know about opportunities, have access to, understand the relevant information, and also to be able to take part in the activities. While these might seem basic requirements, making science accessible in practice demands reconsidering how practitioners, educators and researchers communicate science, as well as undertake sustained actions in removing systemic barriers that hinder participation.

BEING APPROACHABLE

"Don't assume you know what people from diverse backgrounds want if you are not part of this community. Test your ideas and get feedback. Involve them in developing a new format."

LAURA WELZENBACH, ARS ELECTRONICA

Choose your wording and advertising channels thoughtfully. Take a moment to reflect on the implicit messages that certain words and images convey about science. Might you be already excluding some groups or giving the idea that science is not connected to their everyday life without being aware of it? While developing this level of awareness might take some time, you don't need to start from scratch. There are many great resources providing communication guidelines for making science accessible to everyone.

FOR BEGINNERS:
Use plain language and avoid jargon.

FOR EXPERTS:
Dedicate time to identify the groups of potential learners that do not participate in your programs and activities. Run creative sessions with your teams to ideate strategies to increase the access of these groups.

ACCOMMODATING DIVERSE NEEDS

To participate in science learning activities, learners must be able to physically join in, as well as feel welcomed, comfortable and able to take part in the tasks. The geographical location of the venue, including stairs, entrance fees and noise levels can hinder participation as well as making learners excluded from science. Step by step, all these barriers need to be tackled in order to accommodate learners' diverse needs.

FOR BEGINNERS:
Engage different senses when designing materials and activities. Consider using modular activities that allow for different levels of complexity.

FOR EXPERTS:
Consult with stakeholders from a diversity of groups with specific needs when designing activities and programs. In case you offer online programs or activities, make sure the resources and the tools are accessible.

"A quiet hour for visitors with special needs: We open the museum for two hours only for families that have members with disabilities. This enables these visitors to enjoy the exhibits and activities without feeling crowded and noise disruptions."

CHAGIT TISHLER AND ETI ORON, BLOOMFIELD SCIENCE MUSEUM JERUSALEM

Embrace diversity

Societies are increasingly diverse and multicultural, and science should reflect this. Building diversity in science education involves providing access, opportunities, and pathways to develop for those from a diversity of educational and socio-cultural backgrounds. Embracing diversity can be achieved by showing how diverse and rich scientific cultures already are, as well as supporting a wide range of interests and participation formats.

SHOWING THE DIVERSITY OF PEOPLE WHO ENGAGE IN SCIENCE

Diversity in science is key to support different ways of thinking and thus, approach a broader range of questions and problems. Broadening learners' understanding of what constitutes "a scientist" by representing the diversity of scientists is an important step which might challenge stereotypes and provide important role-models.

"While showing diversity within science is important, I rather highlight the diversity of applying science to other fields. Artists, makers, designers, businesses who rely on science to be innovative, creative and future proof illustrate the broader range of science more than scientists themselves."

NEEL BOONE, TECHNOPOLIS

"Show diverse role models, but do not emphasise their background and avoid describing them in stereotypical traits. For example, emphasising female scientists as 'the first lady who...' it seems as if their gender is the most defining personal trait."

FRANK VLOET, WAAG SOCIETY

FOR BEGINNERS:
Use little-known examples of people who have made scientific contributions from diverse fields, geographical locations, age and gender. A good practice can consist in creating a go-to list of these that can be shared and referred to in your organisation.

FOR EXPERTS:
The people who facilitate science learning activities are also role-models who can challenge participants' stereotypes. Making such heterogeneity visible is a great way to embrace diversity.

FOSTERING DIVERSITY AMONG PARTICIPANTS

Engaging diverse audiences starts by capturing their interest. The range of topics, the type of activities, tools and even who is taking part in the activities have a strong impact, as some groups might get the idea that "science is not for them" if they cannot find anything that resonates with their interests.

"Always use gender sensitive language."

JELENA JOKSIMOVIC, CENTRE FOR THE PROMOTION OF SCIENCE

FOR BEGINNERS:
Team up with formal education to broaden access to the activities you offer.

FOR EXPERTS:
Develop new collaborations with facilitators who can attract interest from the groups that are hard to reach. Keep balance between different groups of participants and consider having quotas for specific groups.

Be inclusive

"Don't exclude those participants who seem less interested in the activity. Instead, give them a meaningful role in the task."

MATTEO VILLA, MUSEO NAZIONALE DELLA SCIENZA E DELLA TECNOLOGIA LEONARDO DA VINCI

Inclusion in non-formal science education calls for developing learner-centered activities and programs in which all the participants have the opportunity to engage in a way they find meaningful. For this, it is necessary to develop empathic understanding of the learners who take part in the activities. Being culturally responsive and flexible are both important bases for developing inclusive learning environments.

DEVELOPING EMPATHIC UNDERSTANDING

You can't be inclusive if you don't put yourself in your participants' shoes. This means getting information about what they already know, what skills they have, what motivates them or how they feel when taking part in an activity. While answering these questions might be hard due to limitations in knowing in advance the audience of the activity, it is recommended that you develop such understanding throughout the session. This way you will be ready to adapt and respond to your participants' unique needs and wishes.

"It is essential to be open-minded when you organise an activity, leave freedom for changes depending on your participants' needs. Try to think about all the possibilities, although finally you only choose one."

ANA CRESPO, PARQUE DE LAS CIENCIAS

FOR BEGINNERS:
Do not take things for granted! Pose questions and listen to your participants. You can also get relevant information through hands-on tasks.

FOR EXPERTS:
Look for ways for getting feedback throughout the session. This way you would be able to assess and adapt the activity on the go.

BECOMING CULTURALLY RESPONSIVE

Inclusive science education is also about creating environments and designing activities that resonate with learners' cultural backgrounds. Culturally responsive pedagogy starts by acknowledging learners' diverse values and worldviews. Thus, to develop culturally responsive science education it is important to create opportunities that enable learners to make links to their cultural and ethnic backgrounds in the activities and programs.

"Use your participants' local cultural knowledge, such as well-known stories or myths as starting points for informal science learning activities and experiences. It is surprising how relevant topics can be co-opted to make rich learning opportunities."

MAIRÉAD HURLEY, SCIENCE GALLERY DUBLIN

FOR BEGINNERS:
Include a diversity of topics and participation formats in your programs and activities.

FOR EXPERTS:
Show cultural awareness by encouraging participants to relate their personal life and cultural backgrounds to their learning. Keep an eye on festivities from different cultures!

BY TOM TITS EXPERIMENT

FOR FAMILIES WITH CHILDREN AGED 4 TO 12 YEARS

DURING 10 TO 20 MINUTES

EVERYDAY CHEMISTRY:
The kitchen as a lab

The Chemistry Kitchen is based on the idea that people use chemistry everyday and that kitchen cupboards are an excellent source of material for chemistry experiments. Thus, the materials used in the activities consist of easily available chemicals (in supermarkets or similar stores) and a mixture of kitchen utensils and laboratory equipment. These material choices help to bridge the chemistry work that takes place in the kitchen and the laboratory.

The Chemistry Kitchen is open during weekend afternoons for short drop-in activities. The activities are usually very simple and with short instructions. The simplicity helps to motivate participants to talk about their everyday activities and relate them to chemistry. In order to extend the activity beyond the Chemistry Kitchen, the families receive information for continuing the experiments — or trying alternatives- at their home kitchens.

The facilitators should pay special attention to talking about the scientific concepts in everyday language and show the scientific principles that underlie the activities conducted at the Chemistry Kitchen. This is important in order to make parents and carers aware of the scientific concepts related to the activity and encourage them to continue these activities at home with their kids.

IMAGE BY TOM TITS EXPERIMENT.

CONNECTION TO THE DESIGN PRINCIPLES:

MAKE IT ACCESSIBLE

MAKE IT MATTER

KEEP IT ENGAGING

SATURDAY OPEN MAKER SPACE:

Lowering participation barriers to make STEAM accessible

BY RAUMSCHIFF

FOR ALL AGES. MOST PARTICIPANTS ARE 5- TO 11-YEARS OLDS COMING WITHOUT THEIR PARENTS.

DURING FOUR HOURS EVERY SATURDAY AFTERNOON. MOST PARTICIPANTS STAY FOR BETWEEN 30 MINUTES AND 2 HOURS.

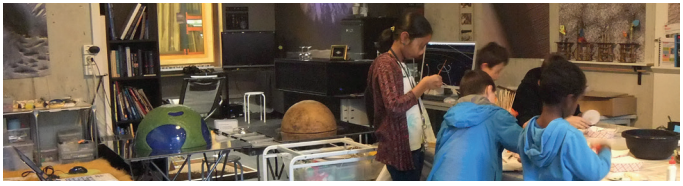
Raumschiff is located in a neighbourhood with many children, most of whom rarely visit a science centre. The space is right beside their playground. In order to support children's participation, barriers like compulsory registration, entrance fees, commitment to a specific date or regular attendance have been removed. The kids have been also involved in organising the space, writing opening signs and making it their own in many ways.

On Saturday afternoons, everyone is invited to join spontaneously in making and tinkering activities. The projects include short introductions to technical tinkering with electrical circuits, motors, LED lights and everyday material. Sometimes, they are linked to astronomy, as this is a central topic at Raumschiff.

All activities are designed to work for drop-in situations, following an open-ended maker and Do-It-Yourself approach. Participants can also pursue their own ideas. A science educator and a scientist support the participants in their personal explorations. The ideas generated during the activity discussions are taken into consideration when planning future programmes and activities.

Participants can use the materials, tools, software and hardware for free. They might need to pay for materials such as electronics or other valuable parts they might want to take home. They can also safely leave their projects at Raumschiff, and continue tinkering another Saturday.

CHILDREN AT THE SATURDAY OPEN MAKER SPACE



CONNECTION TO THE DESIGN PRINCIPLES:

- MAKE IT ACCESSIBLE
- BE INCLUSIVE
- KEEP IT ENGAGING
- INSPIRE & MOTIVATE

BY PARQUE DE LAS CIENCIAS

FOR STUDENTS FROM 9 TO 16, TEACHERS AND GENERAL PUBLIC

TAKES MORE THAN 1 DAY

TRAVELLING SCIENTIFIC MICROEXHIBITIONS:

From the science center to the school neighbourhood

The Travelling Scientific Microexhibitions consist of ready-made exhibition kits that are distributed to schools for them to display to help increase scientific literacy, trigger learners' active involvement and promote scientific vocations by making science accessible and engaging.

The Scientific Microexhibitions address transdisciplinary content like climate change, the relation of science with reality or the life and work of relevant scientists from an interdisciplinary perspective. \he exhibition kits share the same structure: panels with scientific information, didactical materials and a guide with experiments and activities to make scientific concepts tangible. The students are in charge of explaining the content, guiding the visitors to the exhibition and leading the workshops. Before performing these tasks, the students are trained by their school teachers during classroom sessions. By taking an active role in the Microexhibitions, the students are expected to develop scientific communication skills, increase their self-confidence and gain autonomy in learning.

The Microexhibitions have been a successful strategy to collaborate with schools and education communities located in remote villages. They have also contributed in connecting schools with their local communities since the exhibitions are open to everyone.

CONNECTION TO THE DESIGN PRINCIPLES:

MAKE IT ACCESSIBLE

INSPIRE AND MOTIVATE

BUILD SOCIAL LEARNING ENVIRONMENTS

STUDENTS TAKING PART IN THE TRAVELLING SCIENTIFIC MICROEXHIBITIONS.

E-FABRIK:

Empowerment through inclusive design

BY TRACES

FOR YOUNG PEOPLE AGED BETWEEN 15 AND 25 AND PEOPLE WITH DISABILITIES

TAKES 18 WORKSHOP SESSIONS, EACH OF THEM LASTING 2 HOURS

E-Fabrik is a program that embraces social and digital inclusion and empowerment of young people and people with disabilities. By using the digital resources of their area, they develop, create and build concrete solutions that answer a difficulty expressed by the disabled person in the group. E-Fabrik is a journey, a series of encounters, workshops and training sessions for participants (youth and people with disabilities) to lead their projects to completion.

E-Fabrik targets young people, with a special focus on those who live the furthest from digital innovation. Thanks to the local partnerships set up with the neighborhood structures, E-Fabrik has been able to reach young people with limited use and knowledge of ICT (often limited to social media apps). They stay attracted by the solidarity dimension of the project and the digital tools offered.

The people with disabilities involved in the E-Fabrik project have, for the most part, mental and / or physical disabilities. For them, taking part in the project turns out to be very beneficial on various levels.

PARTICIPANTS OF THE E-FABRIK WORKSHOP BY ASSOCIATION TRACES.

CONNECTION TO THE DESIGN PRINCIPLES:

EMBRACE DIVERSITY

BE INCLUSIVE

INSPIRE & MOTIVATE

BY BLOOMFIELD SCIENCE MUSEUM JERUSALEM

FOR TEENAGERS FROM 13 TO 18 YEARS OLD AND THE GENERAL PUBLIC

TAKES 1 OR 2 HOURS

WEARABLES:
Gender inclusion through the design of electronic garments

In this workshop participants build a wearable garment using electronics. Through this process participants learn about design, electricity, circuits and engage in problem solving.

This activity is conducted by two facilitators (more in case the participants use tools with a specific know-how). and is made up of modules to enable diverse learners to engage at their own pace and skill level. For instance, while novices create a simple electrical circuit, learners with more advanced knowledge and skills can add more complex circuits and switches to their wearables.

Participants are provided with a plethora of fabrics, pins, hair ribbons and soft material, batteries, wires and LEDs. The participants work in small groups and are requested to consider the aesthetic and technological aspects when building the garments. Being creative and developing their own strategies to solve diverse challenges is strongly encouraged.

This workshop was designed to be gender inclusive. Thus, during the activity all participants are invited to explore technological tools, and special effort is made in avoiding stereotypical distributions of work based on gender. At the end of the session, participants share their designs with the group and are encouraged to reflect on their personal experiences in relation to gender balance in STEAM.

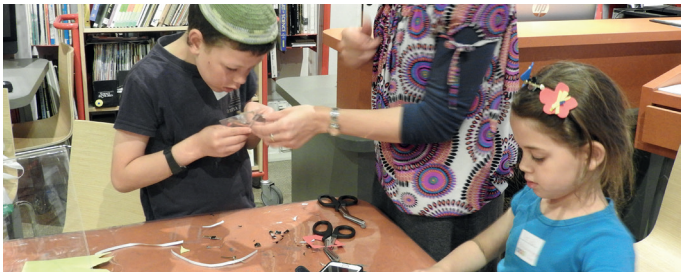
CONNECTION TO THE DESIGN PRINCIPLES:

MAKE IT ACCESSIBLE

EMBRACE DIVERSITY

BE INCLUSIVE

WEARABLES WORKSHOP. IMAGE BY BLOOMFIELD SCIENCE MUSEUM JERUSALEM



Let’s put the design principles into practice

SETTING THE SCENE

Which of the Design Principles would you like to focus on?

MAKE IT ACCESSIBLE

EMBRACE DIVERSITY

BE INCLUSIVE

CHALLENGE YOURSELF

Where do you think you could improve in relation to the principle(s) chosen beside.
Note down a few areas.

MAKE A PLAN

What are your end-goals? This could be: involving a specific audience, developing a new format or supporting a particular strategy at your organisation. Specify a maximum of three.

1.

2.

3.

How are you going to achieve these goals?

MAKE A PLAN

What extra help do you need to do this? For example, is there any extra support, resource or knowledge that you don't have?

What would you recognise as an indicator of success?

What's your timeline? Use this space to sketch/draw out where you are now, where you'd like to get to, and the time and steps required in between.

Design for experience

MAKE IT MATTER
- Showing the relevance of science
- Building on personal interests

KEEP IT ENGAGING
- Triggering positive emotions
- Making concepts tangible
- Encouraging open-ended exploration

INSPIRE AND MOTIVATE
- Guiding learning
- Fostering learners' self-confidence

BUILD SOCIAL LEARNING ENVIRONMENTS
- Encouraging sharing and collaboration
- Cultivating a community feeling

Great learning experiences are meaningful, engaging, inspiring, and they trigger further learning. In education, design for experience is also about the environment where the activity takes place. Many contexts in which informal science learning happens are social spaces. Facilitating successful learning experiences in these contexts requires paying attention to what inspires and motivates your participants, especially in a social context. These design principles and methods focus on the facilitation of science learning in non-formal learning environments.

"There are also three important issues that must be considered and shared at the beginning of the workshop:
- What do the participants expect from each other?
- What do they expect from the facilitators of the workshop?
- What do the facilitators expect from them?"

VANESSA MIGNAN, TRACES

Make it matter

"Science is sometimes still a deterring word. Sometimes it might help to avoid it in titles and descriptions."

HANS CHRISTIAN MERTEN & MARION FRIEDL, ARS ELECTRONICA

People care about what is meaningful for them. When ideating new activities, take some time to envision what would make participants care about science. You can start by showing that science is already relevant in their everyday life, and by encouraging them to connect science to things and activities they are already interested about.

SHOWING THE RELEVANCE OF SCIENCE

The more links learners are able to make to science, the more likely they will find it meaningful. Thus, showing the relations between science and their personal everyday situations is key for helping your audiences realise the meaning and relevance of science in their lives.

FOR BEGINNERS:
Start with what is familiar to the participants. Use examples that connect to their everyday experiences and habits. Don't enforce or direct what these are. Ask your participants and value all their answers.

FOR EXPERTS:
You can go deeper by making links to current societal debates about science. Be ready to handle controversy and diverging positions!

BUILDING ON PERSONAL INTERESTS

Interest and attention go hand in hand. We pay attention to the things we are interested in, and this interest is what will make us engage again with that particular subject in the future. In learning, interest is also deeply connected to the motivation to learn. Thus, a good strategy to support learners' engagement and motivation is to build on what they are already interested in.

FOR BEGINNERS:
Build in a certain degree of freedom to your activities so that learners can adapt them based on their personal interests.

FOR EXPERTS:
Consider using design thinking tools like brain-storming techniques to help learners generate and elaborate their ideas.

Keep it engaging

In learning, engagement is strongly connected to the learners' level of involvement and motivation. When planning activities, think about how participants will engage. Powerful strategies for supporting learners' involvement focus on triggering positive emotions and fostering open-ended explorations. Making science tangible by supporting hands-on activities is also a good way to ensure learners' high level of involvement.

TRIGGERING POSITIVE EMOTIONS

Anxiety and fear are not good learning companions. To support learning, first you need to create a safe environment, where people feel comfortable to make mistakes and ask

"Don't enforce the relevance of science, hand over the mic to your participants to allow them to make the connections. What do they know about gaming? Do they ever cook for themselves? What science was in the news recently? Invite your participants to share their experiences of 'science' and how it relates to their lives. Especially welcome and encourage discussion that redirects focus away from Western science."

SOPHIE PERRY,
SCIENCE GALLERY DUBLIN

"Always start from what children already know – their home, daily experience, what they had for breakfast, what subject they love at school – and build on this to explain a complex subject."

VESSELA GERTCHEVA,
MUZEIKO

"Don't forget that participants do the activity on a (mostly) voluntary basis. It is not school. Also consider that some participants may have had negative school experiences."

HANNA SATHIAPAL,
RAUMSCHIFF

questions without feeling judged, as well as free to experiment. Emotions like curiosity, confidence, trust and joy are powerful drivers for learning in environments that inspire and engage learners. When planning new science activities, think about how to trigger positive emotions that can motivate your participants' and audiences' eagerness to learn.

"Mystery solving is a good way to go. Start your event with a mysterious question, and then make the entire program about solving it."

BORIS KLOBUCAR, CENTRE FOR THE PROMOTION OF SCIENCE

"Don't be afraid to incite other -less positive- emotions in order to achieve positive action. Confusion, disgust, shock, and many other emotions can be a really powerful way into a topic, as long as the learner is supported throughout the experience and empowered to use that initial emotion in positive action."

MAIRÉAD HURLEY, SCIENCE GALLERY DUBLIN

FOR BEGINNERS:
Science offers great opportunities to provoke excitement and fascination through surprise. Use that in your favour to spark curiosity and will to learn!

FOR EXPERTS:
Promote social behaviors like sharing, respect and cooperation to create emotionally safe environments. Encourage reflection on social rules by creating them with your participants.

MAKING CONCEPTS TANGIBLE

Mind and body are not separate entities as people experience the world with both. Be aware of this connection and support understanding of scientific concepts by showing, doing and performing. Learning by making and Do-It-Yourself approaches are also great ways to support learners engage with their full bodies.

FOR BEGINNERS:
Design activities that encourage learners to take an active role and learn by doing. Share the challenges with the families of the younger ones too, so they can do it at home as well!

FOR EXPERTS:
Consider giving your explanations as performances in which you capture your audience's attention and engage them from the very beginning.

"Use examples wisely. Physical artifacts are a great way to explain without speaking. While good examples can inspire, they can also lock down the participant into specific ideas. Think carefully about the examples and have a variety of very different ones."

ELAD PAZ, BLOOMFIELD SCIENCE MUSEUM JERUSALEM

ENCOURAGING OPEN-ENDED EXPLORATION

Scientific literacy is more about understanding processes rather than being acquainted with scientific "truths". For this, activities that encourage open exploration and personal discovery are great ways to support learners to build knowledge based on their first-hand experiences. Plus, figuring out by oneself how something works is engaging and rewarding!

FOR BEGINNERS:
Invite learners to fix something. Set small challenges for them and let them figure out how to make it work.

FOR EXPERTS:
Try using every-day, low-cost materials and tinkering pedagogy. You can also hand out additional documentation so learners can continue exploring on their own and with their friends and family!

Inspire and motivate

When learning is conducted outside the classroom, it is easy to assume that learners are self-driven and motivated. Yet, this might not be always the case. Even if learners are motivated, the facilitation strategies are key in supporting and nurturing learning. Guiding and helping learners gain confidence in their abilities are powerful strategies to facilitate self-directed learning.

GUIDING LEARNING

Guiding is about encouraging the learner to find their own way and supporting that process, while teaching is about showing the way and helping to keep to the path. Guiding offers more freedom, but it also requires more attention to the learners' own interests and ways to go.

FOR BEGINNERS:
While learners might already have access to a lot of information, transforming that information into actionable knowledge is a challenge. You can guide learners' process of knowledge building by asking questions, offering alternatives and giving constructive feedback.

FOR EXPERTS:
Lead by example, there is nothing more inspirational than seeing someone else discover their own path. Remind learners that they need to find their own way.

"Open-ended exploration is simultaneously one of the most fun and the scariest things to do. People expect guidance when experimenting, and as an educator it's hard to find the right balance. I found that storytelling is the answer to this problem as it helps to engage participants in a fictional story that gives them motivation to experiment and try new things to get the story moving."

NEEL BOONE, TECHNOPOLIS

"Don't assume young people will deal well with open-ended exploration. Gauge the audience, and you might have to start with really small steps in open-ended thought. Start too broad or big and a lot of people will close up and the activity will fail."

THERESA CROSSLEY, SCIENCE GALLERY AT KING'S COLLEGE LONDON

"Dare to go on an adventure with the learners without having answers and outcomes yourself. A motto like 'I don't know, but let's find out together', can be very helpful. It allows you to be part of the learning process yourself and to focus on facilitating the process instead of the results."

KARIEN VERMEULEN, WAAG SOCIETY

FOSTERING LEARNERS' SELF-CONFIDENCE

Learning requires self-confidence. When learning, learners need to face new challenges and trust they are able to meet their goals. You can foster learners' self-confidence by helping them set realistic goals, focus on the process and reflect on their past achievements.

FOR BEGINNERS:
Encourage learners to reflect on their strengths and celebrate their achievements.

FOR EXPERTS:
Nurture learners' confidence and reduce their fear of failure by focusing on the process rather than on the outcomes. Reframing «failures» into drafts, prototypes and iterations is a good way to redirect attention into the learning process.

"Highlight that there is no right or wrong when it comes to experimenting. This will foster self-confidence. You always learn and that's the point – if it's right or wrong doesn't matter, learning is in the foreground."

LAURA WELZENBACH, ARS ELECTRONICA

"Tie your hand behind your back and don't hand out solutions too quickly. When a participant is dealing with a problem or failure, it is very easy to simply intervene and hand out the solution. Assess the situation, if the frustration level is not extreme – wait, and let them solve it themselves. They will gain confidence, ownership and agency over their process."

ELAD PAZ, BLOOMFIELD SCIENCE MUSEUM JERUSALEM

"Part of the workshop should be based on the "fail better" concept. Every participant should have a chance to fail, troubleshot and succeed. Let them build something on their own, that you know they will fail. Troubleshot with them and let them succeed."

KRISTIJAN TKALEC, KERSNIKOVA INSTITUTE

Build social learning environments

The social component is an important part of the learning experience. While learners are the ones who build knowledge based on their experiences, this process can be funnier and more motivating if it happens in a social environment. Talking, sharing, working together and feeling part of a community where one can get help and support are strong values you may want to foster when facilitating science learning outside the classroom.

ENCOURAGING SHARING AND COLLABORATION

Sharing and collaboration are about attitudes and behaviours. To create an environment for sharing and collaborating you need to consider the material and the social aspects. Building a collaborative culture takes time and effort, but is extremely rewarding for those involved!

> "Having each tool for each participant kills the collaboration idea. Don't just build gadgets, build friendships."
>
> KRISTIJAN TKALEC, KERSNIKOVA INSTITUTE

FOR BEGINNERS:
Use the space and the materials to nudge sharing and communication. For instance, even if learners work on their own projects, they can share the table with others. Knowing about your peers' projects is a first step towards finding opportunities to collaborate.

FOR EXPERTS:
Encourage knowledge sharing and collaboration through time dedicated to learners talking about their projects and challenges. Make sure everyone understands that the purpose of these sessions is to support and help each other!

CULTIVATING A COMMUNITY FEELING

Having a sense of community supports knowledge exchange and learning amongst peers. By feeling part of a community learners develop self-identities and establish horizontal relationships where power relations are based on merit and expertise.

> "Trigger learners' active involvement by assigning them responsibility roles which work horizontally with both their facilitators as well as their peers. This can be done by, for instance, assigning them a peer-mentorship role and encouraging peer-to-peer learning."
>
> ARIS PAPADOPOULOS, LATRA

FOR BEGINNERS:
Make the people and the work they do visible. One way of doing this is by displaying participants' creations in the workspace, so others can get inspired and identify who to ask for help, in case they need it.

FOR EXPERTS:
Support flexible role taking. Don't be afraid of recognising you don't know something and encourage learners to share their expertise with others facing similar challenges.

BY WAAG SOCIETY

FOR CHILDREN FROM 8 TO 11 YEARS OLD

TAKES 1 OR 2 HOUR

Mapping for understanding global challenges

The mapping exercise is part of a workshop series about sustainability in which the participants create a waste-robot aiming to solve part of the global waste problem. The mapping tool is a method to map big, societal issues like sustainability and global waste in order to make them more concrete and tangible.

During the mapping exercise, the children map out the global production chain of a pair of jeans to see in what part of the product chain waste issues arise. Through mapping, the participants develop a shared understanding of the problem and the steps involved in the production process of a pair of jeans. The mapping tool creates a physical and visual support to discuss the problem from a systemic approach. By dividing the problem in smaller parts, participants become aware of the relation between the parts that make up the problem. This enables children to define the scope of their project and come up with a problem definition on one of the aspects.

Two or three facilitators guide this activity which is addressed to a group of 12 children, approximately. The mapping exercise has a strong collaborative aspect and participants are distributed in teams of four of five members. All the teams share their work with others in order to build the map together.

CONNECTION TO THE DESIGN PRINCIPLES:

MAKE IT MATTER

KEEP IT ENGAGING

BUILD SOCIAL LEARNING ENVIRONMENTS

PROMOTE LEARNER AUTONOMY

DETAIL OF THE MATERIALS USED FOR THE MAPPING EXERCISE. CC BY 4.0 DOIT, HTTP://DOIT-EUROPE.NET, H2020-770063, PICTURE BY WAAG 2019.

THE MICROSCOPE IN ACTION:

A hands-on approach to physics and biology

BY EUROPEAN MOLECULAR BIOLOGY LABORATORY (EMBL)

FOR TEENAGERS OF 13 TO 19 YEARS OLD

TAKES A PERIOD OF TIME RANGING FROM TWO HOURS TO HALF A DAY OR IN EIGHT SESSIONS OF 45 MINUTES EACH

The Microscope in Action (MiA) is an educational resource that bridges the gap between research and schools by bringing a research-grade fluorescence learning microscope to the classroom. In the MiA, students assemble a fully-functional microscope from its individual components, and conduct inquiry-based experiments to understand the applications of fluorescence and imaging in life science research and beyond. A central aspect of the MiA is to foster reflection on the relation between science and technology by showing how technology enables scientists to study the details of life.

The MiA combines the fields of biology, physics and technology with further extensions into chemistry, bioinformatics and arts. The resource is designed to be very flexible with respect to learning level, module length, setting and topic areas, and currently offers complementarities to school curriculum in seven different subject areas for ages 13-19. The modular structure enables teachers to easily adjust the resource for various needs.

The activities of this learning resource stimulate collaboration, learning-by doing and support the development of logical thinking skills in students. The MiA also includes additional learning materials including reading resources, videos and assignment options to engage students in diverse ways.

IMAGE OF THE MICROSCOPE IN ACTION BY MASSIMO DEL PRETE.

CONNECTION TO THE DESIGN PRINCIPLES:

KEEP IT ENGAGING

PROMOTE LEARNER AUTONOMY

BY CENTRE FOR THE PROMOTION OF SCIENCE

FOR CHILDREN AGED BETWEEN 9 AND 13 YEARS

TAKES HALF DAY

PHYLOGENETIC TREE OF IMAGINARY SPECIES:

Learning through storytelling

During the Children's Science Camp, learners were invited to create a completely new insect species named Bubica campensis. The learners applied scientific methodology and made relations between concepts from evolution, geology, phenology, forestry, anatomy and physiology. This activity uses storytelling, to trigger learners' discussion, shifting perspectives and confronting their beliefs.

Learners were introduced to family relationships, natural selection and evolution. These concepts were used as the foundation for a storytelling activity. As part of this task, each of the learners drew an insect and represented the morphological traits that enabled the insect to adapt to a fictional environment which consisted in an archipelago of five distinct islands. Each of the islands represented a different habitat: the mountain rocky desert, jungle, wetland and grassland. Learners matched their drawings with the insect adequate habitat and discussed the adaptations they drew.

The morphological traits of the species were used as a basis for defining a phylogenetic tree, which showed the evolutionary relationships among the species of insects created at the workshop. The phylogenetic tree was made by experts. Together with learners, facilitators traced relatedness among different insects and positioned them in the phylogenetic tree. At the end of the activity, the learners displayed the phylogenetic tree of their imaginary species in a public exhibition.

IMAGINARY SPECIES OF INSECTS CREATED BY THE LEARNERS IN THEIR FICTIONAL .

CONNECTION TO THE DESIGN PRINCIPLES:

KEEP IT ENGAGING

BUILD SOCIAL LEARNING ENVIRONMENTS

LIGHT PAINTING:

Creative expression through experimentation

BY MUZEO NAZIONALLE DELLA SCIENZA E DELLA TECNOLOGIA LEONARDO DA VINCI

FOR CHILDREN AGED 8 AND OLDER

TAKES 1 OR 2 HOURS

The Light painting workshop invites participants to play with light to create photographic effects. The setting and the materials selected for this activity foster participants' creative engagement, encouraging them to self-express and explore the phenomenon of painting with light by experimenting with different possibilities and finding creative solutions.

During the session, the participants use a light source and a computer software that controls a web camera simulating long exposure time. The software captures images continuously and enables participants to "draw" on a photographic image by moving a light source in front of the camera. This activity is quite open and participants are encouraged to tinker with the light source to experiment with diverse effects after showing them examples of light paintings. For instance, they might modify the light source and the materials in order to reflect, refract, diffuse or change the colour of the light. They might even create their own light source and brushes to test what happens when applying different light effects to photos. At the end of the process, participants receive via mail the pictures they produced.

The activity is facilitated by one educator, who introduces and guides the work of a group of 3 to 4 participants. Once the activity starts, the learners work with autonomy. In case more groups work at the same time, it is recommended that there are two facilitators to manage the arrivals of new participants and the engagement in the activity.

IMAGE OF THE LIGHT PAINTING ACTIVITY.

CONNECTION TO THE DESIGN PRINCIPLES:

KEEP IT ENGAGING

PROMOTE LEARNER AUTONOMY

BY LATRA

FOR 6 TO 8 LEARNERS AGED 14 TO 17 YEARS. IT IS IMPORTANT TO CONSIDER GENDER BALANCE WHEN FORMING THE MENTORS' GROUP

TAKES 1 MONTH FOR MENTORS' TRAINING PRIOR TO COMMENCING THE PROGRAM IN WHICH THEY WILL PARTICIPATE.

CONNECTION TO THE DESIGN PRINCIPLES:

INSPIRE AND MOTIVATE

BUILD SOCIAL LEARNING ENVIRONMENTS

SUPPORT IDENTITY BUILDING

PROMOTE LEARNER AUTONOMY

LEARNERS AS MENTORS:

Learning facilitated by peers

Prior to commencing each program, LATRA conducts an open call inviting a small group of teenagers to join as Mentors and work alongside the program facilitator.

Before becoming Mentors, the learners take part in a month-long training that equips them with the soft skills necessary to mentor their peers, such as managing group dynamics, supporting conflict resolution and peer to peer empowerment. During the program, Mentors can put in practice these skills when facilitating, guiding and triggering hands-on participation. The Mentor program has had a positive impact on the participants and the quality of the education activities. In particular, Mentors have contributed to:

- Helping build a stronger relationship between learners and facilitators by bridging the ice and age-gaps
- Improving the learners' experience by offering them guidance in their native tongue.
- Better understanding the learners' needs since they share the learners' age, culture and ethnicity.
- Increasing learners' aspirations to have a stronger involvement in the program by acting as positive role-models.
- Disseminating the program effects by advocating for it within their communities.

IMAGE OF ONE THE LEARNERS AS MENTORS SESSIONS BY LATRA.

COLLABORATION IN ACTION:

Community of young people for intermedia art and science

BY KERSNIKOVA INSTITUTE

FOR LEARNERS FROM 15 TO 29 YEARS OLD

TAKES WEEKLY SESSIONS TO DESIGN WORKSHOPS THAT ARE RUN EVERY WEEK FOR CHILDREN AND ADULTS.

The Community of young people for intermedia art and science enables young people to meet and work together with experts of various fields to understand contemporary projects and concepts. The aim of this project is to encourage young people to develop workshops and art-science projects they are interested in, as well as train them to become future workshop mentors.

In these sessions, young people learn about new technologies and concepts using research learning model approaches like Do-It-Yourself, Do-It-With-Others, hands-on, fail better, the ignorant teacher and peer-to-peer learning. Collaboration and strong motivation are key aspects when designing a workshop. Thus, young people are encouraged to build on their personal interests and team up with people with different knowledge and skills. This is important since mentors are role-models for the children taking part in the workshops they facilitate.

Pairing different expertise is important to ensure that all workshop developers (and future mentors) can bring their strengths and be highly involved. This strategy is also used at the workshops and this is the reason why very different pairs of mentors (for instance: a chemist and a painter; an electrical engineer and a teacher) end working together!

IMAGE BY MIHA GODEC.

CONNECTION TO THE DESIGN PRINCIPLES:

EMBRACE DIVERSITY

KEEP IT ENGAGING

INSPIRE AND MOTIVATE

BUILD SOCIAL LEARNING ENVIRONMENTS

Let's put the design principles into practice

SETTING THE SCENE

Which of the Design Principles would you like to focus on?

MAKE IT MATTER

KEEP IT ENGAGING

INSPIRE AND MOTIVATE

BUILD SOCIAL LEARNING ENVIRONMENTS

CHALLENGE YOURSELF

Where do you think you could improve in relation to the principle(s) chosen beside.
Note down a few areas.

MAKE A PLAN

What are your end-goals? This could be: involving a specific audience, developing a new format or supporting a particular strategy at your organisation. Specify a maximum of three.

1. .....

2. .....

3. .....

How are you going to achieve these goals?

MAKE A PLAN

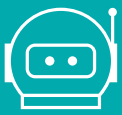
What extra help do you need to do this? For example, is there any extra support, resource or knowledge that you don't have?

What would you recognise as an indicator of success?

What's your timeline? Use this space to sketch/draw out where you are now, where you'd like to get to, and the time and steps required in between.

Design for growth

CREATE PATHWAYS
- Creating continuity and multiple entry points
- Bridging different disciplines



SUPPORT IDENTITY BUILDING
- Recognizing learners' achievements
- Raising awareness of possible futures

PROMOTE LEARNER AUTONOMY
- Supporting learning to learn
- Learn transversal competencies

ASSESS YOUR PRACTICE
- Setting goals and monitoring progress
- Reflecting on your practice

Lifelong learning is as important for learners as for education practitioners. In science education outside the classroom, the learners and educators' sustained growth should be cultivated. In the case of learners, this means helping them become autonomous, as well as building pathways for learning and supporting their science identities. In the case of educators, the emphasis is on developing self-evaluation skills that will help them improve their practice.

Create pathways

Activities and programs that have continuity and coherence help learners gain skills and tackle increasingly complex challenges. Understanding learners' social contexts, their influences and their local environments is also important for enabling multiple entry points and supporting transitions between diverse learning environments that contribute to long-term engagements with science.

CREATING CONTINUITY AND MULTIPLE ENTRY POINTS

People attending a science activity might have very different reasons for taking part in it. Be aware of this variety and make sure that your activities and programs include elements that resonate to audiences' manifold of interests and motivations.

FOR BEGINNERS:
Design each activity so that it includes modules of diverse complexity. This will help you to easily adapt the task based on your participants' interests and skills.

FOR EXPERTS:
Go beyond a single activity and consider how to advance learners' skills throughout your program and in other environments. Make sure learners are aware of these opportunities by highlighting different aspects that connect to their interests.

"Whilst continuity between activities is critical in building up learner's capacity, don't structure continuity in a way that may become a barrier to entry to both existing as well as newly-joined participants. For instance, avoid building-up activities that require acquisition of all learning blocks in order to move to the next one."

ARIS PAPADOPOULOS, LATRA

BRIDGING DIFFERENT DISCIPLINES

Current world challenges go beyond the limits of specific areas of knowledge, as one way of thinking is not enough to understand and tackle these challenges. Understanding how different things are interconnected and learning to think inside and outside the box help to develop a holistic view of science. In science education, this means encouraging learners to make links between different disciplines and master a wide range of skills.

FOR BEGINNERS:
Consider using different techniques to explore a scientific theme. For instance, an arts approach like drama can be a powerful way to bring a scientific story to life.

FOR EXPERTS:
Focus on real-world challenges that don't distinguish between disciplines. Reframing STEM to STEAM (Science, Technology, Engineering, Arts and Mathematics) can help you work around the fringes and explore issues in which science intersects with culture, policy, or art.

"If you use a relevant topic as the focus of your workshop or activity, then a number of disciplines can be used to explore it – demonstrating that one discipline rarely provides a full understanding. For example, Science Gallery doesn't make exhibitions about science and art; we make exhibitions about society, culture, habits and norms. We then explore each of these through a transdisciplinary approach that uses sciences and the arts."

SOPHIE PERRY, SCIENCE GALLERY DUBLIN

Support identity building

Learning is tied to building personal identities. Learners' views on their own abilities has a strong impact on the goals they will set for themselves and how much effort they will put into them. Thus, to support long-term engagement in science learning it's important to create opportunities for learners to develop science identities. You can support science identity-building by recognising their achievements and raising awareness about possible futures connected to science.

"Don't create ways to accredit through ranked prizes. Avoid this when possible, especially if the goal is to reach all learners and encourage them all despite their current STEM identities and abilities."

SHWETA GAIKWAD, EUROPEAN MOLECULAR BIOLOGY LABORATORY

RECOGNISING LEARNERS' ACHIEVEMENTS

Acknowledging learners' achievements in non-formal education is also a way to help them build positive science

identities. Recognition can take many shapes ranging from using digital badges as credentials to more standardised solutions based on accreditation. Whatever is the way to recognise learning, it has to be meaningful for the learners.

> "A great way to trigger reflection on projects and achievements, is to ask the learner the question: 'What does this project mean to you, to others and to the world?"
>
> KARIEN VERMEULEN, WAAG SOCIETY

FOR BEGINNERS:
Celebrate achievements when completing an activity or course. When possible, make it open and invite external audiences!

FOR EXPERTS:
Look for ways to recognise achievement and expertise on the go. Try formulas that encourage peer-recognition with a diversity of skills.

RAISING AWARENESS OF POSSIBLE FUTURES

Long-term goals are hard to pursue, but also hard to imagine. Having a long-term vision can increase motivation for engaging in short-term goals. You can support learners' long-term motivations by raising awareness of possible futures connected to science.

> "Introduce learners to researchers involved in a specific topic of interest. Give researchers the opportunity to tell stories about how they developed interest in science and what was their science path. Give equal importance to the successful and unsuccessful parts of the researchers' stories."
>
> TANJA ADNAĐEVIĆ, CENTRE FOR THE PROMOTION OF SCIENCE

FOR BEGINNERS:
Invite people working in STEAM areas to your programs and sessions. Understanding the work of people who engage in STEAM at a professional level can help learners realise that there is not such division between science and not-science people.

FOR EXPERTS:
Giving examples of contemporary works of people engaged in STEAM can help learners visualise how a science future might look like and how it might impact their lives.

Promote learner autonomy

Becoming autonomous takes time, as it requires finding out what works for oneself. Key strategies for promoting learners' growth and autonomy focus on helping them develop learning to learn abilities and mastering transversal competencies like communication, collaboration, creativity and critical thinking.

SUPPORTING LEARNING TO LEARN

Learning to learn means taking control of the learning process. Autonomous learners who know how to learn are able to set goals, plan how to achieve them, monitor their progress and evaluate the outcome of their efforts. Reflection and self-assessment are an important part of learning to learn skills.

FOR BEGINNERS:
You can support learners to assess their work by asking them questions and making suggestions or light prompts. Invite them to document their projects in a creative way and encourage them to reflect on the process.

FOR EXPERTS:
Encourage learners to set their own goals and plan how they will achieve them. It is important you support them to self-assess their strategies and re-adjust them accordingly.

"To stimulate long-term engagement, it is very important that learners are able to gain autonomy in a learning space; that they gradually get more liberties based on their achievements. It offers a great example and stimulus for other learners as well."

KARIEN VERMEULEN, WAAG SOCIETY

BOOSTING TRANSVERSAL COMPETENCIES

Science learning is not only about hard skills, but also about being able to communicate, collaborate, be creative and think critically. In fact, communication, collaboration, creativity and critical thinking are part of the so-called transversal competencies that are increasingly recognised as key for successful autonomous learners.

FOR BEGINNERS:
Invite learners to work in groups and present their achievements with the whole group.

FOR EXPERTS:
You can trigger creativity and problem solving in groups with different skills by facing them with complex problems that require understanding from different knowledge domains.

"Recognise both learners' 'hard' achievements, such as their completeness of programs, continuity, knowledge build-up, or quality of delivered assignments, as well as learners' 'soft' achievements like their ability to help others and collaborate, contribute to the team spirit and morale, as well as show empathy and compassion."

ARIS PAPADOPOULOS, LATRA

"Having workshops without a trace of research kills creativity. Don't prepare the workshops with step by step instructions so that there is no other way of conducting it."

KRISTIJAN TKALEC, KERSNIKOVA INSTITUTE

Assess your practice

Assessing your practice is a central part of growing and improving. Assessment is about setting goals, monitoring and learning throughout the process of what works and what needs to be improved. Engaging in evaluation is also about taking the time to reflect, individually and as a team, about how well your practice connects to the overarching goals that guide the science learning activities and programs offered at your organisation.

> "Have time dedicated for self-assess or peer-assess within your program not only at the end."
>
> VANESSA MIGNAN, TRACES

> "Don't ignore evaluation, even if you don't have the resources to do it extensively. Find simple ways to monitor progress that work in your particular situation such as collecting numbers, age, gender of participants and writing informal field notes on a regular basis."
>
> HANNA SATHIAPAL, RAUMSCHIFF

> "Monitor progress both by collecting hard data by learners and educators/ facilitators, as well as employing alternative means -driven by the learners- such as storytelling."
>
> ARIS PAPADOPOULOS, LATRA

SETTING GOALS AND MONITORING PROGRESS

Whether you gather 10 or 100 people, your practice has an impact and it is important to think critically about its overall aims and outcomes. Having a vision involves setting goals and making them explicit. Goal setting is a process that involves aspects like defining the criteria, creating commitment and designing routes to reach those goals.

FOR BEGINNERS:

Be transparent about your goals and how you plan to monitor progress. Enable discussion and feedback in order to ensure everyone is comfortable with them.

FOR EXPERTS:

Try setting goals with participatory techniques in which you also involve learners and wider audiences. Participatory monitoring is also a powerful way to support commitment and ensure the goals are useful, viable and feasible.

REFLECTING ON YOUR PRACTICE

Taking the time to reflect and assess the impact of your outcomes helps to learn from past actions and inform the future ones. Reflection can be done individually and as a group. When reflecting, it is important considering a diversity of aspects like your personal impressions, the learners' feedback as well as other types of indicators.

FOR BEGINNERS:
Aim to embed reflection in your work habits. You can do so by debriefing after each session. For instance, you can take notes of your impressions for yourself. Whatever format for reflection you choose, it is important to acknowledge the successes, as well as those aspects that didn't work that well.

FOR EXPERTS:
Dedicate moments to share best practices with your colleagues and iterate the activities and programs. Watching how your peers facilitate science learning activities can help you find inspiration and learn!

"Book in diary time with your team for reflection sessions. Science Gallery Dublin holds compulsory reflections and debriefs after every education workshop. These take place straight after participants leave and they inform future planning and support facilitators' professional development."

AUTUMN BROWN, SCIENCE GALLERY DUBLIN

BY SCIENCE GALLERY AT KING'S COLLEGE LONDON

FOR A SMALL GROUP OF YOUNG PEOPLE AGED BETWEEN 15 AND 25 YEARS

TAKES ONE YEAR

YOUNG LEADERS:
Inspiring diversity

The Young Leaders program brings together young people who represent London cultural diversity and talent, and live, work or study in the London boroughs of Southwark and Lambeth.

The young people taking part in this program are youth ambassadors, advisors and creators who are passionate about bringing new voices to the fore. They do so by programming their own events and projects like workshops, festivals, videos and interviews and collaborating with various staff members at the gallery.

With this initiative, Science Gallery London aims to inspire the next generation of creative thinkers by bringing together artists, researchers, students and local communities. As students and young creatives themselves, the Young Leaders ensure that Science Gallery London work resonates with the institution key audience of 15-25 year olds, bringing new insights and energy to the Gallery.

YOUNG LEADERS, 2019-18,
SCIENCE GALLERY LONDON, KING'S COLLEGE LONDON.

CONNECTION TO THE DESIGN PRINCIPLES:

EMBRACE DIVERSITY

CREATE PATHWAYS

SUPPORT IDENTITY BUILDING

MIND YOUR EGG!

A design challenge for the whole family

BY NOESIS

FOR 7 TO 12 YEARS OLD CHILDREN WITH THEIR FAMILIES

TAKES 2 HOURS

Mind your egg! is a tinkering activity, where participants try to construct a shell to protect their raw egg as they drop it from up above. This activity is part of a program for children and their families in which they develop their skills and achieve meaningful connections with science, technology and mechanics.

During the Mind you egg! activity, children and adults work on the same bench, and using their imagination and creativity, they explore materials, tools and methods. The activity lasts 2 hours and is split in three parts. In the first part, the facilitator describes the activity and its objective. In the second part, the teams work on their ideas and construct the protective shell for their egg. They have a specific budget, which they use to get their materials choosing among the available ones. The facilitator answers questions and intervenes when absolutely necessary.

In the third part, each team throws the egg within its shell from a big height. The facilitator supervises the whole process and the teams are given points according to the budget they used, the precision achieved in landing and the state of the egg after the fall.

PARTICIPANTS AT THE MIND YOUR EGG!

CONNECTION TO THE DESIGN PRINCIPLES:

KEEP IT ENGAGING

INSPIRE AND MOTIVATE

PROMOTE LEARNER AUTONOMY

BY LATRA

FOR LOCAL AND REFUGEE COMMUNITIES AGED 16 AND OLDER

TAKES A MINIMUM PERIOD OF 3 MONTHS

CENTER FOR REFUGEE ART TECHNOLOGY & ENVIRONMENT:

Empowerment through art curation

The Centre for Refugee Art Technology & Environment is a refugee-led contemporary arts centre which assists the social and cultural integration of diverse young refugees, by empowering them to become content creators in art, technology and the environment.

The project explores new forms of curatorial engagement that demonstrate how art and technology can accelerate cultural and social integration. To make the content attainable to a wide and diverse audience, the centre's activities take place in-situ underprivileged communities in Greece (e.g. refugee camps).

The centre's operations are managed by young refugees with LATRA's role consisting of providing access to infrastructure (e.g. finance, venues) which is inaccessible to them due to institutional racism. This way, young refugees are able to produce projects that raise social awareness on critical issues, and their work creates an overarching vision for a diverse and inclusive society.

EXHIBITION CURATED BY THE CENTER FOR REFUGEE ART TECHNOLOGY & ENVIRONMENT.

CONNECTION TO THE DESIGN PRINCIPLES:

- BE INCLUSIVE
- CREATE PATHWAYS
- SUPPORT IDENTITY BUILDING
- PROMOTE LEARNER AUTONOMY

Reflecting on science learning through zine-making

BY SCIENCE GALLERY DUBLIN

FOR 15 TO 25 YEAR OLDS ENGAGED IN A PROGRAMME OR WORKSHOP

TAKES 40 MINUTES TO AN HOUR AS AN OPPORTUNITY TO REFLECT ON A LONGER ACTIVITY

The Science Gallery Dublin trialed using a zine format as a learning portfolio — within their handmade zines, young people were encouraged to document and reflect on their own experience during science learning workshops or programmes. The trials have helped to develop a reflective zine making evaluation methodology which has been used at Science Gallery Dublin for in person education programmes. This methodology has also been used as a key part of digital workshops.

To create a zine; participants are introduced to one of multiple zine folding/binding techniques, provided with pens, pencils and collage material, and given a few prompts or questions to guide their reflection time.

The zine-making activity has shown potential for supporting self-assessment in Science Gallery Dublin programs, as facilitators have noticed that 15 - 25-year olds appreciate having time to sit and reflect in their own way, evaluating their own experience without filling in forms or reporting back formally to facilitators.

IMAGE BY ANDREW WHITTINGTON-DAVIS AT ECSITE.

CONNECTION TO THE DESIGN PRINCIPLES:

SUPPORT IDENTITY BUILDING

PROMOTE LEARNER AUTONOMY

BY ARS ELECTRONICA

FOR EVERYONE

TAKES 5 DAYS

CREATE YOUR WORLD FESTIVAL:

Breaking new grounds

The create your world aims to integrate in everyday life the complex network of art, technology and society. This program is divided in three areas:

- Prix Ars Electronica u19 — Create your world
- Create your world festival
- Create your world tour

u19 — create your world is the Prix Ars Electronica's category for young people. It gives kids and youngsters up to age 19 the opportunity to produce and present their concepts of and ideas and thus, have a say about the world of tomorrow. All the submitted projects receive individual feedback and they have diverse opportunities to engage, even if they do not win the prix, by being part of the Festival or as a young talent and getting involved in the projects.

The create your world festival is not only the stage for the Prix Ars Electronica u19 project winner's exhibition, but also a platform for building a network and inspiring children and young people. Fostering motivation, regardless whether the projects win or not the Prix, is at the core of the festival. For this reason, some of the projects that have not won are also included in the exhibition or selected for follow-up.

The create your world tour is an experimental format in continuous revision in which artists are invited to bring the projects exhibited at the festival to the schools. This initiative enables sharing the most recent projects, sometimes still under development, with educational institutions.

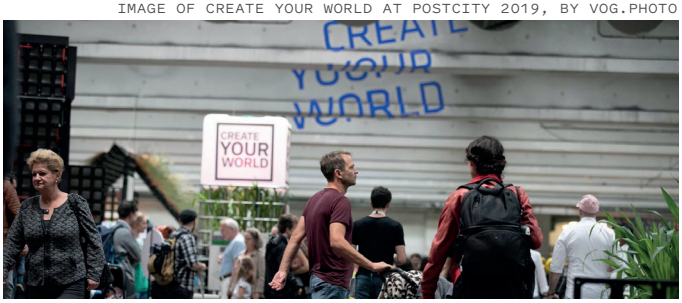
CONNECTION TO THE DESIGN PRINCIPLES:

CREATE PATHWAYS

SUPPORT IDENTITY BUILDING

PROMOTE LEARNER AUTONOMY

IMAGE OF CREATE YOUR WORLD AT POSTCITY 2019, BY VOG.PHOTO



DEBRIEFS AT THE END OF EDUCATION PROGRAMS:

Learning through reflection

BY SCIENCE GALLERY DUBLIN

FOR THE EDUCATION TEAM INCLUDING FACILITATORS AND THE ACTIVITY DEVELOPERS

TAKES LESS THAN ONE HOUR FOLLOWING THE WORKSHOP / ACTIVITY

Reflecting over your own practice has been recognised as a great source of lifelong learning. Yet, too often the benefits of engaging in reflection are missed due to lack of time or because reflection is not considered important. To avoid this, Science Gallery Dublin facilitators participate in debrief meetings directly following the workshops or programs they run.

The debrief sessions are led by the activity developer according to a set agenda, and usually last 30 minutes. They make time for those who developed the activity, alongside the facilitators who delivered it to reflect on the overall process. The topics covered include how the activity was received by the learners, what diverse groups of learners got out of the session, and anything that could be tweaked, tried or tested in future. These discussions help to identify areas that need iteration and think about ways to trial the suggested changes.

These sessions have proven effective at different levels. For the facilitators, having dedicated time to reflect on their practice helps them to understand their role, increase their confidence and be more creative. For activity developers, understanding how the activities are experienced by facilitators and participants is really useful for future planning. At the organisational level, having scheduled debriefing sessions contributes to create a culture of learning through reflection and build a community of practice that is constantly learning.

IMAGE BY SCIENCE GALLERY AT TRINITY

CONNECTION TO THE DESIGN PRINCIPLES:

ASSESS YOUR PRACTICE

PROMOTE LEARNER AUTONOMY

Let's put the design principles into practice

SETTING THE SCENE

Which of the Design Principles would you like to focus on?

CREATE PATHWAYS

SUPPORT IDENTITY BUILDING

PROMOTE LEARNER AUTONOMY

ASSESS YOUR PRACTICE

CHALLENGE YOURSELF

Where do you think you could improve in relation to the principle(s) chosen beside. Note down a few areas.

MAKE A PLAN

What are your end-goals? This could be: involving a specific audience, developing a new format or supporting a particular strategy at your organisation. Specify a maximum of three.

1. .....

2. .....

3. .....

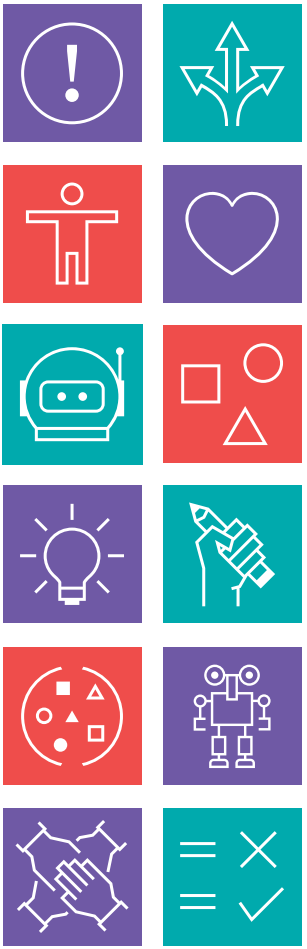
How are you going to achieve these goals?

MAKE A PLAN

What extra help do you need to do this? For example, is there any extra support, resource or knowledge that you don't have?

What would you recognise as an indicator of success?

What's your timeline? Use this space to sketch/draw out where you are now, where you'd like to get to, and the time and steps required in between.



Glossary of terms

Access refers to the ability to enter, approach or make use of something. In education, this term alludes to the ways in which educational institutions and policies guarantee all learners' equitable opportunities to learn and benefit from education.

Accessibility focuses on the ability to access. Accessibility has stressed the need to enable the cognitive and physical access of people with disabilities or special needs, although there is evidence that everyone benefits from accessible products and services. In information and communication technologies, work on accessibility has led to standards and regulations to ensure people can perceive, understand, navigate, and interact with the technological solutions.

Accreditation is the official recognition of a skill or experience level. In the non-formal learning context, accreditation involves recognising participation with learning activities that take place outside of the classroom, such as in science centres, museums, makerspaces or galleries.

Assessment is the process of observing and collecting evidence to understand the state of a process like learning. In education, assessment is considered process-oriented, continuous and focused on improvement. The standards set for guiding assessment are based on reaching ideal outcomes.

Autonomy in learning is the learners' capacity for taking responsibility for their learning, engaging in critical reflection, making decisions and acting independently. Autonomous learners understand the purposes of their learning and are able to set goals, use appropriate strategies and keep track of their progress.

Co-design is an approach to design that advocates for the active involvement of people without professional design training in the creative process. Co-design is based on the assumption that people are creative and are experts of their own life. From this view, designers need to engage diverse stakeholders in the design process to create solutions that respond to people's needs and are usable.

Collaboration is a process in which several people work together to perform a task or achieve a goal. In education, approaches based on collaboration support learning through group work in which learners jointly engage in complex tasks like goal setting, problem-solving and knowledge building.

Competency refers to a set of skills, knowledge and abilities that enable a person to competently perform specific tasks. A competency-based learning approach to education is oriented towards mastery and outcomes. This approach advocates for placing learners at the center, supporting their learning process and respecting learners' own pace.

Creativity has been defined as the ability to produce something new, adapt something, or find a new way of looking at things. Creativity has been recognised as a transversal skill, which in addition to creative expression, plays an important role in problem-solving and sense-making. Sociocultural approaches to creativity have placed the attention on the relations between the society, the culture and the individual, considering creativity as a process that needs to be nurtured over time.

Critical thinking is a rational process that requires active conceptualization, analysis and evaluation of diverse types of information to guide belief and action. Good critical thinkers are curious, open-minded and reflective. They take time to make the right questions before making a decision. Critical thinking has been recognised as an important skill for life and work.

Culturally responsive education is a pedagogical approach that acknowledges the importance of including learners' cultural references in all aspects of learning. From this perspective, learning is deeply related to culture and thus, to support learners' equitable access to education, it is necessary that pedagogical practices enable a dialogue with learners' diverse cultural backgrounds. In science education, culturally responsive programs and activities are able to draw on the cultural histories of groups, challenging assumptions that reduce scientific thinking to Western science and culture.

Diversity refers to variety. In social contexts, diversity involves recognizing a diverse range of characteristics (based on race, ethnicity, gender, sexual orientation, socioeconomic status, age, physical abilities, cultural background, education and more) that make an individual or group different from one another. In organisations, calls for diversity focus on the need to recognise different ways of being and knowing, critically reflect on the dominant group privileges and proactively eradicate all forms of discrimination.

Do-It-Yourself in this toolkit refers to a pedagogical approach in which learners are encouraged to focus less on outcomes, and instead on innovative solutions, processes and experimentation. Instead of relying on existing knowledge frameworks and power structures, Do-It-Yourself learning explores transdisciplinary spaces and is firmly rooted in the here and now.

Engagement. In education, learners' engagement deals with the learners' involvement at different levels. Educational strategies oriented towards supporting the learners' engagement take into consideration how developmental, intellectual, emotional, behavioral, physical, social and cultural factors may impact the learning process.

Equity in education is a quality concerning fairness and inclusion. In education, equity refers to ensuring everyone has equal opportunities to develop and perform at the best of their capacities. Equity should not be confused with equality since aspects like gender, race, physical and cognitive abilities as well as cultural and socioeconomic status have an impact on learners' opportunities. Equity advocators call for taking into consideration these differences and take proactive measures to ensure that individuals are treated according to their needs.

Formal education refers to learning that takes place within schools, colleges or universities. Commonly, this is part of a system that recognises learning through examinations, credentials, and/or grades.

Inclusion in education is a basic right and refers to a process through which barriers limiting the presence, participation and achievement of all learners are removed. Inclusive environments are those in which everyone — regardless of race, age, gender, disability, religious and cultural beliefs and sexual orientation — feels respected, supported and valued.

Interdisciplinary describes the integration of knowledge and practice from multiple disciplines. Interdisciplinary practice focuses on thinking across boundaries to generate new understandings and solutions. For instance, interdisciplinary activities in science education can consist in merging artistic and scientific methods to make sense of a particular phenomenon.

Learner-centered education, also known as student-centered education, describes a teaching approach that shifts the focus from the teacher to the learner. From this perspective, learners are responsible for their learning as they are the ones who can learn by constructing meaning from previous experiences and building knowledge. Thus, instruction aims to support learners' lifelong learning skills in order to help them gain independence and autonomy.

Learning by making is an approach to learning that emphasises learners' active role through hands-on activities. From this perspective, first-hand experiences in which learners make sense through observation, exploration and experimentation are central. Usually, activities following a learning by making approach invite learners to engage in problem-solving and to adopt a Do-It-Yourself and Do-It-With-Others attitude. In these contexts, learners are asked to build and test their ideas with the resources at hand.

Learning to learn has been recognised as a lifelong learning competency. In particular, learning to learn refers to learners' ability to organise and manage their learning process over time, whether this happens individually or in groups. Learners who are able to learn to learn successfully are aware of their learning process and needs, can identify opportunities and overcome the obstacles they find in their learning journey.

Non-formal education refers to education that is intentional and organised by an education provider outside formal education. Typical non-formal education institutions are museums, libraries, galleries or other types of institutions supporting lifelong learning of diverse learners. Non-formal education activities can have diverse formats and duration, might not have a continuous pathway structure, and are less likely to lead to qualifications or credentials than they would be through a formal system.

Recognition of prior learning refers to a process in which the skills and knowledge acquired outside the classroom are evaluated against a standard by official institutions. This process enables individuals to obtain official recognition for their competencies and thus increase their opportunities to further access education and work. The methods used to recognise prior learning are diverse and focus on the assessment of evidence provided by an individual.

Reflection is a particular type of thinking that has been strongly related to experience. When reflecting, individuals develop new understandings by exploring their experiences, individually or with others. Reflection has been considered a high order thinking skill, essential for sense-making, solving problems, taking decisions, and enabling change and transformation.

Scientific literacy alludes to the ability to apply scientific and technological understanding in discussions and other areas of one's life. Scientific literacy means that a person is able to ask and find answers that derive from everyday experiences, describe and explain natural phenomena, understand and evaluate information about science in the general media, as well as engage in conversations and express positions that are scientifically and technologically informed. Scientific literacy has been recognised as an important ability for nowadays citizenship.

Skills deal with specific aptitudes or abilities people need to successfully perform a given activity. There has been a distinction between two different types of skills: hard and soft. Hard skills refer to technical and

quantifiable abilities, whereas soft skills are transversal and non-technical.

Social learning environments build on the idea that observation and modeling play a key role in learning. Watching and observing others help individuals to learn new behaviors. Thus, being part of a social context is important for learning. From this perspective, the learning environment should support social interaction between peers since people learn by interacting and collaborating with others.

Special educational needs refer to learning difficulties or disabilities that learners might experience. The learning difficulties might be due to cognitive, emotional and behavioral or physical aspects. Learners with special educational needs might need additional help or access to specific types of resources to aid their learning.

Tinkering is an approach to learning that stresses the value of experimentation with materials and ideas to gain understanding. It supports the construction of knowledge within the context of building personally meaningful artifacts and designs opportunities for people to "think with their hands". Thus, hands-on experience, learning from failure and unstructured time to explore are key aspects of tinkering. This approach was pioneered by the Exploratorium of San Francisco and is increasingly adopted within informal learning settings to engage people with STEAM learning.

Transdisciplinary describes a particular type of relation between different areas of knowledge. Transdisciplinary is characterised by the adoption of a holistic approach that unifies frames of thinking beyond the disciplinary perspectives. Transdisciplinary thinking has been claimed as critical for successfully solving complex societal challenges like climate change and sustainability, and thus formal education institutions have been urged to help students become transdisciplinary thinkers, able to think "outside the box".

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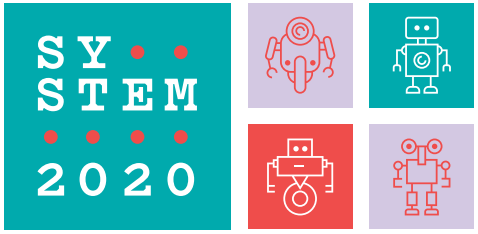

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