PERFORM: Guidelines for including values related to science using performance-based science communication in museums

In the PERFORM project, we have designed a methodology to include students' concerns, perceptions and interests about STEM careers and values related to science (ethics, critical thinking, gender issues and societal challenges) in performance-based activities. We designed a toolkit to implement this methodology that can be consulted here.

We adapted this methodology to be used in the context of a science museum. Through a review of the activities currently conducted at the science museum, as well as a knowledge transfer workshop and a training with science museum facilitators and members of the PERFORM team, we developed a series of steps to transmit and disseminate not only scientific content, but also the values related to science in science museums (i.e. i.e. *How Science is related with EU - Societal Challenges, Critical Thinking in STEM, and Ethical issues and gender barriers in STEM*), using a drama-based science communication approach.

If you want to **convert your science museum activities into drama-based activities addressing some of the key values related to science (**i.e. *How Science is related with EU - Societal Challenges, Critical Thinking in STEM, and Ethical issues and gender barriers in STEM***),** follow the next steps.

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1.- Science Museums for new societal challenges: reframing the scientific content.

Museums are spaces that can promote free, critical and complex thinking required for modern citizens; they can stimulate new ideas as well as intellectual, critical and ethical enrichment. A good opportunity is to "reframe" and redefine the content of some of the activities carried out in Science Museums to match real contextual perspective in view of present and future societal challenges and ethical controversies of scientific and technological developments. Museums have the role to provide a fundamental contribution to public knowledge and culture. Thus, they can be powerful resources to raise awareness and address solutions for societal challenges by their activities, topics and relationship with communities and the public. Surprisingly, most activities reviewed for the purpose of these guidelines are not yet thinking explicitly about societal challenges and/or ethical issues neither promoting a critical thinking. The scientific content of these activities should address how to meet the expectations of fast-changing societies.

Here, we propose a methodology to design activities to be developed at science museums exhibitions that not only include STEM content, but also values related to science.

1) The first step is to **select an activity that is running in a science museum**. It can be a hands-on activity, a science talk or a guided tour.
2) Once you have selected the activity, **think about the core scientific concepts** that you aim to deliver. It may be useful to answer the following question in just one sentence: *what will my audience learn today?*
3) Now it's time to include **science related values (ethics, societal challenges, gender issues, critical thinking)** in your activity. Those should be related to your scientific concepts. As a museum facilitator, you can play a fundamental role in in drawing the attention of museum visitors to these science related values by proposing controversial topics, inquiring questions, etc**.** Here is a list of ideas:

- Include in your speech a discussion about some of these societal challenges

- ✓ Health, demographic change and wellbeing
- ✓ Climate action, and environment
- ✓ Secure societies, freedom and security

- Include in your speech a discussion about ethical issues in the research process

- ✓ Good /bad considerations about genetically modified organism (GMO), Artificial Intelligence (AI), Robots, medical advances (cloning, genetic modifications in humans)
- ✓ Discoveries that improve/ impair the environmental quality
- ✓ Social inclusive/ exclusive new technologies

- Introduce in your speech new ideas and role models that can break science related stereotypes related to gender

- ✓ Break social related stereotypes about scientists: highlight positive considerations of science and scientists, like external recognition, knowledge motivation, the "power of knowledge"…
- ✓ Break gender related stereotypes about scientists: Give special mention to female physicists, engineers and computational scientists.

- Promote critical thinking among your audience

- ✓ Include controversial scientific claims and promote debates and discussions on how the science knowledge is generating, tackling important concepts as:
  - *Who is making the claim?*
  - *What is the scientific evidence for the claim?*
  - *How does the claim fit with established science?*

2.- Promote participation: listen to what visitors have to say.

Science museums and science centres have a long history of interactive display techniques, which makes them naturally suited to encourage visitor participation. The PERFORM project wants to go beyond the "facilitator as expert"-approach, in which the visitor is only focused on following protocols, to a “facilitator listens to opinions and contributions from audiences”-approach, in which visitors can have an opinion about the present and future of STEM & Societal challenges.

Nevertheless, we have identified two main barriers for visitors’ participation in science dialogue at science museums:

Barrier 1: Visitors’ expectations: Some visitors shy away from controversial topics that might be perceived as too complicated. This can be the case with groups of teenagers.

To overcome this barrier, we propose to promote participation with activities that include games or hands-on activities. Some examples are:

Card games.- Cards can feature different scientists profiles. The facilitator can ask the audience to play the role of a “Scientist” to explain how, with his/her skills, he or she can contribute to address some societal challenges (some examples in annex 1). Cards can also feature organisms contained within the museum. Audience can play the interactions between them. What will happen if one of these organisms disappears?

Performing activities.- Visitors can play different roles and discuss certain scientific topics. For example, in a Climate Change Alliance, half of the visitors could play the role of businessmen of the automobile industry and the other half the role of indigenous populations in South America.

Breaking News.- Present the visitors opposite pieces of science news about a chosen topic. Try to have live news. Ask your audience: Which one is more reliable? Why? What clues does the museum give us to say so? It can be a good start to discuss science reliability.

- Barrier 2: The atmosphere of a science museum: Science museums normally have a busy and noisy atmosphere and can be difficult to find quiet spaces to promote self-reflection and participation in dialogues.

To overcome this barrier, it’s important to keep in mind the quiet spaces within the science museum. Visit them with your audience and promote dialogue delivering the activities proposed in the previous section.

3.- Integrate drama-based activity.

For the PERFORM project, one of the key ideas is to engage visitors by generating a drama-based story that catches their attention while developing an activity. The story will allow science museum facilitators to maintain the conceptual coherence and to connect with the young audience, humanising the scientific topics explained and tackle the values related to science.

To generate a story, follow these simple steps:

- Look for an introduction that catches the attention of the visitors. It is important to take into account who they are (visitors can be students, families, kids…), using something related to their daily life that they can easily identify with.
- Combine the scientific explanations in the stands with emotional content embedded in the story. It will be useful to tell stories about real scientists, fictional characters or maybe stories that happened directly to museum facilitators. Talk and reflect about important topics and values, such as societal challenges, stereotypes in STEM, gender barriers in science, ethical issues in the research process or STEM careers job opportunities. This will catch the attention of the visitors by connecting with issues they can comment on.
- Allow the visitors to actively participate in the story. We recommend asking questions that they can easily answer, not related to science content but related to emotions. Some examples are: Have you ever tried to have a bath in iced water? Would you like to fly? What would you do in my place?

Practical example

Exhibition name: Fossils (permanent exhibition at CosmoCaixa)

Stand			
Science Content	Fossils can tell us about… feeding habits	… locomotion.	… natural disasters. --- evolution.

Science content (key concepts to be delivered).

By studying the fossil record we can tell how life was in the past and use this information to find out about ancient environments.

Possible discussion about science related values.

Societal challenges: Climatic changes are recorded in fossils. Do you think the climate change nowadays is also due to natural conditions? How do you think fossils in the future can register our current climate change?

Stereotypes: Talk about real scientists who work reconstructing the history of fossils. Think about women (ex. Nieves López Martínez).

Possible story.

What can an old photograph tell us? Show a photograph of your grandmother:

or

What kind of information can you extract from this photo? (clothes, technology, cultural context, behaviour …)

Compare fossils with the old photos of your grandparents. Fossils are more ancient photographs, imprinted in sediments, instead of photograph paper. What kind of information can we extract from fossils? (feeding habits, way of movement, natural disasters etc.)

4.- Rehearse, perform and rehearse again.

Generation of a PERSEIA is a *trial and error* process. Allow you to create, to explore, and to make mistakes. Create your PERSEIA as a living process. Rehearse first with

your science museum colleagues, and when you deliver it to real visitors, do not hesitate to change and update the story, according to their reactions. This is the best way to get an authentic PERSEIA.

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ANNEX 1

1.- Examples of cards to be used to promote participation