toolkit

Hypatia
PROJECT

INTRO

The toolkit is a ready-to-use digital collection of modules aimed at teenagers to be used by teachers, informal learning organisations, researchers and industry.

The aim is to engage young people and especially girls in STEM and in the discovery of the variety of STEM related careers in a gender inclusive way. The toolkit includes a wide range of hands-on activities: workshops with a scientific content, informal discussions and meetings with STEM professionals.

Each module is composed of three guidelines:

- Explanatory guidelines specific for each activity
- Guidelines dedicated to the theme of gender inclusion
- Guidelines with suggestions for the facilitation

The guidelines give practical support and guidance for the users, recommendations on how to debate gender approaches and differences with young people, support and guidance for facilitators on how to overcome their own stereotypes and suggestions on how to manage the group dynamics by implementing different facilitation strategies.

The toolkit is produced in the context of the Hypatia project by five science centres and museums (NEMO Science Museum, Museo Nazionale della Scienza e della Tecnologia “Leonardo da Vinci”, Bloomfield Science Museum Jerusalem, Experimentarium, Universcience) in collaboration with gender experts, teachers, research industry institutions and teenagers.

The Vision of Hypatia is of a European society that communicates science to youth in a gender inclusive way in order to realise the full potential of girls and boys around Europe to follow STEM related careers.

Below is the complete list of modules that compose the Toolkit, divided into the three contexts.

Schools

- Find Gender Stereotypes in STEM Representations
- Gender Inclusiveness in your Science Teaching
- Inquire: Shape and Action
- Play Decide Game & Debate
- Science Ambassadors and Ambassadresses
- STEM Women Cooperative Card Game
- Test Yourself
- What's your Opinion?

Science Centres & Museums

- Find gender stereotypes in STEM Representations
- Science Café or *Café Scientifique*
- STEM Women Cooperative Card Game
- Test Yourself
- Wearable Technology
- Your Role in Research: Inquiry into Chemical Reactions

Industry & Research Institutions

- Gender optimizing software programming
- Science Ambassadors and Ambassadresses
- Skill Game
- Speed Dating
- Your Role in Research: Inquiry into Chemical Reactions

GUIDELINES ON GENDER BALANCE

WHY IS IT IMPORTANT FOR PEOPLE OF ALL GENDERS TO STUDY AND WORK IN STEM AREAS?

In the coming years, with Europe's knowledge economy developing and new technologies on the rise, skills in science, technology, engineering and mathematics (STEM) are becoming increasingly necessary in order to guarantee an adequate & professional workforce in a broad range of careers. It is therefore imperative to attract and recruit more youth to STEM study programs and ensure the diversity of STEM-trained professionals. The Vision of Hypatia is of a European society that communicates science to youth in a gender inclusive way in order to realize the full potential of girls and boys around Europe to follow STEM related careers.

Institutions and facilitators responsible for implementing science education activities, such as schools, museums and industries have a key role in this. They may influence the ways in which learners construct and negotiate their gender and their attitude towards STEM. This is why it is important to reflect on the gender and science biases we have, to acknowledge the stereotypes and make sure we do not perpetuate them in our interactions with the participants.

FACILITATING GENDER INCLUSION

In facilitating gender inclusive activities it is important to be aware of a few significant concepts.

GENDER AND SEX

Sex refers to biological characteristics and functions which distinguish between males and females: chromosomal sex, gonadal sex, morphological sex.

Gender refers to the social construction of men and women, of masculinity and femininity, which differs across time and space, and across cultures. It is a hierarchical and hierarchizing system of masculine and feminine norms.

GENDER STEREOTYPES AND SKILLS

A gender stereotype is our social perception regarding the attributes of males and females (character, abilities, tendencies, preferences, external appearance, types of behavior, roles, career paths etc.) and our tendency to relate such attributes to individuals of each sex, prior to meeting them (example of stereotype: male are more rational and female more emotional).

When we talk about gender stereotypes and science we refer to roles and abilities that are supposed to be "suitable" for males and for females in science (for example engineering and building are associated more with males than with females).

GENDER AND SCIENCE

STEM are fields of inquiry and knowledge. Like other forms of knowledge, they may include gendered dimensions. When the gender variable is not taken into account by researchers, this can influence the results: for example when medicines are not tested on both male and female. Furthermore, there is a persistent gender gap in the production system of scientific and technological knowledge and in many European countries women are over represented in biology and medical sciences while they are

under-represented in mathematics or informatics. Besides, women are less likely to reach a high level of responsibilities in sciences.

They are depicted as rational, intellectual and independent, and these characteristics are often associated with masculinity. This means that boys or girls who do not identify with such characteristics will think that STEM studies and occupations are "not for them" and avoid STEM completely. This is why it is important to present a complex and diverse image of science.

SUGGESTIONS FOR THE IMPLEMENTATION OF THE ACTIVITY

Defining, recognizing and implementing gender inclusive activities is complex and challenging and requires a constant auto reflexivity of the facilitator about his/her own gender stereotype and bias. Here are some practical indications and reflection questions to assist the facilitator in being inclusive.

INTERACTING WITH THE GROUP

- **Neutrality in assigning tasks and roles**

  How will I assign tasks? What responsibilities will I assign and to whom?

  Avoid assigning stereotypical gendered roles to participants that may contribute to the internalization of 'female' or 'male' identities, for example asking boys to build things and girls to take notes. Ensure that the different roles required by the activity are rotated between participants.

- **Attribution of success and failure, overcoming stereotypical responses**

  Do male students who have failed link their failure to themselves or to external factors?

  Do female students who have succeeded link their success to themselves or to external factors?

  Set a high level of expectations for both sexes. Avoid over indulging with the girls (this leads to dependency rather than independence). Encourage both girls and boys to take risks.

- **Adopt a "Wait Time" to encourage girls to speak in an environment of risk-taking boys who might respond faster than they do**

  How attentive was I to the students' responses? How long did I let them speak for?

  Wait 4–5 second before calling on a student to answer a question. Delaying the answer enables all the students to respond, thus giving everyone the opportunity to come up with it.

- **Interaction with the sexes to overcome the tendency to engage with male students more than with females:**

  Did I direct questions to boys more than to girls?

  Be aware whether the questions are directed more to boys or to girls.

- **Unaware expression of stereotypes**

  Did I pay attention to the students' behaviour in relation to their expression of gender stereotypes?

Teenagers often reproduce gender stereotypes unconsciously or in a subtle way. This might be taken as the chance to underline it and use it as a point of reflection.

DURING A DISCUSSION

- *Are boys more interested in building things and girls in decorating the things produced? Can you switch these roles in the activities?*

  Challenge learners to depart from their preferred interests and widen their engagement in science (many children have gender stereotypic interests that might be challenged).

- *Do you think it could be useful to introduce and discuss the concept of gender or stereotype before or after the activity?*

  Consider if a forgoing explanation of the main concepts about gender and about the terminology/concept connected could enrich the discussion.

- **While facilitating a discussion**

  Acknowledge that different learners have different kinds of prior knowledge that may be relevant in different ways. Discussion can take its point of departure in what learners already know about the subject matter.

MEETING A STEM PROFESSIONAL

Role models are effective in stimulating girls' and boys' interest in STEM. Many activities have STEM professionals as protagonist or give examples of STEM professionals. It is important that these role models do not reinforce gender stereotypes.

- *How many men and how many women appear in the example of STEM professionals I give in the activity? Are they stereotypical?*

  Keep a balance between the number of females and males as speakers or examples. Where possible ask them to talk not just about the scientific content but also about their personal life.

  Ensure that the involved science educators and scientists reflect a broad variety of personalities. Girls and boys are most inspired by role models they feel psychologically similar to themselves (as regards to origin, culture, age, etc.). Otherwise, the standards set by the other person can be seen as contrasting, and girls and boys may react against them.

- *In the activities, do I present the variety of STEM – from computer games to engineering?*

  While choosing STEM professionals and examples involved in the activity, ensure that the diversity of science is represented to the largest extent possible.

FACILITATING AN EXPERIMENTAL SITUATION

While dealing with a specific scientific content participants might not see clearly how this is related with gender balance in STEM. Hypatia activities aim to propose unexpected ways to approach science and scientific content (like chemistry, robotics or making), breaking the stereotypical perception of STEM. This serves to introduce and disseminate a different view of the world of science, unveiling different aspects with which more people – girls and boys – can identify. You can emphasize this aspect while facilitating an activity focused on scientific content rather than on gender.

- For example, an activity framing technology such as the one on wearable technologies could attract more girls than one on transport or missiles.
- Many girls feel more comfortable in a situation based on cooperation, and others even avoid competitive activities. The facilitator could present a challenge with a “story” behind and not just as a competition, or pay attention in balancing competition and cooperation in the same activity.
- Many studies show that girls learn better in an environment that is esthetically pleasing. This is why it is important to create a pleasant and esthetic environment for the activities.

USEFUL LINKS ABOUT GENDER INCLUSION IN THE CLASSROOM

HYPATIA’S THEORETICAL FRAMEWORK

The present document proposes a framework to address gender inclusion in STEM activities. It gives rise to a set of criteria for the analysis of the gender inclusiveness of existing STEM education activities, or for the design of new, gender-inclusive activities.

Theoretical Framework

GENDER EQUALITY IN THE CLASSROOM

We are frequently unaware of the manner in which we relate to boys and girls. School classrooms are no exceptions. Here is a list of points of attention and suggestions aimed at improving the degree of equality in the class in order to encourage girls and boys to pursue the fields of STEM.

Gender Equality in the Classroom

GUIDELINES ON FACILITATION

A BIT OF ADVICE FOR GOOD FACILITATION

A key element for good facilitation is the active involvement of the participants every time a concept or content is presented. Involvement means for example:

- Considering participants' personal experience as a starting point of the engagement.
- Building on their own point of view or prior knowledge.
- Embedding continuously the contributions of the participants in the process.

Facilitation is not easy; it takes practice, time and reflection! In order to transfer these concepts into practical situations – and thus to foster engagement, interaction and discussion – you can find a brief list of suggestions below. They can be helpful in developing good facilitation.

INTERACTING WITH THE GROUP

- Prepare the environment where the activity will take place in advance, organize the space according to the needs of the activity, even changing its usual structure if needed (i.e. you can move tables and chairs around).
- Make sure that all participants can see and hear well.
- Keep eye contact with the participants.
- Address participants as peers rather than as passive spectators or ignorant individuals.
- Listen to people and use their own terms.
- Use questions as much as possible – they can be a useful tool to encourage interaction among the group.
- Stimulate reflections among participants.
- If possible, ask and build on information or elements that can be discovered through direct observation.
- Engage people by linking to their personal experience.
- Encourage participants to express their opinion and elaborate their own considerations.
- During an activity, you might want to organise different group settings – work in smaller groups or in pairs, create plenary moments – to help engagement and better interaction with the experience.
- Before interacting with the participants in plenary, you might want to ask participants to discuss in small groups as a "warm up". This helps involving the shiest people or helps everybody to feel more comfortable about the topic before sharing any consideration in plenary.
- When the discussion is set in small groups, move around the groups checking on work and discussion, and intervene – only in case of difficulties!
- In plenary, try to address everyone as much as possible, encouraging everybody to participate and engage.

FACILITATING AN EXPERIMENTAL SITUATION

- Try to make the activity as participatory as possible: every participant should have the possibility to engage directly with the experiment; avoid demonstrations.
- Do not reveal the results of the experience before the participants' own discoveries and considerations.
- Encourage participants to make initial hypotheses/descriptions/comments about what they think would happen.
- Keep the experiment at the centre of attention and of the discussion.

- Engage learners through an alternation of manual activity, questions and discussion.

DURING A DISCUSSION

- Engage learners through a balance of open-ended questions, closed questions, discussion and exchange of opinions, etc.
- You might want to use provocative dilemmas as tools for debate. Disagreements can be valuable for analysing notions and negotiating views, use them constructively.
- Stimulate and build not only on participants' already-acquired knowledge but also on emotions and imagination.
- Challenge the participants at a suitable level.
- Avoid:
    - A didactic approach and the assessment of participants' knowledge.
    - Monologue.
    - Specialized terms with no reference to real objects.
    - Seeking and dealing only with the correct answers or, even worse, with the correct questions.
    - Not listening.

HOSTING A STEM PROFESSIONAL

- You might suggest to the speaker to alternate between questions and speech allowing participants to take up a more active role and prevent long talks.
- Before introducing a STEM professional, you can ask participants to share their perception about the particular profession, and then discuss it with the speaker.
- Young participants, when they have the possibility to ask free questions, often seem to be interested in the speaker's daily personal lives, in their career path and about what they were like when they were students. You can suggest that speakers use these topics as "hooks" during speeches and conversations.

It helps if speakers bring tools or objects from their daily work with them as examples from their daily practice.

QUESTIONS: A FUNDAMENTAL TOOL FOR LEARNING

Building a relationship with an object is like 'getting to know a new person'. Indeed, this kind of comparison can help understand a possible way of developing questions to be used in learning experiences. In the process of getting to know a person or starting a conversation we move from the basic and concrete to the abstract and more complex. Using questions in a learning situation involves similar steps: starting from basic information (usually elements that could be discovered through observation) working at levels where there is compatibility (i.e. levels where the pupils can become involved and engage through their knowledge, experiences and views), in order to proceed to the discovery of more complex information and concepts. Such an approach invites learners to search within their own repertoire of knowledge and experience for the necessary elements that would help them discover new insights, while at the same time it can operate as the foundation for the development of questions by the learners themselves.

In fact, we are not arguing here for a linear process of 'facilitator-asks – learners-answer'; rather, we argue for a two-way-contribution process, in which both facilitator and

learners are in the position to ask and answer questions. In this sense, questions are the stimulus for initiating dialogue, the tool and *not* the objective. They help new knowledge to be elicited and information to be added within a free flow of ideas, leading to the broadening of understanding.

What are the types of questions that would operate as the method for eliciting information and interpretation, for initiating constructive dialogue, for developing skills and self-confidence in learners – and facilitators themselves?

First of all the basic categories:

- Closed questions – the ones that have only one correct answer.
- Open questions – those that accept more than one correct answer.

Closed questions are usually used when we seek specific information about the phenomenon/topic/exhibit/object etc. and can be further divided to:

- Questions for examination: Answering those questions requires careful examination. The answers offer the first information on the basis of which we construct more detailed knowledge.
- Questions for explanation: The answers offer an explanation – how something works, how it was created, etc. and are closely related to the information derived from the examination questions.
- Questions for comparison: These stimulate comparisons with other situations of the same type, materials, dimensions, etc. and encourage the identification of similarities, differences and connections with the learners' personal knowledge and experience.

On the other hand, open questions encourage the expression of personal views, the employment of pre-existing knowledge of the learners, and the search for personal meanings. Discussion and open-ended questions offer learners the opportunity to pool ideas and share insights in the group followed by opportunities to develop understandings further through deploying and defending insights and opinions.

Open questions can be divided into the following categories:

- Questions for problem-solving: Those demand the use of critical thinking, imaginative thinking, hypothesis and analysis skills and ability for using knowledge for problem solving.
- Questions for prediction: The answers to those questions offer predictions in instances of changes of parameters.
- Judgement questions: Answers to those can be very personal and unique. They demand choices, evaluation of a situation, justification, etc.

You should be seeking a balance between closed and open questions. Asking only closed questions might create a feeling of ignorance among those learners who find it difficult to answer them, since they require relatively minor use of skills and more of specialised knowledge. Closed questions should be used for exploring the object and the new knowledge around it, and, in addition, offer the basis on which to ask the open questions. For any learner, answering open questions implies using their personal context to find the new information. It also enables them to use their own personal experiences, emotion, imagination and skills for meaning-making and personal interpretations.

In the philosophy of an interactive, constructivist approach to learning, the asking-answering of questions means not only the acceptance of more than one correct answer (through open questions), but also ‘allowing learners to get things wrong’, that is, not allowing a learning situation to be limited by seeking only ‘correct’ answers, or by the expectation of pre-determined outcomes. It is important that the facilitator does not jump in too quickly to correct learners, but rather uses the conflicts that arise between their different perspectives helping them to see that there are standards and that their own interpretations are not necessarily the same or as good as those held by other learners. Learning results from reference to, and drawing from, learners’ own understanding of situations, and opportunities for exploration through trial and error.

FIND GENDER STEREOTYPES IN STEM REPRESENTATIONS!

AT A GLANCE

Age Group	13 – 18 years old
Format	Moderated discussion
Duration	90 minutes

OVERVIEW

The workshop focuses on gender-stereotyped representations of science and technologies in advertisements for technological objects (such as computers, smartphones, video games, cars, etc.) and recruitment campaigns for schools, training, or jobs in STEM fields. Through the discovery, comprehension and analysis of stereotypes in these visuals, students will be led to question:

- How these stereotypes influence the way they view the skills/abilities associated with women and men in science and technology.
- How these stereotypes influence their choice of studies and careers.

OBJECTIVES

- Understand what sex and gender stereotypes are and identify them.
- Heighten students' awareness of stereotypes in their daily lives.
- Increase awareness about the negative impact they can have on their own representations of sciences, the world of science and technology, and their study/career choices.
- Learn about careers in STEM and develop an interest in them, regardless of their sex.

SUGGESTED SCENARIO

The activity is designed for a class of students. It could take place during a research center/museum ‘open day’ or for the International Women’s Day. It could also be implemented as a workshop or as an open lesson for secondary schools.

TARGET AUDIENCE

Age	13 – 18
N. participants	20 -30
N. facilitators	1
Type of audience	Students

FORMAT

Moderated discussion.

TOPICS COVERED BY THE ACTIVITY

This activity deals with science and technology in general with a societal approach. In France, this workshop has links with the civic education curricula that promotes gender equality; the mechanisms of sex-differentiated socialization are also studied in high school economic science classes.

DURATION OF THE ACTIVITY

90 minutes.

RESOURCES

MATERIALS

Computer		1
Video projector		1
Flipchart		1
Visual Images	Google search, newspaper	6 (3 different ads + 3 different campaigns)
Pen or pencil & paper		1 per student
Post-its		100
Analysis grids	See “Development of the activity”	6 (1 per group per visual)

NOTE:

To prepare for the activity, facilitators will need to choose the ads that will be shown during the workshop and prepare the analysis grids that will be distributed to students.

USEFUL LINKS, VIDEOS, ARTICLES

- The TWIST project: www.the-twist-project.eu
- Expect Everything campaign: www.expecteverything.eu
- Hypatia Project D2.1 (Criteria for Gender Inclusion) and D2.2 (Good Practices on Gender Inclusion in STEM Communication)
- The most appropriate images, visuals in each country: recent ads for smartphones, computers, video games, recruitment campaigns for researchers or STEM careers in engineering, transportation, energy, nuclear, aeronautics, or information flyers on science and technology programmes at universities and higher education establishments.
- Centre audiovisuel Simone de Beauvoir/Genrimages: www.genrimages.org

SETTING

Closed and modular space so tables can be moved to work in small groups.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

Students will work in plenary sessions and small groups, preferably mixed boys and girls.

INTRODUCTION, 5 MINUTES

Quick introduction explaining to students that they are going to comment on advertisements for daily technological objects and recruitment campaign visuals, followed by an analysis and discussion. The facilitator or teacher will emphasize that they are really interested in what the students think.

DEVELOPMENT OF THE ACTIVITY

Step one, 10 minutes

- The activity begins with a question: *What are the skills, ideas, adjectives, qualifiers that you spontaneously associate with men, boys, girls and women?*
- Give 2 post-its to each student: they will write what they associate with women/girls on one and what they associate with men/boys on the other.

  Note: post-its are anonymous, a very short period of time is given to write down the associations.

- The post-its are then stuck on the flipchart, arranged into 2 columns: one column for words associated with women/girls and one for words associated with men/boys. They will be commented at the end of the workshop.
- The person leading the workshop (the facilitator) then explains the general notion of stereotypes, clichés, preconceived ideas.

Note: definition of sex and gender stereotypes:

- Sex and gender stereotypes are over-generalizations of what girls and boys/men and women are and are not, by nature: "women have no sense of direction", "men are tech-savvy", "women are intuitive", "men are not emotional", etc.
- *How do they work?* Sex and gender stereotypes legitimize the roles of each sex by "naturalizing" them: they make the different and hierarchical roles of sexes assigned to men and women seem biological and natural.

Step two, 30 minutes

- The facilitator shows the first ad and the group comments on it together to give students an idea of how to analyse an image.
- The students are asked to form three groups, preferably mixed girls and boys.
- The facilitator gives each group a recent ad for a technological object (the ad is printed on a A3 coloured sheet of paper); each group receives a different visual. For example:
  - an ad for a pink phone and for a blue phone
  - a computer marketed for girls, and one marketed for boys
  - an ad for video games showing girls and boys
- Each group is given a blank analysis grid (prepared in advance by the facilitator). Students observe and discuss the visual, and fill in the grid.

Note: the grid indicates the following points to be analysed:

- the link between the object in the ad and the person or people shown in the image
- the target audience of the ad
- the construction of the image

    - the size of the different elements in the image and their connection
    - the colours used (boy/girl gendered colours)
    - description of the people: activity, posture, body part featured, clothing (or nudity), accessories
    - gaze: direction of eyes, intent
    - mouth: position of lips, smile, lipstick, etc.
    - hair: length, colour, done up or loose
    - relationships between men and women: position, expression, size, attitude, etc.
    - text
- Each group chooses a presenter, boy or girl. During the plenary session, each presenter explains the group's findings to the rest of the students.
- A group discussion can follow to give everyone an opportunity to share his or her opinion.
- The facilitator can further comment if necessary and briefly explain what is meant by "gender" and sex and gender stereotypes.

The aim of this step is to highlight associations that advertisers make between technical skill and, in most cases, men; this stereotype often portrays women as incompetent or seductive, and also gives a very narrow and formatted view of masculinity.

Step three, 30 minutes

- The same approach is used for the recruitment campaign visuals. Students are presented with:
    - a very stereotyped visual
    - a less stereotyped visual to foster debate
    - a more neutral visual in terms of sex and gender representation and, if possible, diversity, one that can be used as an example of respecting gender equality and diversity.
- Attention is given to the people represented and the field or place where they are represented: for example, in a recruitment campaign for researchers of all disciplines, a woman is shown in a laboratory in the foreground, another photo shows a medium shot of a man contemplating the stars. This distinction between interior/exterior, infinitely small/infinitely large, is produced in recurring stereotypes.
- Students are asked to identify and discuss the sex and gender stereotypes in the visuals, to fill in the analysis grid, and discuss their observations.
- The teenagers will have a sharper eye after the first step of the activity, but they will still have to consider the presence of stereotypes by themselves in these pictures and the impact they can have when they think about a career in STEM jobs. The previous grid will again help to raise their awareness.
- This step will conclude with a look back at the post-its. Students will compare what was written on the post-its, i.e. women/girl and men/boy word associations:
    - with the stereotypes identified in the ads for technological objects
    - with the stereotypes tied to careers in science and technology

In most cases, there will be many similarities.

- The facilitator asks students for their opinion and launches a discussion on the impact stereotypes have on study/career choices and the representation of careers in STEM.
- The facilitator emphasizes that jobs should be mixed-gender, the need to choose one's studies and career based on skills and likes/dislikes without the influence of preconceived ideas.

CONCLUSION

The activity ends with:

- Students' general feedback on the workshop.
- A quick presentation of images of "role model" women in various fields such as engineering, astronomy, video games, etc.

The idea is to show students that skill and success have nothing to do with a person's sex.

PARTNER DETAILS

This module was originally developed by Universience in Paris, France.
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universcience

SCIENCE CAFÉ OR CAFÉ SCIENTIFIQUE

AT A GLANCE

Age Group	13 – 15 or 15 – 18
Format	Meet a STEM professional
Duration	2 hours

OVERVIEW

The Science Café focuses on broadening the scope when it comes to choosing a future career. Many girls find it difficult to see themselves within the field of science and technology and specifically within the field of technology. Some of this is due to boundaries often associated with gender.

This activity is a facilitated discussion following the principles of *Café Scientifique*. Facilitators educated in these principles will create a dialogue meeting between a couple of female scientists from various fields and a group of teenagers. The topics to be discussed will be chosen by the researchers, and facilitators will create the discourse for the meeting. Researchers should be asked to also focus on their career and touch on the challenges they have met and how they managed to overcome them.

Following the opportunity to meet with real life scientists, participants are given the chance to reflect on what role gender plays when choosing a future education and career, and in what way gender has affected the professional lives of the female scientists.

OBJECTIVES

The objective is to enhance awareness about the possibilities in the world of science and break down possible (un)conscious biases people might have about scientists with a specific focus on female scientists. Many teenagers lack a variety of real life role-models they can relate to, and the Science Café gives them the opportunity to meet up with researchers that can tell about their personal motivations and choices – and the challenges and opportunities they have met along the way. The participants may even be inspired to choose a career within STEM.

SUGGESTED SCENARIO

The scenario is well-placed in an informal science learning setting such as a science center or museum. It can also be placed in other settings, where a group can be gathered in a relaxed, egalitarian and informal way. It is important that the setting creates an atmosphere, where you are not expected to take notes, rather the participants should be inspired to enjoy themselves and engage in discussions. It is a place where anyone can come to explore the latest ideas in science and technology and can also take place in cafes, bars, restaurants and even theatres, but always outside a traditional academic context.

TARGET AUDIENCE

Age	13 – 15 or 15 – 18
N. participants	20 – 50
N. facilitators	2
Type of audience	Teenagers and their teachers

FORMAT

Presentations by role models in science and moderated plenary discussions.

TOPICS COVERED BY THE ACTIVITY

This activity aims towards giving career guidance targeted to teenagers in regards to the education and career paths they might choose or aspire to choose and specifically focusing on STEM careers.

DURATION OF THE ACTIVITY

Suggested duration: 2 hours.

RESOURCES

This moderated discussion uses a mix of presentations and Q&A-sessions.

The following table with recommended materials will cover any needs for running the workshop.

MATERIALS

Video projector and screen		1
Coffee/tea and cake or biscuits		Enough for all participants
Poster post-it or flipchart		1

USEFUL LINKS, VIDEOS, ARTICLES

- cafescientifique.org
- sciencecafes.org
- the-twist-project.eu
- Hypatia project

SETTING

The venue needs to strike a balance between being large enough to accommodate the audience and small enough to allow them to hear each other and interact successfully. We recommend that the size is 20-40 persons. Above this number it can be hard to have a lively discussion, where everyone feels addressed.

Set time aside to let the teenagers engage in activities or exhibits after or during the Science Café if it is held in an institution that has such activities. These can range from engaging in a science exhibition on water to engaging in an activity that focuses on health for example. This will also give an opportunity to further inspire and engage.

Sometimes teenagers see science as difficult, boring and ‘a closed world of its own’. By putting science back into culture and everyday life – and doing it in a setting, where everyone is feeling comfortable – it hopefully becomes relevant and intriguing.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

Science Café will usually be held in plenum, yet it is optional for the researchers to suggest small group discussions during the café in order to engage all of the participants.

INTRODUCTION

The Café Scientific starts with an introduction to the researchers and the aim of the day – to broaden and inspire towards the scope of possible education and career paths for the participants. Facilitators will encourage participants to ask questions, participate in discussions and otherwise contribute from the very beginning.

DEVELOPMENT OF THE ACTIVITY

It is important here to mention that the following is merely meant as examples and can be seen as inspiration to the organisers and researchers. The different parts included in the examples will also vary from country to country and from institution to institution.

The number of speakers is one of the first things to consider. Is a single speaker enough if combined with a well-facilitated discussion? It can be. Yet, often two scientists will cover a broader spectrum of science and give different perspectives on STEM and also on gender-related issues. Three or more is also an option, but it requires that the facilitators can balance the different parts of the café in order to make room enough for each scientist, yet keeping an eye on the overall timeframe. This risk if you have a 'panel' of speakers is that the audience becomes viewers of, rather than participants, in a debate. It is crucial that the visiting scientists are good at addressing and relating to the participants.

It can also be a good option to mix different kinds of speakers, so that different perspectives are given and discussed. Scientists are one kind of group (that can easily be divided into several subgroups), yet also people from other parts of society can be inspiring, when it comes to discussing STEM and gender, e.g. philosophers and sociologists – maybe even politicians.

In order to get the right persons as speakers, take contact to different groups and organisations. It can be outreach departments of your nearest university, scientists that are used to work with education and teenagers, the local council, NGO's. It all depends on what works in your local circumstances.

At the beginning of the café suggest introducing gender and why it is important to reflect on and even challenge gender stereotypes when considering a future career path.

Suggested program and time schedule:

- **12 minutes welcome and introduction** to Science Café, the topic is briefly introduced, welcome to participants and researchers and welcome to the 'set-up' – which is briefly explained.
- **2 x 20 minutes talks.** Each scientist (or other speaker) presents themselves, their fields, personal choices and considerations and challenges they have met along the way. Q&A sessions after each presentation.
- **15 minutes break** after either the first or second presentation. (Remember there may only be one presenter).
- **40 minutes discussion.** It might be a good idea to prepare the overall discussion question with participating teenagers before the Science Café. This would also add to a sense of ownership. It might even be a possibility that one of the participating teenagers presents the discussion question in the beginning and why they have chosen it. The following question is simply an example of

what a question might look like: “Is it a problem that fewer girls than boys choose to follow a career in science and technology?”. The discussion is facilitated by the organisers.

- **Conclusion, 10 – 20 minutes.** What do we take home from the café?

CONCLUSION

To conclude the Science Café we end with an evaluation and reflective feedback. Participants are asked to discuss in small groups (or two and two) if this has made them reconsider the options they have in regards to choosing a future career path and study. Equally important is whether their view upon gender and the career stereotypes often associated with these has either changed or been challenged.

After the groups or pair discussions there will be a short plenum discussion. The organisers thank the researchers and teenagers (and teachers) for showing up and taking part in the café.

GENDER INCLUSION CRITERIA

The “gender inclusion criteria” developed in the Hypatia project are relevant for the adaption of software programming classes and should be reflected on and discussed with the people who are offering such a class or activity. Even more they might lay the ground for the success criteria in which to measure the results of the adapted activity. The following are some examples of how this workshop addresses gender inclusivity on the different criteria levels.

INDIVIDUAL LEVEL

- Includes presentations or talks by scientists, who are asked beforehand to reflect on their own experiences as women (or men) in science. They bring their experiences to the participants, who are about to choose their own careers.
- Introduces participants to the concept of gender and the role it plays when choosing what to study.

INTERACTIONAL LEVEL

- Will alternate between different types of discussion formats such as group discussions, plenum debates and for example short discussions in small groups.

INSTITUTIONAL LEVEL

- Can take place in a physical learning environment where participants can come together in plenum. It might be supportive if the setting is informal and could be followed by a chance to try out hands-on activities or other exhibits related to science – in other words perhaps in a science center or museum.
- Might bring up how an institution might influence the teenagers’ feeling of being included and discuss and reflect on what gender representations are found and used in their school or workplace.

SOCIETAL/CULTURAL LEVEL

- Will touch on the way gender is implicitly or explicitly conceptualized in society in general and how this concept is created and maintained through media, politicians and other powerful groups. Depending on the time participants can reflect and discuss more on this.

LEARNING OUTCOMES:

- At the end of the Science Café the participants should be able to:
    - Reflect on different career options in STEM and how gender biases may influence their own. understandings of possible study and career paths.
- At the end of the workshop participants should have acquired some of the following:
    - Knowledge of certain career possibilities within STEM.
    - A clearer understanding of what being a scientist might encompass.
    - Understanding of everyday life and/or careers of scientists.
    - Some knowledge on gender issues in science
    - Knowledge and ideas that can inspire them when choosing a future career path.

PARTNER DETAILS

This module was developed by the Danish Science Center Experimentarium, Hellerup, Denmark. Contact: Sheena Laursen, sheenal@experimentarium.dk and Christoffer Muusmann, christofferm@experimentarium.dk

EXPERIMENTARIUM

Cover image: the Danish Science Center Experimentarium, Hellerup, Denmark.

STEM WOMEN COOPERATIVE CARD GAME

AT A GLANCE

Age Group	13–18 years old students, groups and families
Format	Moderated discussion
Duration	20 minutes to 1 hour

OVERVIEW

By playing a cooperative card game, the public will discover the role of women in STEM knowledge and inventions throughout history.

OBJECTIVES

The activity aims to:

- Offer new role models to teenagers.
- Promote a better representation of women in schools, science centers and museums.
- Show women’s contribution to scientific knowledge.

SUGGESTED SCENARIO

The activity can be conducted in museums as a moderated discussion or at school. It can take place within a broader event or as a standalone activity.

TARGET AUDIENCE

Age	13 – 18
N. participants	2 – 30
N. facilitators	1 or 2 depending on the number of participants
Type of audience	Students, school groups, families, public

FORMAT

Moderated discussion.

TOPICS COVERED BY THE ACTIVITY

Women in STEM throughout history, history of sciences and technologies, and equality.

DURATION OF THE ACTIVITY

20 minutes to one hour depending on the format.

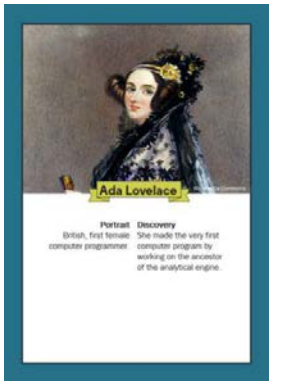
RESOURCES

MATERIALS

Cards printed on both sides: **FRONT** Photo or painting of a woman scientist + name + a short text presenting her and her biggest/most famous accomplishment or discovery *Note: don't indicate any dates on this side!* **BACK** Photo or painting of a woman scientist + name + year of her biggest/most famous accomplishment or discovery	(See illustration bellow)	30 cards (or more)
Hooks or clothes pegs and rope to hang the cards	 	60 (2 per cards)

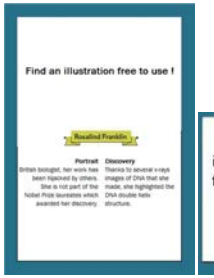
Note: How to create a card?

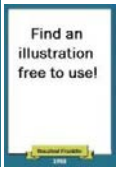
- The content of the cards, including the portrait and the discovery, can be found on online encyclopaedias (Wikipedia for example) or in books.
- Be careful when you choose the illustration/picture: it must be free to use. You can find online database to get license free pictures (Wikimedia commons for example).
- Here are three examples of cards (the front page of the card is on the left, the back side of the card is on the right):



Ada Lovelace

Valentina Terechkova





USEFUL LINKS, VIDEOS, ARTICLES

Wikipedia website, Britannica, books...

SETTING

- If the activity is implemented for a group including more than 10 people: a big wall to hang the cards as the game progresses. You can also choose to place the cards on the floor.
- If there are between 2 to 10 players: several tables and chairs, each with a set of small cards.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

The game can be implemented either for small groups of 2 to 10 and for bigger groups of 10 or more (up to 30).

INTRODUCTION

- For a large group, 5 min to explain the game. The facilitator(s) introduce themselves. They show a portrait card: “We are going to travel back and forth in time, to meet women scientists and learn about their discoveries. This is a cooperative game, so you can discuss as a group to find the correct place for each discovery in the timeline.”
- For small groups: Rules of the game are printed ahead of time and left on the tables with a set of cards. A poster close by lets the public know that they can play without asking. Facilitators can stay nearby to provide any necessary explanations.

Note:

- Choose the women you want to show carefully: you need as much diversity as possible in terms of scientific field, education, age, nationality, sexual orientation (when publicly sated by the woman herself) etc.
- It is best if there are not all “extraordinary” stories: boys and girls need to relate and sometimes highest profiles may do the exact opposite.

DEVELOPMENT OF THE ACTIVITY

For a large group: one of the facilitators hangs a first card with the date showing.

- They pick another card and ask to the group where it should go: before or after the first one.
- The second facilitator (if there is one) can walk among the public to catch some thoughts and encourage the players to share them with the group.
- Facilitators can give some clues, but without providing correct answer.
- The card is hung where the group says it should be.
- The answer is revealed and the card repositioned if needed.
- The facilitators pick a new card (or ask one of the players to take their role).

Note:

- The public can participate on several levels:
    - seek and find answers,
    - engage and encourage others by taking the facilitator’s role,

- handle the cards and hang them,
- suggest new discoveries by women to the game.

- Facilitator(s) must be briefed on the importance of involving girls in the discussion. Especially in groups where there are fewer girls than boys, there is a risk that only boys engage in the discussion. The speaker should also be prepared to hear sexist comments and react accordingly.

CONCLUSION

When the game is completed, or time is up, facilitators invite participants to have a look over the entire timeline: “In a short time, we have seen a lot of discoveries by women throughout history.

- *Do you know other women who are not represented here?*
- *Who is your favourite?*
- *Why?*

Facilitators explain why women are under-represented: prohibited from teaching, publishing, studying, etc.

A general discussion can then be engaged, if there is time and demand on how to ensure better representation of women in STEM.

PARTNER DETAILS

This module was originally developed by Universience in Paris, France.
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universcience

TEST YOURSELF!
THE INFLUENCE OF OUR IMPLICIT ASSOCIATIONS

AT A GLANCE

Age Group	Teenagers from 15 years old, adults
Format	Game and Moderated discussion
Duration	About 45 minutes

OVERVIEW

This activity explores the participants' sub-conscious associations regarding the connection between gender and involvement in STEM subjects (sciences, technology, engineering and mathematics) and the liberal arts.

The activity starts with a card game for two players, which explores whether the players tend to relate certain subjects to a particular gender. Through the game, the participants are exposed, in a non-obligatory way, to the gender bias embedded in their sub-conscious, which is likely to influence their behaviour without conscious intent. Thereafter, a group discussion is held, as well as a discussion in the plenum, on the influence of latent associations regarding gender, and their impact on the females' choice to study and to later work in STEM areas.

* *The activity is based on the IAT (Implicit Association Test) that measures the implicit opinions and beliefs that people do not want to, or cannot, reveal (in addition to gender, also race, weight, nationality, origin, skin colour and age). The test was developed by Tony Greenwald of the University of Ohio, a little over a decade ago. The test was developed and studied in various states through this site and on the TWIST project site.*

OBJECTIVES

- Exposing to the participants the gender biases implicit in their sub-conscious.
- To be aware of their implicit gender biases in order to reduce their impact on their behaviour and on their decision-making.
- To enable participants to make a more rational decision regarding the choice of STEM area in their studies and future careers.

SUGGESTED SCENARIO

At the museum in the following frameworks:

- A meeting for students on a scientific topic of choice, that includes a module about gender and science;
- An event for students, to encourage the choice of STEM subjects.

TARGET AUDIENCE

Age	Teenagers from 15 years old, adults
N. participants	20
N. facilitators	1 facilitator for 20 participants (no need of external experts)
Type of audience	School groups, groups of teachers or groups of pre-service teachers

FORMAT

Game and Moderated discussion.

TOPICS COVERED BY THE ACTIVITY

This activity has an unspecified STEM content but it deals with the issue of encouraging teenagers to choose STEM studies.

DURATION OF THE ACTIVITY

About 45 minutes.

RESOURCES

MATERIALS

Playing cards on which are written the words: **woman, girl, aunt, daughter, wife, lady, mother, grandmother, man, boy, father, male, grandfather, husband, son, uncle, philosophy, literature, art, sociology, music, language, history, physics, engineering, chemistry, statistics, neurosciences, biochemistry, astronomy**	You can find a graphic file for producing the signs (size A7) here	30 cards for each participant
Four signs with the captions: Liberal Arts **or** Female Science and Technology **or** Male Liberal Arts **or** Male Science and Technology **or** Female	 You can find a graphic file for producing the signs (size A5) here	4 signs for each pair of participants
Link to the internet or copy the following film to the computer:	royalsociety.org	1 per group
Projector		1 per group
Computer		1 per group
Blackboard or white wall for projection		1 per group

USEFUL LINKS, VIDEOS, ARTICLES

Before holding the activity, we recommend reading background material on the subject that includes statistical data and sources deal with the following topics: Why is it important to encourage equal opportunities? Possible reasons for the given gender inequality and proposals for improving the existing situation

You can find data in English in the report from UNESCO: Women in Science and in the document “Criteria for Gender Inclusion at the individual, interactional, institutional, and societal/cultural levels”.

SETTING

- Arrange the room to enable holding a discussion and watching a short film.
- Tables on which the cards will be placed, so that each two participants will be able to stand on both sides facing each other (the number of tables will be according to the number of participants).

Please note!

- It is important to place the signs in advance in the correct order, so that one can immediately start playing, after receiving the instructions.
- It is important that before the activity, the person directing the game will him/herself play, enjoy the experience, and ask him/herself the questions arising during the discussion.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

The activity includes playing in pairs and discussion in plenum.

INTRODUCTION

Presenting the game, 5 – 10 minutes

The instructor introduces him/herself (name, the scientific/technological area of academic study, his/her stage in studies, etc.). Thereafter, the subject of the workshop is presented in general – "Workshop on Gender and Career in the Sciences and Technology Areas", and the instructions for the game are expounded.

The participants in the game are to classify the cards as fast as possible, according to the two categories appearing on the cards: A category of "female" or "male", and a second category of "Liberal Arts "or "Science and Technology".

Each of the words on the cards is suitable to one of category-pairs: male/female or Liberal Arts/Sciences and Technology. For example, in the category male/female, the word "daughter" pertains to "Female", while the word "son" pertains to "Male". In the category Liberal Arts /Science and Technology, the word "art" pertains to "Liberal Arts" and the word "physics" pertains to "Science and Technology".

Please note!

Some students don’t know what liberal arts subjects are and what science and technology subjects are. It is highly recommended to give them some examples and make sure they understand and will be able to sort correctly the cards according the two categories.

DEVELOPMENT OF THE ACTIVITY

Paired card game, 5 minutes

- The participants are divided into pairs.
- Each pair of players participates in two rounds, with a different pair of captions shown them in each round.
- The pair: Liberal Arts or Female; Science and Technology or Male.

- The pair: Liberal Arts or Male; Science and Technology or Female.

- At the end of the first round, the players change places and repeat the exercise with the second pair of captions. The cards must be shuffled well after each round.
- At the end of the game the players return to their seats and a discussion is held.

In the following link you can find a short video that demonstrates the cards' game:
https://www.youtube.com/watch?v=SqAZfXBkeG4&feature=youtu.be

Discussion in the plenum, 10 – 15 minutes

Ask the participants:

- Was the level of difficulty identical in both rounds of the game?
- In which pair of categories was the classification easier?

Listen to the participants' comments.

The game, in fact, examines whether the players tend to relate certain subjects to a particular gender. Through the game, most of the participants are exposed in a non-obligatory manner to the gender bias implicit in their sub-conscious, which is likely to influence their behaviour without any conscious intent.

Studies based on this test show that most people usually take longer to place words associated with the exact sciences when they are connected to the category "Female" rather than to the category "Male", although there is no fundamental connection between the two categories. When there is an associative connection between the categories, people reply very quickly and attribute the word to the correct category, but it will them longer to answer when there is no associative connection between the two categories. But there is also room for optimism: researchers have found that although the stereotypical connection between science and masculinity is common globally (including in countries in which the indices of gender equality are higher, such as Denmark and Norway), it is lower in countries where there were actually more female scientists! In other words, the more women there are in science, the less will be the gender bias and *vice versa*, the less the gender bias, the greater will be the number of women in science.

Please note!

The results are likely to be affected by diverse external factors, such as distractions during the game. The game is intended to raise awareness of the subject and not to serve as a diagnostic tool. The results should be approached with a healthy dose of scepticism.
The claim is that those same biases in our sub-conscious can also affect our behaviour, our attitude towards males and females, and, of course, our decision making.

For example, a study conducted in Israel (by Victor Lavy, Professor of Economics from Warwick University, England and the Hebrew University, and Dr. Edith Zand, an economist from the Bank of Israel), showed that in external examinations for 6th grade pupils, in which the examiners did not know the examinees' gender, the girls attained better results than the boys. In comparison, in those same examinations that were checked internally by teachers who knew the pupils, the boys obtained significantly better results. This result proves unequivocally that the school teachers discriminated against the girls in mathematical scores, based on a gender. This discrimination affects not only their future success in junior high school and in university, in these subjects, but is one of the factors leading to the absence of females from these professions in the labour market, and even to their lower incomes compared to males.

Questions for discussion:

The claim is that since parents and teachers see more women than men in the liberal arts subjects and more men than women in the science and technology subjects, it may cause them to relate differently to boys and girls in the stage of choosing their course of study at school, and therefore, may influence their decisions making.

- *Have you experienced a different attitude from the teachers towards girls and boys in your class?*
- *How can this affect their success?*
- *Are there differences at home in the way your parents encourage brothers or sisters to study science and technology?*

  Listen to the participants' comments.

Showing a short film, 5 minutes

Show a short animated film on the influence of our implicit biases on our decisions, opinions and choices, and on the importance of recognizing them and raising them to awareness. The film is accompanied by subtitles and concludes with the claim that the existence of implicit biases cannot be prevented, but awareness of their existence can reduce their impact. *We can't cure unconscious bias, but with self-awareness we can address it.*"

The link for this film is: https://royalsociety.org/topics-policy/publications/2015/unconscious-bias/

We recommend inserting subtitles in the suitable language to the film (approval is given by the Royal Society Organisation to insert translated subtitles in the film).

CONCLUSION

Summary, 5 – 10 minutes

We spoke about the implicit biases we all have that can influence the choice by girls and women of professions in science and technology.

- *Is it/why is it important for both groups to study and work in STEM areas?*

  Hear the pupils' comments and summarise:

Culture is one of the main factors influencing the lesser participation of women in the world of science and technology. One piece of evidence for this is the existence of cultures in which both genders are represented and succeed equally in these professions. In the western world the participation of women in computer sciences is particularly low, while in eastern cultures, in Eastern Europe, in South America and in Africa, women are represented equally in this profession (and sometimes their percentage of participation is even higher than that of their male counterparts).

- *And why is it important for women to work in STEM areas?* (Or you can also ask about the importance of participation of other minorities such as those based on the socio-economic status)

  Hear the students' comments and raise the following claims:

It is important for women to work in STEM areas for several reasons: The value aspect of social equality in an advanced society; for the benefit of society at large, it is important to create a culture that encourages diversity. Diversity enables the expression of diverse opinions and approaches necessary to solving complex problems, and facilitates the full realization of the potential embedded in a particular society. If the potential of 50% of the population is not fully realized the entire society loses out.

GENDER INCLUSION CRITERIA

INDIVIDUAL LEVEL

- The activity enables all the participants to have an emotional experience in a simple card game on which the activity is based.
- The activity includes diverse formats of activity that enable different learners to be engaged: playing a card game, watching a short film and participating in a group discussion.

INTERACTIONAL LEVEL

- The activity includes playing and a group discussion, during which the participants discover that they all have the same experience of implicit bias regarding gender, and discover that none of them is free of stereotypical thought.

INSTITUTIONAL LEVEL

- During the discussion the participants broach situations that occur in their immediate environment, in school and at home, where implicit biases regarding gender are manifested. Bringing those implicit biases to the awareness in the context of gender and of STEM can

influence the attitude of pupils/teachers to males and females regarding their choice of scientific and technological subjects.

SOCIETAL/CULTURAL LEVEL

- The activity exposes the participants to the impact of culture and society on the females' choice of STEM subjects in school and in their future careers.
- The activity exposes the participants to the opinion of policy makers (Ministry of Education, Ministry of Science and Industry) regarding the importance of adequate representation of girls and women in STEM subjects in school, in academia and in industry.

LEARNING OUTCOMES

At the end of the lesson:

- The participants should be aware:
  - That their implicit biases can influence their decisions, opinions and choices and that there is a big importance to recognize them and be aware of them.
  - That females can develop a career in STEM to the same extent as can males. The main reason that their representation is not compatible in some of these professions is the social attitude (of males and females) regarding the status of females in society.
- The pupils will be able to make a more rational decision when choosing an area of study in high school and later in the academia.

PARTNER DETAILS

This module was first developed by Bloomfield Science Museum Jerusalem, Israel. Contact: Eti Oron, etio@mada.org.il

Cover image: Courtesy Bloomfield Science Museum Jerusalem, Israel.

WEARABLE TECHNOLOGY

AT A GLANCE

Age Group	13 – 18 years old
Format	Workshop
Duration	2 hours (for workshop) 45 minutes, minimum (for drop-in)

OVERVIEW

The activity involves the participants in:

- The exploration of technological tools (sewing machines, laser cutters, digital cutter…) and materials (textile oddments, leds…) for the creation of wearable products.
- The approach to the process of selection and organization of elements and materials through which people create objects.
- The reflection about the gender balance among the makers.

OBJECTIVES

The activity aims to:

- Create a connection between the interest of youngsters and the work of a technologist.
- Involve participants in designing and creating new technological objects using technological tools (with a gender connotation).
- Create a gender inclusive environment.

SUGGESTED SCENARIO

MUSEUMS

- Workshops with school groups.
- Drop in for weekend visitors.
- Maker space and fablab.

TARGET AUDIENCE

Age	13 – 18 years old
N. participants	25 (dimension of the workshop group or maximum number of participants in the drop-in setting)
N. facilitators	2 (if the participants use technological tools that require a specific know-how – sewing machines, laser cutters…– extra explainers are essential)
Type of audience	Families, youngsters, adults.

FORMAT

Workshop.

TOPICS COVERED BY THE ACTIVITY

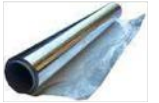
Electricity, circuits, work of designers and problem solving.

DURATION OF THE ACTIVITY

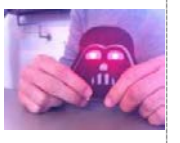
2 hours for workshop or 45 minutes, minimum for drop-in.

RESOURCES

MATERIALS

Scissors		20 – one per participant
Post-it		4 reels
Posters with STEM professional profiles (drafts in annex 1)		1 box
LEDs		100 (approximately 8 for each project)
Copper wire		100 m
conductive wire		1 reel
Aluminium Foil (for food packaging)		1 roll
button batteries (3 v)		20

Felt (2mm thick)		25 sheets (approximately 10x10 cm)
Automatic bottons		30
Hairclips		15
Shoestrings		10
Mini Motor		5
Oddments		3-4 small pieces (10*10 cm)
Elastic Band Roll (about 1 cm wide)		3 m (this can be used both as a wearable material and to attach the batteries to a surface)
Safety Pins (different dimensions)		60

Examples of Wearable Technology (objects if possible, otherwise images)	  

USEFUL LINKS, VIDEOS, ARTICLES

- www.instructables.com
- www.plugandwear.com
- www.opitec.com

SETTING

- 8 working stations for 2/4 participants per station.
- A big table with all the materials. The materials should be easily accessible for the participants during the entire activity.
- The materials on the table are divided by type: conductive materials, fabrics, decorative materials...
- One or more tables where to put working tools (the position of the technological tools should encourage participants to use them).
- 3 or 4 examples of wearable technology with circuits.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

In pairs, in small groups.

With school groups the pairs should possibly avoid a mix of males and females in order to encourage the engagement with all the different aspects of the object production (avoiding, for example, that females deal with the sewing part while males deal with the technological part).

INTRODUCTION

- Show different examples of already made wearable technologies (keep in mind that examples influence largely the visitors' work. It is important to present examples relating to all the available tools).
- Let people explore the materials and the tools on the tables.
- If you use special tools like sewing machines or laser cutters show how to use such tools.
- The participants also get to test an existing circuit to understand how circuits work.
- The explainers support the exploration of the participants if there are any questions.

DEVELOPMENT OF THE ACTIVITY

- The participants are requested to create their own wearable technology inspired by the materials and relying on their own creativity.
- They start making hypothesis (also by drawing their ideas on paper), choosing materials and building strategies.
- Explainers should become involved if the participants require it or when someone gets stuck for lack of creativity or confidence with the materials and tools.

CONCLUSION

Once objects are completed, each group describes how they work. The group can take pictures or videos and share them on social media with the museum tag. At the end of the day there can be a parade and a photo shoot or mini video with all the objects created that day.

As a conclusion of the activity, participants are invited to reflect about the connection between what they have done and gender balance in STEM.

In the case of a workshop, explainers should facilitate a plenary discussion about how much the participation in the activity is gendered and if the actions required by the activities are gendered in daily life (for example sewing or building a circuit). The facilitator can ask: *Who personally used needle and thread today? Who used LED Circuits?* And so on for the different tools*. Was it the first time for you? Did you do anything in this activity that you did not before? Did you have the chance to do anything you do not usually do? Is there something that you would like to try and you do not had the opportunity to use? Why? What was most usable? And what most challenging?*

The facilitator can even present some gender data from statistical analysis, in order to underline the gender gap in the public opinion, (i.e. from www.aauw.org)

In the case of a drop-in activity, the discussion can be difficult to propose to every single group, so you can use the linked evaluation sheet. One can leave for every participant the printed evaluation-file in order to encourage a personal reflection.

PARTNER DETAILS

MUSEO NAZIONALE SCIENZA E TECNOLOGIA LEONARDO DA VINCI

This module was originally developed by Museo nazionale della Scienza e della Tecnologia "Leonardo da Vinci" in Milan, Italy. Contact: Erica Locatelli, locatelli@museoscienza.it & Sara Calcagnini, calcagnini@museoscienza.it

Cover image: Photograph: Lorenza Daverio. Courtesy Lorenza Daverio and Museo Nazionale della Scienza e della Tecnologia “Leonardo da Vinci”, Milan.

YOUR ROLE IN RESEARCH
INQUIRY INTO CHEMICAL REACTIONS

AT A GLANCE

Age Group	13 – 16 years old
Format	Workshop
Duration	60 minutes

OVERVIEW

An authentic way to interact with materials, chemical substances and specimens. Boys and girls perform an experiment to test the characteristics of common substances. The students are directly involved in an inquiry process and will be able to see the link to the larger picture of the societal context wherein this activity fits. They use this experience in a discussion on the profession and roles within laboratories and will be able to see the link to the larger picture of the societal context wherein this activity fits.

OBJECTIVES

- Provide a way to practically engage with STEM content and material.
- Create the condition for participants to alternate between the specific details of a task, and its more overarching implications.
- Enthuse a diverse group of young people for scientific research/topics.
- Introduce working with an inquiry process.
- Introduce a look into the working life of a scientist.
- Get acquainted with the different roles within laboratories.
- Introduce the societal context of research.
- The experiments proposed in the activity stimulate wonder and surprise with the students.

SUGGESTED SCENARIO

Open days for families, orienteering days for secondary schools, workshop for school groups. As a workshop in the laboratory of a science museum. A workshop for school classes, for families (e.g. special holiday workshop), for teenagers (career orientation events or open nights).

TARGET AUDIENCE

Age	13 – 16
N. participants	25 – 30
N. facilitators	2
Type of audience	Students, visiting families or teenagers

FORMAT

Workshop.

TOPICS COVERED BY THE ACTIVITY

This activity will relate to the science curriculum for chemical reactions of BTB (bromothymol blue) diluted in distilled H2O, CaCl2 and NaHCO3. The essence of the test is an acid/base reaction, with BTB as an indicator.

It gives an image on the work a scientist/researcher can do and helps the students to see science as a serious career choice.

During a discussion the link is being made to the context of the laboratory and examples where the students can relate to.

DURATION OF THE ACTIVITY

1 hour.

RESOURCES

MATERIALS

Short guideline for the facilitator	Annex 1	1
Short guideline for the students	Annex 2	1 per working station
Re-sealable zipper bags, 1 Liter, max. 1 ½ Liter		3 per working station
20ml bottles of BTB (bromothymol, acidity indicator) diluted in distilled H_2O, with pipette	 or 	1 per working station
Black pots with $CaCl_2$ (calcium chloride)		1 per working station
White pots with $NaHCO_3$ (sodium bicarbonate/baking soda)		1 per working station
Measuring cups small	 or 	3 per working station
Measuring spoon		1 per working station
Pen or pencil & paper		2 per working station
Mortar (if needed)		1 per working station
Lab coats		1 per student
Lab glasses		1 per student
Paper towels		1 per working station

USEFUL LINKS, VIDEOS, ARTICLES

- Zip lock bag reactions on chymist.com
- Reaction in a Bag on ucsb.edu
- Reaction bag on YouTube

SETTING

Prepare the experiment in part 1: a scientific experiment which includes the opportunity for the participants to make choices about the variables, and not only follow the instructions of a procedure.

Choose the facilitators with care.

- Students might react better to a charismatic person that has experience in leading conversations with students or some might react better to a young person with whom they can identify better.
- Ensure that the involved science educators and scientists reflect a variety of personalities/characteristics and roles within the organisation! Make sure the level of ranking is not divided high = male, low = female.

Make sure the space where you receive the students has the possibility to do the experiment and have a group discussion. 1 Working station/table per 3/4 participants is needed.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

The students will be working in groups of 3/4 all the time with clear instructions. In general the facilitator encourages participation by all students, make sure that students don't get stuck, encourages questions and discussion, makes the transitions of what this experiment shows and what that tells us in the larger view of the socio-scientific role of the specific institution, makes an active link to diversity where possible

INTRODUCTION

Introductions, 5 minutes

The facilitator shows the materials, explains the safety rules and introduces his/herself:

- *What is your role and how did you get there (education and/or prior jobs)?*
- *What do you do on a regular day of work? You work together with who?*
- *How that relates to being a scientist?*
- Briefly tells what the students can expect, explain that they are going to do the work a scientist does, doing their own inquiry with experiment they'll chose themselves

Start with a general question that will be answered in this experiment and put it in a context. The facilitator asks the students this question and valorises the answers. The students let their ideas go freely.

- *Have you ever been in a chemistry lab?*
- *What, do you think, does a chemist do?*
- *How do you become a scientist?*
- *What, do you think, is a reaction?*

DEVELOPMENT OF THE ACTIVITY

The facilitator explains that the following experiment they will do provokes a chemical reaction determining whether a substance is alkali or acidic.

A type of experiment we would do to, for example, test cleaning products: acid products react with calcium (bathroom) and alkali/base products react with fat (oven), but also to your skin.

Guided experiment, 15 minutes

Scientists sometimes need to follow very specific guidelines/ already established procedures to conduct an experiment to discover and understand the specific characteristics of specific substances. For example when they want to perform the same test on different products.

First we are going to do an experiment in a zipper bag with guided action:

Each group (4-5 students) has a kit with:

- 3 zipper bags
- a bottle 50ml BTB (bromothymol, acidity indicator) diluted in distilled H_2O
- a black pot with $CaCl_2$
- a white pot with $NaHCO_3$
- 3 measuring cups
- 1 measuring spoon
- a mortar (if needed)
- a paper and pen
- paper towels

The facilitator does this experiment together with the students to guide them through the guideline:

- (If needed) grind the chunks of $CaCl_2$ with the mortar.
- Take 1 zipper bag.
- Put three teaspoons of $NaHCO_3$ and one teaspoon of $CaCl_2$ in the zipper bag.
- Fill the measuring cup with 10 ml. BTB in H_2O and place it upright on the bottom of the bag.
- Close the bag and try to squeeze out the air, while the measuring cup stays upright.
- Shake the bag and see what happens.
- Write down all your observations.

The students collect observations.

The facilitator moves between groups and focuses on the comments about changes in colour, change in temperature, foam/volume changes, but does not comment on them.

When mixing CaCl2, $NaHCO_3$ and BTB in a zipper bag, we can see and feel different phenomena (from the outside of the bag):

- Heating and subsequent cooling of the bag.
- The change of the colour.
- Foam formation resulting in the inflation of the bag.

We continue without discussing the observations

Open experiment, 15 minutes.

Scientists sometimes conduct a more open experiment/procedure if the scientific question is more open on the substances. For example when they want to know what different reactions are with different proportions. So we will try this out as well. Freely experiment with zipper bag:

The facilitator explains that, to find out what is happening, we are going to repeat the experiment by changing the variables. For example, we may choose to use only two substances at a time.

Each group of students has 2 extra zipper bags and 2 extra measuring cups and are free to choose variables to experiment with to find out what happens in the zipper bags and understand it.

The students collect observations. The facilitator moves between groups.

CONCLUSION

Discussion of the results & findings of each group, 25 minutes

- *What have we discovered in this specific experiment?*
  - A solution of $CaCl_2$ is slightly acidic and BTB gives it a yellow colour. Explain the terms acid-base
  - A solution of $NaHCO_3$ is alkalic and BTB gives it a blue colour.
  - If these solutions are added together, an acid-base reaction occurs, releasing CO_2 gas. At first it generates bubbles and the air blows up the bag (CO_2 – carbon dioxide– generated by the reaction of $CaCl_2$ and $NaHCO_3$ with H_2O).
  - At first it is warm to the touch (because heat is released during the reaction between H_2O and $CaCl_2$), this is an exothermic reaction.
  - Then we feel cold (because the formation of CO_2 –from $CaCl_2$ and $NaHCO_3$– absorbs the heat), this is an endothermic reaction.
  - The essence of the trial is an acid-base reaction with BTB as indicator substance.

- *What did each of you just do? What different roles did you have/what role does a scientist have in these kinds of experiments?*
  - selecting variables
  - conducting observations
  - making deduction
  - documentation.

  The facilitator might add needed skills as well, speaking from her/his own experience: persistence, diligence, patience, to be able to work alone and on the other hand to work in a team, to be prepared for satisfaction besides moments of frustration.

- *What other roles can a scientist have/what kind of job can a chemistry graduated do?*

  The facilitator can point out the following examples when the students don't think of them, to give a good idea of the societal impact a scientist can have:

  - Teacher, like your own teacher present.
  - Explainer, like a facilitator in a science museum.
  - Interviewer, like science journalists.
  - Writer, every experiments should be shared in science magazines.
  - Briefing of (inter)national colleagues, so the outcome can be used by others.
  - Creative, to think of what is important in the research by writing research plans.
  - Influencing policy, so governments act on discoveries made.
  - …etc.

During this discussion the facilitator or another present researcher discusses with the students her/his daily work.

- *What does a(n average) day look like?*
- *Who does (s)he work with?*
- *What are the different activities that are typical to her function?*
- While going into this, (s)he explains what is being done in laboratories:
  - Substances that do not exist in nature are being produced.
  - Substances that do exist in nature can be purified
  - Producing chemicals (legally or illegally).

- Research into materials (like research into radioactive materials and yet undiscovered elements).
- There are also a range of laboratories that do all kinds of analyses (for example analyses of soil samples or household cleaners).

- *What do you think we do in this kind of laboratories?*

Explain that laboratories can be part of a hospital or a university, but also be part of a small or large company, or a government agency. Next to laboratories for scientific research there are also laboratories for practical uses:

Quality Laboratory

Many companies have a quality laboratory, where they test the purity and properties of raw materials, auxiliary materials, semi-finished and finished products. In the pharmaceutical and food industry is a microbiology laboratory is essential to avoid the risk of food poisoning and contamination of the final product.

Hospital Laboratory

Hospitals have a general clinical chemical/haematological, medical microbiological, pharmaceutical toxicological and pathological laboratory. To examine all bodily fluids, but especially blood, urine, faeces, sputum and tissue. Mainly the general clinical chemical/haematological laboratories perform a 24/7 role and are continuously available for urgent analysis. The other laboratories listed are not constantly being used, only when needed. At the head of a hospital laboratory is a laboratory specialist. In the case of the clinical chemical laboratory, this is the clinical chemist. In the case of the microbiological laboratory, this is the clinical microbiologist. At the pathology lab, this is the pathologist. And the hospital pharmacist manages the pharmaceutical toxicological laboratory.

Forensic laboratory

A forensic laboratory investigates traces to determine the facts of crimes and identify the perpetrators. The investigation into traces of DNA has boomed in recent years, so even older crimes can be solved, where researchers previously searched for a solution unsuccessfully.

Construction Physical Laboratory

Some examples of research are:

- Wind nuisance and wind loads on and around buildings in the wind tunnel.
- Sun and shade on and around buildings
- Air- and waterproofness of facade elements
- Sound insulation of walls, doors and facade elements.
- Fire resistance of structural parts.

- *What aspects of this work do you think is most socially relevant and why? How can we impact the society most?*
  The facilitator notes and points out his/her observations in this: different type of people, gender etc.
- *Who sees him/herself becoming a scientist (like me☺)?*

GENDER INCLUSION CRITERIA

The “gender inclusion criteria” developed in the Hypatia project are relevant for the adaption of Your Role in Research and should be reflected on and discussed with the people who are offering such a class or activity. Even more they might lay the ground for the success criteria in which to measure the results

of the adapted activity. The following are some examples of how this workshop addresses gender inclusivity on the different criteria levels.

INDIVIDUAL LEVEL

- Encompasses a variety of different ways of engaging students by doing an activity, using discussing both in a groups as well as in small groups and showing different contexts where research can take place (different kind of labs, different roles).
- Involves activities that include a variety of problem solving and research methods such as selecting variables, conducting observations, making deductions and documentation.
- Uses activities that incorporate a clear context so participants understand what their role in research could be.
- Reflects on which previous knowledge and experience participants have.

INTERACTIONAL LEVEL

- Alternates between instructions in plenum; work in groups and discussions in plenum.

INSTITUTIONAL LEVEL

- Support the planned activities within the organization, the lab that already exists
- Include thinking about what kind of an impact the institution itself has – in the discussion the workshop leader discusses with the group what different roles scientist can have in society.

SOCIETAL/CULTURAL LEVEL

- Puts the different carriers you can have in science into context.
- Showcases and/or discuss areas where science is used to benefit the society.
- Broadens the views students have on science and scientists.
- Discuss the ‘whys’ and ‘where’s’ of society’s use of science.

LEARNING OUTCOMES

The following learning outcomes are divided accordingly between teachers or facilitators and participants:

- **Teachers or facilitators:**

  After planning and preparing this workshop the facilitator or teacher should have knowledge of and/or be able to:

  - Adapt the activity in relation to targeting a broader group of participants.
  - Gain inspiration from science.
  - Have an awareness and understanding of how to motivate girls and boys to engage in the activity.
  - Have awareness and understanding of the cultural restraints that might be part of a classroom teaching in regards to gender.
  - Realize how to counter target some of the cultural restraints in regards to gender that might be part of a classroom teaching.

- **Students/participants:**

At the end of the lesson participants should be able to:

  - Deduce which factors influence different phenomena in a chemical reaction.
  - Have an idea how to work with an inquiry process
  - Know what kind of skills you need to have to be a scientist.
  - Know the different kind of roles you can have within research
  - Be aware of some examples of what science can be used for in society.

PARTNER DETAILS

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Cover image: NEMO Science Museum, Amsterdam.

Hypatia PROJECT

Hypatia is an EU Horizon 2020 funded project that addresses the challenge of gathering different societal actors around bringing more teenagers, especially girls, into STEM careers both in school and as a choice of learning and career in the future. It aims at changing the ways sciences are communicated to young people in and out of school to make them more gender inclusive.

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