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

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**INQUIRY: SHAPE AND ACTION**

**AT A GLANCE**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>13 - 15 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Workshop for students</td>
</tr>
<tr>
<td>Duration</td>
<td>2 hours</td>
</tr>
</tbody>
</table>

**OVERVIEW**

The activity explores some elements of Physics and Engineering in a gender inclusive way and presents different approaches to these topics: play, discussion, representation and construction.

**OBJECTIVES**

This interactive activity aims at increasing the students’ self-confidence in representing scientific concepts in an abstract way and in constructing a structure in order to solve a practical problem.

It deals with an engineering topic, without specifying it until the final discussion, through an activity characterized by play, representation and construction.

The activity aims at presenting Engineering in a gender inclusive way, supporting the participation of all the students and discussing the gender balance in Engineering.

**SUGGESTED SCENARIO**

The activity can be held in the framework of a science lesson.
TARGET AUDIENCE

<table>
<thead>
<tr>
<th>Age</th>
<th>13 – 15 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. participants</td>
<td>20 – 25</td>
</tr>
<tr>
<td>N. facilitators</td>
<td>1</td>
</tr>
<tr>
<td>Type of audience</td>
<td>The audience could be a class of middle-school students.</td>
</tr>
</tbody>
</table>

FORMAT

Workshop for students.

TOPICS COVERED BY THE ACTIVITY

This activity has connections to Physics and Engineering in treating themes as trajectories, speed, force, distance, materials.

DURATION OF THE ACTIVITY

2 hours.

RESOURCES

MATERIALS

<table>
<thead>
<tr>
<th>Ping pong balls</th>
<th>1 per student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper cups</td>
<td>1 per two students</td>
</tr>
<tr>
<td>Paper</td>
<td>1 per workstation</td>
</tr>
<tr>
<td>Pencils/markers</td>
<td>1 per workstation</td>
</tr>
<tr>
<td>Rolls of masking tape</td>
<td>1 per workstation</td>
</tr>
<tr>
<td>Cardboard boxes</td>
<td>At least 1 per workstation</td>
</tr>
<tr>
<td>Scissors</td>
<td>1 per workstation</td>
</tr>
<tr>
<td>Box cutters</td>
<td>1 per workstation</td>
</tr>
<tr>
<td>PVC tubes</td>
<td>At least 1 per workstation</td>
</tr>
</tbody>
</table>

USEFUL LINKS, VIDEOS, ARTICLES

- Awesome Pong Trick Shots
- Unbelievable ping pong tricks
- Unbelievable ping pong tricks! trickshots extreme!
SETTING
You need 4/6 working stations for 4/6 persons per station and a table where prepare all the necessary materials.
If the activity is run in a classroom you could for example put together 4 desks in order to create big working stations.
You can ask students to help you to prepare the setting. They felt involved.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT
Students work in couples and small groups and are sat around the working stations. The teacher that know the students could form the groups, mixing males and females and avoiding that some group dynamic could reproduce inequality. The activity includes an alternation of pair work, work in small groups, plenary moments, and even an alternation of playing, representation, reflection, construction and discussions moments. That offers to students different group dynamics and help them to find their own favourite way to express themselves.

INTRODUCTION
10 minutes of plenary introduction.
The teacher introduces the pong-shot game: the player throws a ping pong ball in a paper cup. The ball should bounce once before landing in the paper cup.
The teacher can show the game asking a student to try or showing a video as inspiration (for example: Awesome Pong Trick Shots).

DEVELOPMENT OF THE ACTIVITY
10 minutes in couples
The teacher divides the group in couples and distributes a paper cup and a ball for every couple. The students play the pong-shot game.
10 minutes in groups of 4/6 persons, one group for each working station.
The teacher asks each group to represent what they observed on a sheet of paper.
10 minutes of plenary discussion.
The teacher collects the representations, hangs them in order to show them to the entire classroom. The teacher asks students to find the different and the common elements in their representations.
Quite often the students find a way to represent the trajectory. Therefore the teacher can underline it and ask to the students: Which are the main elements that can influence the trajectory? What could you do in order to control the ping pong ball trajectory? The discussion can touch many different aspects: the spot where we make the ball bounce, the direction towards we shoot it, the intensity of the force we use in the movement, the way we throw the ball, the height of the cup, its width, etc.
60 minutes in groups of 4/6 persons, one group for each working station.

The teacher invites the students to create a structure for the pong shot in order to have a controlled trajectory. Therefore the ball should fall from this structure, bounce once and land always in the paper cup. The structure could be a sort of slide or a ramp. The teacher presents the available variety of materials for construction.

During the construction time the teacher is around, asks questions to students about what are they doing and why, she/he can possibly give some tips. Moreover the teacher updates the students about the remaining time to make it easier for them to plan.

CONCLUSION

20 minutes of plenary discussion.

Every group of students presents, shows and tests his structure.

The teacher asks students which were the different variables as speed, starting point, bounces, heights, inclination, materials of the bouncing surface, rotation of the ball, force, distance, and how these factors influenced the trajectory.

The teacher underlines that a scientific activity can have different aspects: observation, exploration, representation, calculation, construction and asks some questions to students that can answer raising their hands: Which was the favorite part of this activity? Who preferred the introductive play? Who preferred the representation? Who preferred the discussion? Who preferred the construction?

The teacher can present data asking questions. For example she asks to answer raising the hands to the following question: Which is the percentage of women engineers employed in US in 2013? 12%, 36% or 48%? (The right answer is 12%, source: www.aauw.org/research/solving-the-equation/). Why?

The teacher concludes discussing about engineering, she can ask: How many people liked this activity? Why? How many people like the Engineering? What you do not like about engineering? What do you think is the most challenging aspect? Have you ever experimented an activity about engineering?

The teacher underlines that this activity treats topics related to engineering, such as design, representation, problem solving and construction, without ever mentioning the word “engineering”, that often discourage some students. The teacher therefore encourages girls and boys to go beyond bias and prejudices about some professions.

PARTNER DETAILS

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: Mauro Fermariello. Courtesy Mauro Fermariello and by Museo nazionale della Scienza e della Tecnologia "Leonardo da Vinci" in Milan
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 organize 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.

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