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

---

**WHAT'S YOUR OPINION? ABOUT THE CONNECTION BETWEEN GENDER AND SCIENCE**

**AT A GLANCE**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>15 - 18 year old pupils, adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Moderated discussion</td>
</tr>
<tr>
<td>Duration</td>
<td>70 - 80 minutes</td>
</tr>
</tbody>
</table>

**OVERVIEW**

The activity offers an interactive way to confront participants with their own prejudices and stereotypes. In an individual, secret ballot, each participant expresses an opinion regarding stereotypical claims as to whether females are capable of, and suitable to scientific and technological professions.

Thereafter, discussions are held in small groups and in the plenum on the reasons for the under-representation of women in some fields of STEM (Science, Technology, Engineering and Mathematics), on the value, social and economic importance of equal opportunities, and on proposals for activities that could improve the existing situation.

**OBJECTIVES**

- To expose the participants to, and to have them confront themselves with, the prejudices and stereotypes regarding gender and science.
- To enable the females to make a more rational regarding their choice of STEM areas in their studies and careers.
**SUGGESTED SCENARIO**

The activity can be held at school in the framework of a social activities class, in a science class, in the context of encouraging choosing scientific technological tracks, or in the framework of an event for choosing high school graduation study tracks. For teachers and pre-service teachers the activity can be held in the framework of teachers’ training.

**TARGET AUDIENCE**

<table>
<thead>
<tr>
<th>Age</th>
<th>15 – 18 year old pupils, adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. participants</td>
<td>15 – 40 participants</td>
</tr>
<tr>
<td>N. facilitators</td>
<td>1 (there is no need for external experts)</td>
</tr>
<tr>
<td>Type of audience</td>
<td>School groups, groups of teachers or groups of pre-service teachers</td>
</tr>
</tbody>
</table>

**FORMAT**

Moderated discussion.

**TOPICS COVERED BY THE ACTIVITY**

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

**DURATION OF THE ACTIVITY**

70 – 80 minutes.

**RESOURCES**

**MATERIALS**

<table>
<thead>
<tr>
<th>Beads (2 colours)</th>
<th>3 beads per pupil (different colour for each gender)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velcro</td>
<td>A strip of 10 – 15 cm</td>
</tr>
<tr>
<td>Stickers (a text or an icon representing “Agree”, “Don’t know”, “Disagree”)</td>
<td>Stickers for each statement</td>
</tr>
<tr>
<td>A4 sheet with the text of the statement</td>
<td>3</td>
</tr>
<tr>
<td>Scissors</td>
<td>1</td>
</tr>
<tr>
<td>masking tape</td>
<td>1</td>
</tr>
<tr>
<td>Cutting knife</td>
<td>1</td>
</tr>
</tbody>
</table>
3 possible options to create a ballot box

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoe box</td>
<td>3 or 6 see in the linked picture above option 1 or 3</td>
</tr>
<tr>
<td>Cardboard box</td>
<td>3 see in the linked picture above option 2</td>
</tr>
<tr>
<td>Transparent plastic cups</td>
<td>3</td>
</tr>
<tr>
<td>Opaque paper cups (much bigger than the transparent plastic cups)</td>
<td>9 see in the linked picture above option 1</td>
</tr>
</tbody>
</table>

USEFUL LINKS, VIDEOS, ARTICLES

Before holding the activity, we recommend reading background material on the subject that includes:

Statistical data regarding:

- The scores of males and females in the STEM subjects that indicate the abilities of both sectors.
- The updated number of students from both genders in academia in diverse STEM subjects (mathematics, physics, computer sciences and biology).
- The updated number of employees from both genders in industrial R&D departments.

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

ORGANIZATION OF THE CLASSROOM OR ACTIVITY AREA:

- A table for placing the ballot box, positioned in a way that will enable a secret voting as far as possible: In one corner of the room, beside the entrance door, behind the door etc.
- The tables in the classroom are arranged in a way to facilitate working in groups of 4-5 pupils.
- A blackboard on which one can write.

BALLOT STATION

- Prepare beads of different colours for the males and the females (three for each participant).
- Prepare a ballot box. One can prepare a large box with nine holes (in groups of three), into which the beads are
to be dropped. Next to each hole is a mark meaning "agree", "disagree", or "no opinion". Each group of three holes relates to a separate statement. Inspiration for constructing the ballot box from three other boxes (shoe boxes or cardboard boxes) can be obtained from three construction proposals shown in the picture in the section on "materials" (note – each proposal pertains to one statement; a box should be prepared for each statement).

- A transparent container (transparent plastic cup or soft drink bottle) should be placed under each hole. The containers are covered during the voting, and it is not possible to see how the others voted (see picture in the section on "materials").

PRINT OR WRITE ON A SHEET OF A4 PAPER THE THREE FOLLOWING STATEMENTS:

1. Some believe that men are better than women in science and technology.
2. Some believe that women are less rational than men and therefore less suitable to work in STEM.
3. Some believe that women may be good students but lack scientific talent.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT
Pupils work individually, in small groups and in plenary session.

INTRODUCTION

Voting at the ballot station, 10 – 15 minutes
We recommend starting the activity with individual secret voting at the ballot station and only thereafter presenting the subject of the lesson.

Please note!

- Maintaining secrecy is important in order for the voting to manifest the personal opinion of each voter, rather than that expected of him/her.
- It is important for the voters not to see how others voted, so that their vote will not be biased.
- It should be emphasized to the pupils that there is no correct or incorrect answer. Voting is according to what they feel.

DEVELOPMENT OF THE ACTIVITY

Presenting the subject and counting votes, 15 minutes
After the voting, the pupils should gather in their places, the subject of the lesson should be presented, the balloting station opened, and the results noted on a chart on the blackboard.

Presenting the lesson topic

- What do you think; is there a difference in the number of men and women engaged in the STEM subjects? Do you know more female engineers or male engineers?

Listen to the pupils and say that the lesson will deal with the subject of gender equality in the context of science and technology.
What is the significance of the word “gender”? Is the word gender parallel to the word sex (biology)? It is worth listening to the pupils opinions and only thereafter explaining the difference.

The concept of gender refers to social aspects of biological sex, i.e. the social and cultural significances of the biological aspects. Thus gender attributes do not necessarily emanate directly and exclusively from the biological differences between the genders, but manifest the cultural perception that translates biological difference to values that determine the social status of the two genders in society. When we talk about gender and science we refer, in fact, to the gender role that manifests the social customs and habits customary in that society, in other words, which roles and abilities are "suitable" for males and which for females.

Therefore, what is the significance of a gender stereotype or prejudice regarding gender? It is worth first hearing the pupils' comments and then to summarize and explain.

A stereotype is the social perception of attributes that are distinctive of groups of people and social categories, and their attribution to people who belong to these groups. Stereotype causes us to analyse social situations incorrectly. A gender stereotype is our social perception regarding the attributes of males and females (character, abilities, tendencies, preferences, external appearance, types of behaviour etc.), and our tendency to relate male attributes to males and female attributes to females, still prior to meeting them.

Opening the ballot box, counting the votes and their notation on the chart on the blackboard

We recommend dramatically opening the ballot box and allowing the pupils to be impressed by the results. Clear differences can be seen according to the number of beads and their colour in each of the transparent containers.

Thereafter, two volunteers will count the beads and note the results on the blackboard according to the following table:

<table>
<thead>
<tr>
<th>Some believe that men</th>
<th>Some believe that women are less rational than men and therefore less suitable to work in STEM</th>
<th>Some believe that women may be good students but lack scientific talent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td></td>
<td>Agree</td>
</tr>
<tr>
<td>No opinion</td>
<td></td>
<td>No opinion</td>
</tr>
<tr>
<td>Disagree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>♂</td>
<td>♂</td>
<td>♂</td>
</tr>
<tr>
<td>♀</td>
<td>♀</td>
<td>♀</td>
</tr>
<tr>
<td>SUM</td>
<td>SUM</td>
<td>SUM</td>
</tr>
</tbody>
</table>
opinions prevalent in the public (other areas, other ages, etc.)? Do the questions annoy you? Do you resent them? Do you think the results reflect the reality in the field?

Listen to the pupils and provide some national data from the field regarding the situation of males and females in science and technology - in school, in academia and in industry.

Please note!
The data shown below relates to Israel. Please enter the data according to the country where the activity takes place.
The data can be presented in brief or through questions and answers as follows:

Ask the pupils the following questions and ask them to raise their hand when they hear the answer compatible with their opinion.

- **Who received higher scores in the 8th grade national examinations in science and mathematics - the males or the females?**
  Whoever thinks that the females received higher scores - please raise your hand; whoever thinks the males received higher scores - please raise your hand; whoever thinks that the males and the females received equal scores - please raise your hand.
  Answer: Almost equal scores, small disparity in favour of the females.

- **What is the ratio between the number of females and the number of males studying for a (first and second) university degree in mathematics, statistics and computer sciences?** (Raise your hand according to the ratio each thinks exists.)
  Half of the students are males and half females; about \(\frac{1}{3}\) of the students are female and about \(\frac{2}{3}\) are male, some \(\frac{3}{4}\) are female and about \(\frac{1}{4}\) are male.
  Answer: Less than \(\frac{1}{2}\) of the students are female. The situation is worse regarding doctorate studies, where only 20% of the students are female.

- **What is the ratio between the average number of female and male Hi-Tech employees in all areas of science and technology?** (Raise your hand according to the ratio each participant believes exists.)
  An equal number of males and females, about \(\frac{1}{3}\) females and \(\frac{2}{3}\) males, about \(\frac{2}{3}\) females and about \(\frac{1}{3}\) males.
  Answer: About 65% males and about 35% females.

In conclusion, we have seen that the girls' scholastic abilities are similar to those of males, but fewer of them address certain academic scientific and technological studies (In school, too, there are fewer females who choose to study physics and computer sciences), and the number of females in R&D departments in industry is very small relative to the number of males in those departments.

**Discussion in small groups, 10 - 15 minutes**

Division into groups of 4-5 pupils

The groups will discuss three subjects, will note the main points of the discussion on a piece of paper, and thereafter will present the result of the discussion in the plenum.
1. What do you think are the reasons for the existing situation of inadequate representation of females in some areas of science and technology and in R&D departments in industry? List at least two reasons.

2. National policy makers (government ministries, senior stakeholders, etc.) are convinced of the importance of an equal number of females studying and involved in all areas of science and technology. What do you think? Note at least two reasons.

3. What do you think can be done to improve the existing situation in school and/or in academia and/or in industry? Note at least two suggestions.

Presenting the results of the group discussion in the plenum, 10 - 15 minutes

Each group will present the results of the discussion for 2-3 minutes.

During the presentation one can ask whether the decisions were unanimous? Did anyone make a suggestion that was rejected? Was there a difference between the females' opinions and the males'? Did anyone of the participants raise a point that you did not think of previously? Did questions or considerations arise for which you do not have answers?

If indeed questions were raised for which the pupils did not know the answer, we recommend trying to explore the topic and/or asking them to seek information on the subject, and afterwards to involve the other pupils.

Please note!

Try not to be judgmental during the discussion regarding the opinions expressed by the pupils. Raising diverse claims can be based on facts (such as statistical data) over which there are (usually) no argument and on the participants' different perceptions of the world, which is based on the influence of family, friends, and personal factors for which no judgmental opinion can be voiced.

CONCLUSION

Summary, 5 - 10 minutes

Should a matter of principle not be mentioned in the pupils' presentation the teacher will add the information. It is important to conclude the discussion with a clear position that the current situation is that females are not adequately represented in science and technology, and that the main reason for it does not lie in the lack of compatibility or their ability, but in social, cultural influence. The decision whether or not to choose to study and work in science and technology should be taken not in accordance with "what is accepted" and what is expected of one, but according to ability and personal interest. It is important to emphasize that there are differences between males and females, but these differences are smaller than those existing amongst all males and all females. Different people with different abilities are suitable for working in science and technology. Furthermore, researches have proven that the more varied the work teams and the greater variety of communities they represent, the more points of view they offer and the more creative solutions they reach.
Additional option for teachers and pre-service teachers for humoristic conclusion of the workshop:

Does something seem strange to you in the following sentences? (Or alternately, one can ask in which year do you think the following sentences were published?)

- Fact! Women have a career and men go to work.
- Today's question: Is it time we took men's contribution to academia seriously?
- Today's question: Can men really be both good dads and have good careers at the same time?
- Congratulations to all men in STEM for juggling housework, a job, and developing a career. Some even have kids too! How do they do it?

Do you think that in a hundred years they will also sound strange?

* These sentences were published on twitter @manwhohasitall

GENDER INCLUSION CRITERIA

INDIVIDUAL LEVEL

The activity includes diverse ways to express the personal opinions of all the participants and their involvement in activities:

- Secret, individual balloting by all the participants.
- Discussion in small groups enables the involvement of participants who find it hard to express their opinions in the plenum.
- Presentation in the plenum enables some participants to express themselves as best possible.
- The need to express opinions regarding social issues causes emotional involvement in the activity.

INTERACTIONAL LEVEL

- The activity includes diverse formats of activity that facilitate diverse interactions amongst the participants: discussions in small groups, discussions in the plenum, and presentations of group representatives in the plenum.

INSTITUTIONAL LEVEL

- During the activity the participants are asked to make suggestions for activities that the school can do in order to encourage more females to choose STEM subjects.

SOCIOETAL/CULTURAL LEVEL

- During the activity, the pupils are aware of the policy makers' (government ministries, senior stakeholders, etc.) agenda regarding the importance of integrating more females in academia and in industry, and of the need to encourage females to choose STEM subjects in school.
- Presents the subject of gender in the context of STEM subjects in a manner that obligates the involvement of pupils and expressing their opinions on associated issues.
- Presenting statistical data regarding gender and STEM in a manner that surprises and arouses thought.
LEARNING OUTCOMES

At the end of the lesson pupils should be aware:

- 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.
- Of the social reality of the incompatible representation of females in STEM, of the possible reasons that led to this, and of the possible ways the situation can be improved.

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.

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 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.**
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:
  o A didactic approach and the assessment of participants’ knowledge.
  o Monologue.
  o Specialized terms with no reference to real objects.
  o Seeking and dealing only with the correct answers or, even worse, with the correct questions.
  o 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.
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.

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation (H2020-GERI-2014-1) under the grant agreement No. 665566.