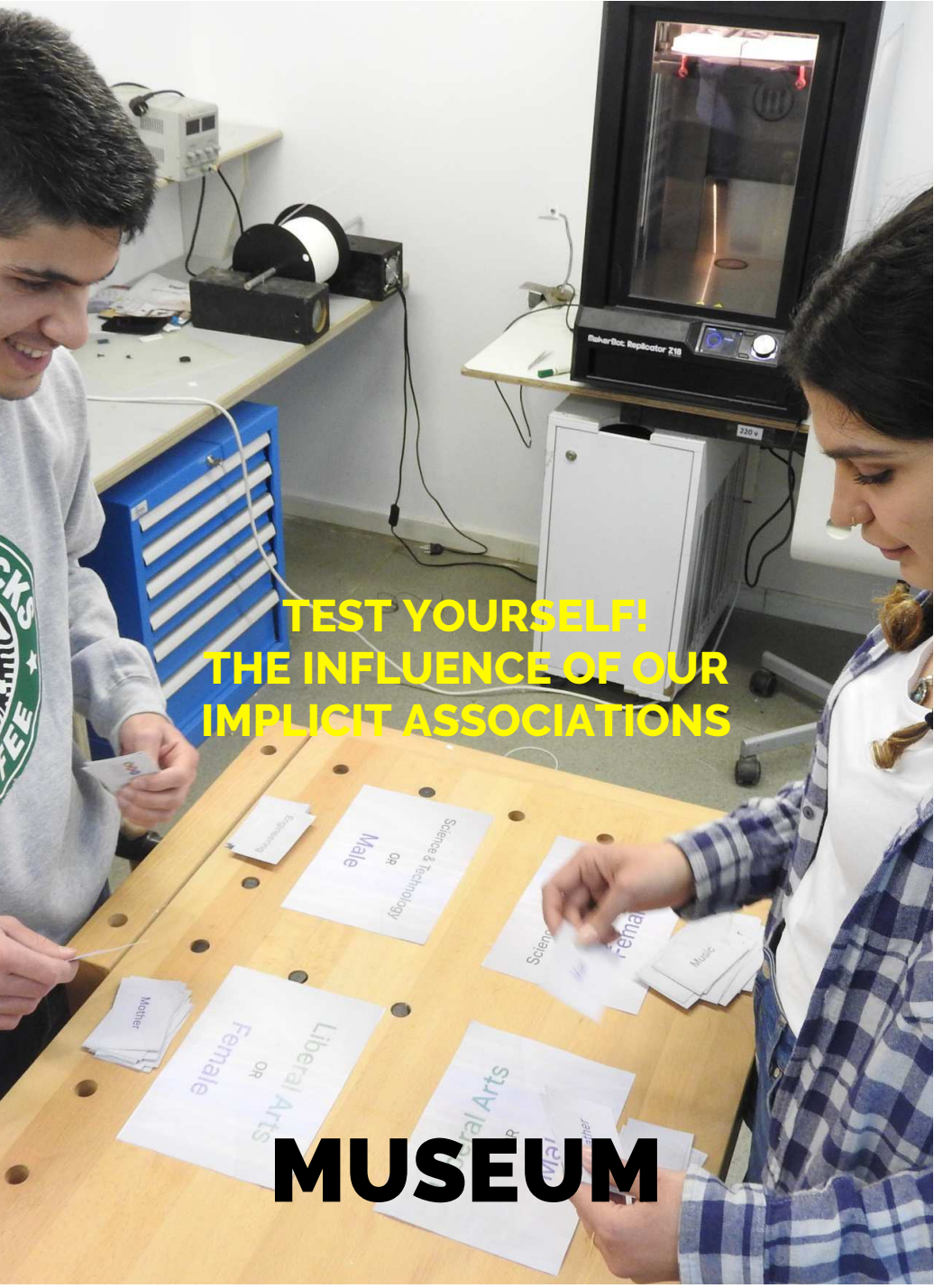


INTRO

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

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.

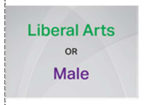
DURATION OF THE ACTIVITY

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	40 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.

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.

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.

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.