toolkit

Hypatia PROJECT

INDUSTRY & RESEARCH

INTRO

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

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

Each module is composed of three guidelines:

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

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

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

The Vision of Hypatia is of a European society that communicates science to youth in a gender inclusive way in order to realise

the full potential of girls and boys around Europe to follow STEM related careers.

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

Schools

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

Science Centres & Museums

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

Industry & Research Institutions

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

GUIDELINES ON GENDER BALANCE

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

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

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

FACILITATING GENDER INCLUSION

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

GENDER AND SEX

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

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

GENDER STEREOTYPES AND SKILLS

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

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

GENDER AND SCIENCE

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

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

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

SUGGESTIONS FOR THE IMPLEMENTATION OF THE ACTIVITY

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

INTERACTING WITH THE GROUP

- **Neutrality in assigning tasks and roles**

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

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

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

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

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

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

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

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

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

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

  Did I direct questions to boys more than to girls?

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

- **Unaware expression of stereotypes**

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

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

DURING A DISCUSSION

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

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

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

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

- **While facilitating a discussion**

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

MEETING A STEM PROFESSIONAL

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

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

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

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

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

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

FACILITATING AN EXPERIMENTAL SITUATION

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

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

USEFUL LINKS ABOUT GENDER INCLUSION IN THE CLASSROOM

HYPATIA’S THEORETICAL FRAMEWORK

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

Theoretical Framework

GENDER EQUALITY IN THE CLASSROOM

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

Gender Equality in the Classroom

GUIDELINES ON FACILITATION

A BIT OF ADVICE FOR GOOD FACILITATION

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

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

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

INTERACTING WITH THE GROUP

- Prepare the environment where the activity will take place in advance, organize the space according to the needs of the activity, even changing its usual structure if needed (i.e. you can move tables and chairs around).
- Make sure that all participants can see and hear well.
- Keep eye contact with the participants.
- Address participants as peers rather than as passive spectators or ignorant individuals.
- Listen to people and use their own terms.
- Use questions as much as possible – they can be a useful tool to encourage interaction among the group.
- Stimulate reflections among participants.

- If possible, ask and build on information or elements that can be discovered through direct observation.
- Engage people by linking to their personal experience.
- Encourage participants to express their opinion and elaborate their own considerations.
- During an activity, you might want to organise different group settings – work in smaller groups or in pairs, create plenary moments – to help engagement and better interaction with the experience.
- Before interacting with the participants in plenary, you might want to ask participants to discuss in small groups as a "warm up". This helps involving the shiest people or helps everybody to feel more comfortable about the topic before sharing any consideration in plenary.
- When the discussion is set in small groups, move around the groups checking on work and discussion, and intervene – only in case of difficulties!
- In plenary, try to address everyone as much as possible, encouraging everybody to participate and engage.

FACILITATING AN EXPERIMENTAL SITUATION

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

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

DURING A DISCUSSION

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

HOSTING A STEM PROFESSIONAL

- You might suggest to the speaker to alternate between questions and speech allowing participants to take up a more active role and prevent long talks.
- Before introducing a STEM professional, you can ask participants to share their perception about the particular profession, and then discuss it with the speaker.

- Young participants, when they have the possibility to ask free questions, often seem to be interested in the speaker's daily personal lives, in their career path and about what they were like when they were students. You can suggest that speakers use these topics as "hooks" during speeches and conversations.

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

QUESTIONS: A FUNDAMENTAL TOOL FOR LEARNING

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

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

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

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

First of all the basic categories:

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

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

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

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

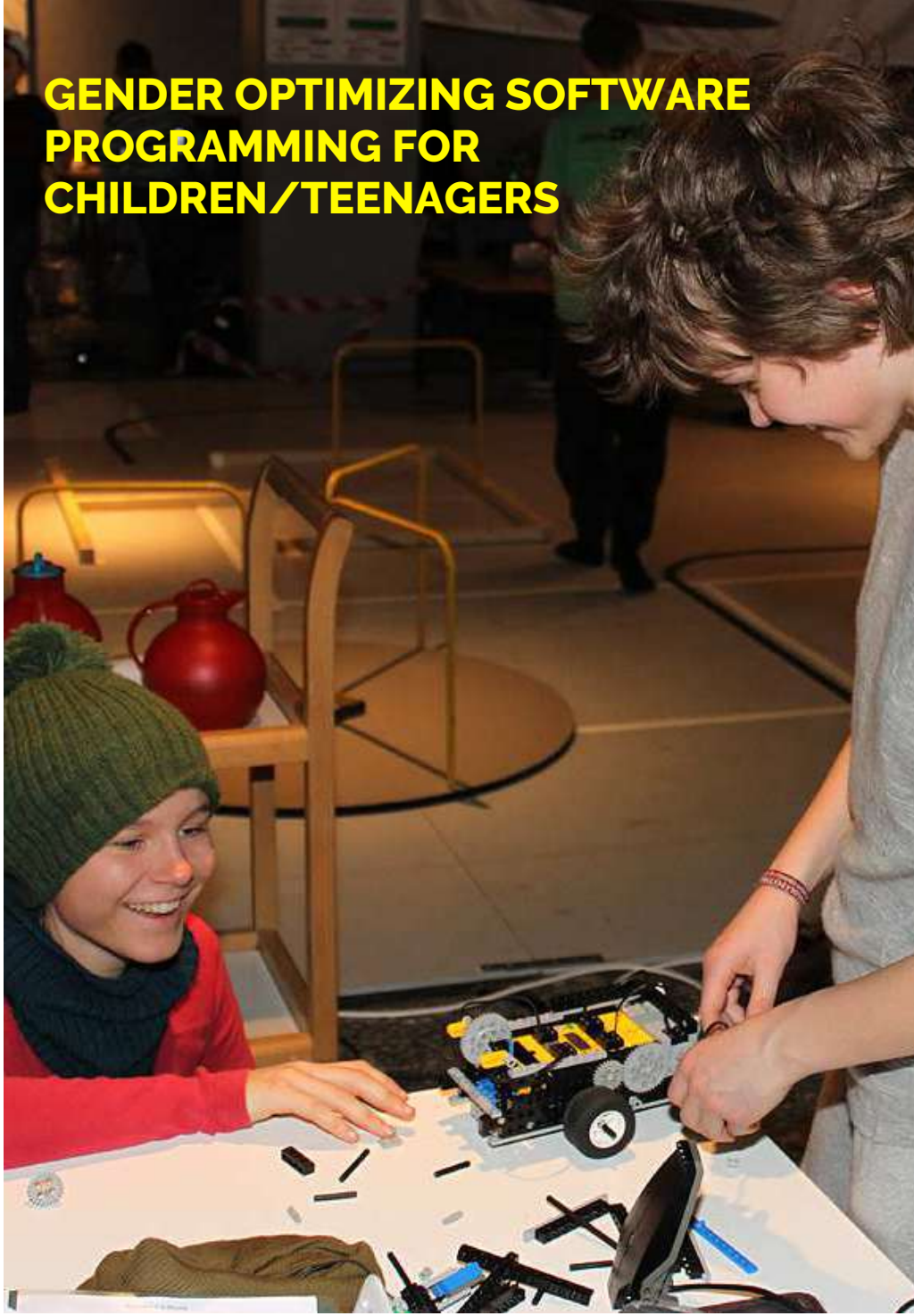
Open questions can be divided into the following categories:

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

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

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

GENDER OPTIMIZING SOFTWARE PROGRAMMING FOR CHILDREN/TEENAGERS



GENDER OPTIMIZING SOFTWARE PROGRAMMING FOR CHILDREN/TEENAGERS

AT A GLANCE

Age Group	Adult trainers/teachers and educators
Format	Workshop
Duration	Between 2 and 6 hours

OVERVIEW

This activity aims to gender optimise and improve already existing workshops on software programming for children/teenagers. Most schools must teach software programming to middle school groups and quite a few industrial companies choose to offer workshops on programming for schools. This activity aims to reach out to developers, teachers and facilitators to gender optimise these workshops and ultimately target a broader group of girls and boys. In other words this workshop is about redesigning an activity in order to take gender into account.

This activity will in turn help prepare teachers and student teachers to work with and teach their students software programming. The activity will focus on a science and technology approach as well as a didactic approach in regards to teaching software programming to school students.

OBJECTIVES

The main objective is to create gender optimised activities that lead to a larger interest in STEM. The objective is to raise the interest in technology with regards to software programming. The

focus is specifically on engaging more young people to take an education within STEM (here specifically within technology). The engagement is reinforced through the tools and suggestions on gender inclusiveness.

SUGGESTED SCENARIO

The activity will relate mainly to mathematics and ‘science and technology’ and will focus on already developed workshops that could benefit from an adaption to motivate and reach a broader group of school students (girls and boys).

The following are the main topics and connections within software programming to the school curricula in relation to mathematics:

- Students can see the common language between everyday language and expressions with mathematical symbols (to get something (perhaps a robot) to do ‘this and this’ – we need to use a programming language).
- Students can use expressions with variables – here under with digital tools.

The following are the main topics and connections within software programming to the school curricula in relation to “Science and Technology” (which is a school subject in Denmark):

- Students can describe a process from a first resource to a final product.
- Students can develop and use steering and simple sensors in their programming and use these to handle robots.

TARGET AUDIENCE

Age	Adult trainers/teachers and educators who develop and host programming workshops for 12 – 15 years old.
N. participants	15 – 25
N. facilitators	2
Type of audience	Facilitators of software programming workshops – who might be school teachers, teacher trainers or in-training teachers as well as other kinds of educators or trainers.

TOPICS COVERED BY THE ACTIVITY

The scientific contents of such an activity are software programming as well as an understanding of how to translate everyday language into a programming language.

This activity will promote an understanding of a technology that isn't always visible and noted but used on a daily basis.

DURATION OF THE ACTIVITY

Suggested duration: 2 – 6 hours.

RESOURCES

Note that the following resources are suggestions that might be used in a software programming class and these can vary and will depend on the activity and available resources.

As this activity aims to gender optimize already existing classes/activities on software programming (such as MicroBot Technology, Lego MindStorm, etc) the resources mentioned below are not necessary to make the activity, rather it is suggestions for needed materials in a class setting, where the students would work within this workshop area.

MATERIALS

Lego Mindstorm sets (or MicroBot Technology or other programming sets)		1 set per 2 participants
Lego Mindstorm table for test		1 per 10 participants if possible – otherwise the floor can also be used for testing
Lego Mindstorm program		1

USEFUL LINKS, VIDEOS, ARTICLES

- Lego Mindstorms
- www.firstlegoleague.org
- Search on YouTube for Lego Mindstorm films – also in your own language.
- Gender guidelines for adapting activities:
  - *One size fits all?* is teacher training development programme developed in the framework of the TWIST project (Towards Women In Science and Technology – EU funded FP7 project).
  - Check out The Twist Project website for other suggestions.

SETTING

After identifying and contacting industrial partners or research institutions or others that develop and offer software programming workshops for school groups it will be necessary to see if the contacted partner is interested in adapting their workshop. Once this is established the next step will be to find a date and setting to meet up. Here it is important to discuss how the workshop targets a broad group of children taking different learning styles and preferences into account and discuss how the workshop could be improved taking these considerations into account.

The setting for the workshop will depend on the contacted partner and could be at the industrial partner that develops the workshops or at the school where the workshops take place. Following this initial meeting the workshop should be jointly adapted.

DESCRIPTION AND TIME SCALE

Here is an example of how a software programming class might be set up in a gender inclusive manner. You could even call this task ‘Redesigning’ an activity in order to take gender into account with the following considerations.

- Less competition and more structure.
- Greater focus on achieving a meaningful and creative outcome.
- Maintain time constraint but with no single correct response.
- Alleviate stress levels by promoting a more supportive, non-confrontational approach.

- Emphasise the mathematical and problem solving element by creating an algorithm as a sequence of instructions.
- Ensure the experience is more multidisciplinary in character.
- Promote a balance of study and application.
- Foster perceptual and symbolic learning and foster gross motor skills.
- Retain kinesthetic and experiential activities.

GROUP MANAGEMENT

A workshop will usually start with an introduction in plenum where after participants are divided into pairs for the remaining of the workshop.

INTRODUCTION

The teacher/facilitator briefly presents the workshop introducing the objective.

The teacher goes on to introducing the teaching/learning cycle to put the workshop into a relevant didactic context for the class. The workshop can also be put into science context by explaining which skills are developed in relation to science literacy, technological literacy and mathematics literacy. This is important to target a broad group of girls and boys and to put the science into context where more participants will realise the relevance of the workshop.

Mention that this activity aims to redesign a programming activity where gender is taken into account. The following are considerations that might be relevant to reflect on:

- Less competition and more structure.
- Greater focus on achieving a meaningful and creative outcome.
- Maintain time constraint but with no single correct response.
- Alleviate stress levels by promoting a more supportive, non-confrontational approach.
- Emphasise the mathematical and problem solving element by creating an algorithm as a sequence of instructions.
- Ensure the experience is more multidisciplinary in character.
- Promote a balance of study and application.
- Foster perceptual and symbolic learning and foster gross motor skills.
- Retain kinaesthetic and experiential activities.

DEVELOPMENT OF THE ACTIVITY

The pupils are then introduced to the element of programming via for example the “Learn to program” on the Lego Mindstorm site or via other software programming programs.

They work like this for ca. 30 minutes.

Once the pupils are introduced to the software programming they could receive an engineering challenge that they then solve with the Lego Mindstorm robot.

CONCLUSION AND FOLLOW-UP

The adapting of the workshop will involve a discussion with either the industrial partner or the teachers who develop this programme. The focus here will be of a didactic manner and focus on a teaching situation with a specific focus on how to involve

a broad group of students – hereunder girls (who often are not involved in software programming). Focus should be on putting the learning into context – where is this used in life? (for example for optimising robots in elder care – or in the medicinal industry – or in regards to sustainable development and energy efficiency).

This workshop example has looked at the concept of First Lego League, which focuses on reaching all the way around with a concept that is put into context and aims to solve a societal problem – often in collaboration with a company/industry.

There should always be a follow-up and evaluation of each workshop and this should in part focus on whether the workshop managed to involve a broad group of participants (girls and boys) and whether or not they alternated in the different roles – such as experimenting, testing, planning, etc. It is highly recommended that some success criteria are set up covering these areas. Read more below under “Gender inclusion criteria” on this.

GENDER INCLUSION CRITERIA

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

INDIVIDUAL LEVEL

- Will encompass a variety of different ways of engaging students.
- Will involve activities that include a variety of problem solving and engineering methods such as planning, developing, building, testing and improving.
- Will use activities and approaches that incorporate a clear context so participants understand how, why and where their new knowledge may be put into practice.
- Will reflect on which previous knowledge and experience participants have.

INTERACTIONAL LEVEL

- Will alternate between presentations in plenum; work in pairs and discussions in plenum.
- Focus on changing roles/work areas (such as taking turns in planning, making notes, programming and building).
- Will note that all participants experience success in regards to solving the challenges.

INSTITUTIONAL LEVEL

- Should support the planned activities and this could include the physical learning environment and for example creating space in order to build and test the robot in an inspiring setting.
- Could be set up differently in the room – re-think where you plan – and why – re-think where you are creative – and why.

- Should include thinking of what kind of an impact the institution itself has – how do teachers present or speak of science or technology?

SOCIETAL/CULTURAL LEVEL

- Will put programming into context.
- Showcase and/or discuss some societal areas where programming offers solutions to societal challenges.
- Will invite participants to bring forward situations where they have seen results of programming.
- Will discuss the ‘whys’ and ‘wheres’ of society’s use of programming.

LEARNING OUTCOMES:

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

- Teachers or facilitators:
  After planning and preparing this workshop the facilitator or teacher developing the software programming activities should have knowledge of and/or be able to:
  - Adapt the activity in relation to targeting a broader group of participants
  - Reflect on how programming can be used in classroom teaching.
  - Gain inspiration from technology and specifically ICT (Information and Communication Technologies).
  - Have an awareness and understanding of how to motivate girls and boys to engage in the activity.

- Have an awareness and understanding of the cultural restraints that might be part of a classroom teaching in regards to gender.
- Realise how to counter target some of the cultural restraints in regards to gender that might be part of a classroom teaching.

• Students/participants:

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

- Program a (Lego Mindstorm) robot or other.
- Solve a challenge in relation to programming.
- Be aware of some example of what programming can be used for in society.
- If discussed – realize that gender stereotypes might influence our choices.

PARTNER DETAILS

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EXPERIMENTARIUM

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

SCIENCE AMBASSADORS

PEOPLE BEHIND SCIENCE AND TECHNOLOGIES

AT A GLANCE

Age Group	13 – 18 years old
Format	Meet a STEM professional
Duration	One hour or more

OVERVIEW

- The person in charge of outreach activities in a private/public company or a research institute invites one or two speakers, including at least one woman, to meet a class or a group of teens.
- The activity can be followed by a visit of the key locations in the company or research institute: labs, machines, computer control centre, etc.

OBJECTIVES

The activity will give teens the opportunity to:

- Meet professionals they can relate to.
- Make connections with a woman/man working in a stem-related job.
- See the workplace and people in their work environment
- Discover their course of study and background: obstacles (economics, gender, etc.), doubts, changes in orientation include.

- See the connection between their work and the needs of society.
- Demystify the image of the scientist seen as a white old man in a lab coat with strange glasses and get an idea of gender imbalance in the stem workforce.
- Make them see how representations can influence their career choices.

SUGGESTED SCENARIO

This activity can address a group of teens or a class invited with a teacher. In any case, it is important to maintain a reasonable number of participants, as small groups are more likely to foster interaction.

TARGET AUDIENCE

Age	13 – 18
N. participants	15 –30
N. facilitators	1
Type of audience	Students

FORMAT

Meet a STEM professional.

TOPICS COVERED BY THE ACTIVITY

The activity has links with job orientation curricula.

DURATION OF THE ACTIVITY

One hour or more.

RESOURCES

MATERIALS

Computer		1
Video projector		1
Seats		15 – 30
Goodies or a souvenir of the activity (ex: USB sticks, pen, key rings….)		15 – 30

USEFUL LINKS, VIDEOS, ARTICLES

The company’s website and the link on human resources.

SETTING

As it is not a top-down meeting, any arrangement can be used so that the researcher/engineer/technician and the teacher are sitting with the teens (and their families) to foster interaction. It is important to ensure that teens are close to and at eye level with the speaker(s).

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

- It is important for the outreach activity responsible to create a positive atmosphere and working conditions so that all participants feel welcome.
- The person in charge of outreach activities will preferably be there for the meeting and will have briefed the speakers beforehand:
    - If it is not possible to visit any other site of the workplace, speakers should bring pictures of their work environment to provide a view of the workplace: lab, office, team, key locations in the institute/center/company, etc. The speaker(s) should also be invited to show any artefacts/materials that might interest the participants.
    - Ask the speaker(s) to check how many women work in their company/research institute and in which jobs; and who, man or woman, is the head of the unit/department/company. It is an easy way to show horizontal and vertical gender segregation.

- It is also be useful to provide the speaker with some frequently asked questions and examples of answers:
  - *What qualifications do I need to apply to your company?*
  - *How many graduates does the company hire per year (What levels of qualification, kinds of degrees, for which departments?)*
  - *Is speaking English or other languages a hiring requirement?*
  - *How do beginners get their start in the company or research institute?* (internships, volunteering for International Experience programs, etc.)

Note:

- It is important to select profiles that everyone can relate to so as to avoid feelings of exclusion. Although it is interesting to have young role models because students can easily identify with them, priority should be given to the diversity of personalities and the fields they work in. For example, speaker(s) may not necessarily have bright and successful careers, they can be: an intern, a young researcher, an engineer or a technician employed in the company with a STEM-related job.
- Speaker(s) must be briefed on the importance of involving girls in the discussion. Especially in groups where there are fewer girls than boys, there is a risk that only boys engage in the discussion. The speaker should also be prepared to hear sexist comments and react accordingly.

INTRODUCTION, 5 MINUTES

Warm welcome to the teenagers. The speakers will explain why they are willing to meet young people (not only because they were asked to) and to exchange with them: W*ho am I?* (name, age) and *What is my scientific discipline?* (and if the speaker wishes: questions about private life: hobbies, partners, family, etc.)

Note:

A good way to kick off the meeting could be to ask students to share what comes to mind when they think of a scientist and/or what jobs they associate with science. It helps encourage students to speak freely and stereotypical representations of scientist are likely to emerge (glasses, man, white coat, laboratory, chemistry, mathematician, medicine, etc.)

DEVELOPMENT OF THE ACTIVITY

First set, 15 min total, (5-minute presentation, 10 minutes questions from students.)

- The speaker(s) will preferably begin with a focus on their personal experience: what they did during their studies when they were the age of the participants. It is an important step so that teens can easily identify with them:
  - *What did I like to study?*
  - *How did I get the job I have now?*
  - *What was I passionate about when I was younger?*
  - *How did I end up in this specific career path among (probably) several others?*
  - *Who influenced me? Who did I listen to?*

    - *Did I encounter any orientation issues/challenges?*
    - *If I failed at something, how did I choose another path?*

Students will be interested in the wide range of individual experiences. It will reassure them to know there is more than "one way".

- It would be useful to show the teens the different paths after high school to emphasize the multitude of bridges to get somewhere.
- It is also interesting to evoke, if that is the case for one of the speakers, some more "chaotic" path or any doubts they may have had to reach their current professional situation. The ideal model is not very challenging for everyone.

Second set, 25 min total, (10-minute presentation, 15 minutes questions from students.)

- The speaker(s) can talk about:
    - *What do I do on a daily basis? What is the purpose?*
    - *Who am I in contact with during the day? Who works with me?* (organization of the unit/lab)
    - *How would I describe a typical day?*
    - *Who controls/checks what I do? Who is my boss? Do I have one? How is my work evaluated?*
    - *What is more specifically the content of my job? Is it innovative and why? Why is it interesting?*
    - *Also, what is boring about it? What is challenging?*
    - *What do I like about this field?*
    - *What about salaries?*

    - *What are the impacts of my job in daily life or for future uses if there are any?* Otherwise speak about the specific nature of the scientific activity that has no links with everyday life, e.g.: research in astronomy.
    - *Do I have doubts or concerns about my job and my role?*
    - *Does my job match my previous expectations?*
    - *What are the basics qualities of my job?*
    - *What is my future (job prospects, openings)?*

Note:

- The development of the activity can obviously be flexible and adjusted accordingly to the reactions of students and speaker(s).
- Any material on the real and concrete life of the speakers is welcome (or videos, little experiments, pictures of working tools).

Tips:

- To prevent only boys from asking questions:
    - Split teenagers up into small groups (2-3) to prepare their questions for the speaker(s), give them a few minutes to come up with questions.
    - Teens should be given the option of sending emails to the scientist if they are too shy to ask in front of everyone.

- If students seem unconcerned about gender diversity issues:
    - The facilitator can stress the fact that boys and girls have the same possibilities, and both are part of gender equity.
    - It can be mentioned that promoting gender equity, especially in STEM, is on the agenda of the ministries of education in most European countries and major companies.
    - Promoting a gender-balanced workforce is also a key issue in European and national politics.

CONCLUSION

Time for discussion, other questions or remarks and feedback. Teens must leave with the feeling that they are able to choose some paths in STEM, that this is a possibility for them too.

PARTNER DETAILS

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

SKILL GAME

AT A GLANCE

Age Group	13 – 18 years old
Format	Meet a STEM professional
Duration	1,5 hour

OVERVIEW

The activity asks participants to reflect on their own skills. Different STEM professions are represented through a game and the participants discuss the associated skills with STEM professionals.

OBJECTIVES

This activity aims to discover the variety of skills that can be developed in a STEM career, emphasizing the unexpected ones, and to face some bias concerning STEM professions.

SUGGESTED SCENARIO

The activity works with a group of participants who know each other. It could take place during a research center/industry ‘open day’ or workshop for secondary schools.

TOPICS COVERED BY THE ACTIVITY

This activity deals the orientation after secondary school and helps to develop awareness towards STEM carriers.

TARGET AUDIENCE

Age	13 – 18 years old
N. participants	25 – 30
N. facilitators	1 facilitator and at least 3 STEM professionals. We suggest to represent a variety of STEM professions and of gender.
Type of audience	Secondary school students

DURATION OF THE ACTIVITY

1 hour and 30 minutes.

RESOURCES

MATERIALS

Pencils		30
Post-it		100
Posters with STEM professional profiles	drafts in linked doc	

USEFUL LINKS, VIDEOS, ARTICLES

- Video “Unsung heroes of science”
- Holland Codes career tests
- Gardner multiple intelligences

- "Talent Viewer" activity in Dutch
- Professions atlas in Italian

SETTING

Create a circle with all the chairs (one for every participant). Hang to the wall or to a poster support the posters with STEM professional profiles.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

There is an alternation of individual work, work in couples and plenary moments following this schedule:

Activity parts	Time	Group management
Welcome & introduction	10 min	Plenary
Individual skills on post-it	5 min	Individual
Skill circles	15 min	Couples
Comments on personal skills	5 min	Plenary
Posters	10 min	Individual
Meet the STEM professionals	40 min	Plenary
Conclusion	5 min	Plenary

INTRODUCTION

10 minutes of plenary introduction.

Present yourself and all the STEM professionals without specifying the profession of everyone (the participants have to guess it later).

Everyone has skills and we want to help the participants to discover what their main talents are or could be developed in every environment. Sometimes is hard to define a quality for the participants. In order to help them to focus their own predispositions, give some examples asking questions to be answered raising the hands. You can ask: *Who likes to chat with other people? Who likes playing role games? Who finds easy to remember quotes, poems or song lyrics? Who sings under the shower? Who finds easy to remember telephone numbers?*

DEVELOPMENT OF THE ACTIVITY

Individual skills on post-it, 5 minutes of individual work.

Distribute post-its and pencils and ask students to write down their own skills, using one post-it for each.

Skill circles, 15 minutes of work in couples.

The group of students should know each other. We ask participants to divide in two groups. The first group forms a circle facing outwards. The second group forms a second circle, around the first one, facing inwards. In this way, each person would be in front of someone. In 3 minutes every one has to state which is the best quality of the person in front of her/him and listen his best quality stated by the other. After 3 minutes, the external circle will turn clockwise in order to have new couples. They will start again to state qualities. The rotation is repeated a third time.

The facilitators and the professionals go around, listen the participants and possibly help who finds difficulties.

Comments on personal skills, 5 minutes in plenary.

The facilitator collects spontaneous comments about this first part of the activity. She/he can ask: *Who found a correspondence*

between what was written on the post-it and what was stated by the schoolmates? Who had correspondence among different schoolmates statements? Who received unexpected statements of qualities? Which ones? Why? Who feels rewarded after this comparison?

Posters, 10 minutes of individual work

The posters present different professions, the related daily tasks and work contexts. An empty space is left for the related skills.

The facilitator delivers post-its and pencils asking each student to look at the posters, to write down one or more associated skills and to stick the post-its in the reserved space.

Meet the STEM professionals, 40 minutes in plenary

Ask participants to guess and associate every STEM professional to one STEM profession represented in the posters. Each professional comments then his/her related poster valorising every students contribution and referring to their own personal experience. It would be interesting if the professionals

CONCLUSION

5 minutes of plenary conclusion

The facilitator thanks the STEM professionals and all the participants and underlines how much variety there is among STEM professions and how much a variety of people with different skills are necessary in STEM careers.

PARTNER DETAILS

MUSEO NAZIONALE SCIENZA E TECNOLOGIA LEONARDO DA VINCI

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

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

SPEED DATING

ENCOUNTERS BETWEEN PUPILS AND SCIENTISTS & ENGINEERS

AT A GLANCE

Age Group	Teenagers from 15 years old
Format	Meet a scientist and moderated discussion
Duration	About 1 hour

OVERVIEW

Young scientists and engineers who work in diverse STEM fields (Science, Technology, Engineering and Mathematics) in the academia and the industry, meet small groups of pupils for one time informal encounters. The participants are exposed to diverse STEM fields by female scientists from under represented fields such as computer sciences and physics, and male scientists who represent fields where male representation is inadequate or equal to female representation such as biology or chemistry. The activity will emphasize representation of various careers in STEM disciplines, including less familiar ones such as patent registration and consultancy. The activity ends with a short interactive game (Kahoot – see the explanation below), intended to expose the participants to a stereotypical approach and generate curiosity over statistics regarding STEM and gender.

OBJECTIVES

- To expose the participants to the diverse STEM subjects, especially those in which women are poorly represented.
- To expose the participants to the diverse careers in STEM subjects.
- To present female engineers and researchers as role models for the school girls (on the assumption that the public is more familiar with male engineer and researcher role models).

SUGGESTED SCENARIO

- For the industry: In the framework of open days for pupils that include visits at authentic work place of the engineer/researcher (laboratories, clean room etc.).
- For schools: In the framework of an event to encourage the choice of STEM subjects followed by presentation of the STEM subjects taught in school by the teachers.
- For museums: In the framework of an event to encourage the choice of STEM subjects at schools and STEM careers in the future.

TARGET AUDIENCE

Age	Teenagers from 15 years old
N. participants	40 pupils
N. facilitators	1 facilitator and 5-6 researchers & engineers
Type of audience	Pupils 9th-10th grade (before selection their course of study in high school)

FORMAT

Meet a scientist 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 1 hour.

RESOURCES

MATERIALS

Gong		1
Stopper		1
An easel or something else to hang a sign with information about the researcher / engineer		1 for each researcher/engineer
Computer + internet connection		1
Projection screen or white wall		1
Smart phone		1 for each pupil

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

Preparation for the activity includes recruiting several researchers and engineers. While recruiting it is important to consider the following topics:

- The researchers and the engineers will represent a broad variety of STEM subjects. Female will represent STEM areas with low female representation and male will represent STEM areas with low/equal male representation.
- The researchers and the engineers will represent a broad variety of careers that can be developed in the STEM subjects.
- We recommend choosing researchers and engineers as far as possible, with good communications abilities with people in general and with pupils in particular.
- The number of researchers and engineers is in accordance with the number of participants – an engineer/researcher for each six-seven pupils. We recommend conducting the activity with a minimum of five researchers and engineers, so that each participant will be able to meet five researchers and engineers.
- When the activity is held in school, we recommend recruiting the engineers/researchers from amongst the parents. It is important to maintain the balance between the number of men and women.

Please note!

We recommend holding two rounds of the session, i.e., for a double number of pupils. Much time is invested in the recruitment of the researchers/engineers, and it is a pity not to expose them to many school students.

- It is important to talk to or to meet the engineers and the researchers before the session with the pupils:
  - To explain to them the format in which the sessions with the pupils will be held (small groups for seven minutes).
  - To tell them what is expected of them when talking to the pupils:
    The personal aspect – why and how they chose their occupation, was there anyone who influenced their direction of choice? Were there difficulties on the way? What were they? Etc.
    The professional aspect – talk about their work, about the larger picture of the subject in which they work, rather than only about the small details: how does their research/work contribute to society at large and to them personally?
  - To emphasize the importance of a conversation at the level suitable to the pupils, so that they can

understand and gain an impression regarding the work. It is important to use scientific terms with which the pupils are familiar, and if necessary to explain their meaning. There is no need to go into small details. One should think of ways to simplify the subject so that it will be popular and give a feeling of understanding, even if not in depth. (It cannot be expected that a talk of a few minutes will cause them to understand the occupation/research in depth.)

- To prepare them to questions the pupils might ask at a personal level, so that they are not surprised… pupils often ask very practical questions such as *What subjects did you study in school?*, *Were you an outstanding student?, Are the university studies difficult?*
- To send them the "Gender Equality in the Classroom" brochure, with the tips for egalitarian teaching and the guidelines on facilitation and on gender issue (see below).

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

The pupils work in small groups at the speed dating stage and work together in the plenum at the conclusion.

INTRODUCTION

The moderator tells the participants that in the next 45 minutes they will meet females and males scientists who work in diverse STEM fields in the academia and the industry. They will have a short conversation with each scientist/engineer in small groups

and will have the opportunity to ask them about their professional careers and some personal aspects such as: challenges, obstacles, successes, disappointments etc.

DEVELOPMENT OF THE ACTIVITY

Speed Dating activity, 40 minutes

- The participants are divided into groups of seven male and female pupils (we recommend maintaining a numerical balance between the genders).
- Each female researcher or engineer sits on a chair with seven chairs around her. Next to her is a sign with her name, her field of work, and the name of the company or university in which she works.
- Each group sits on the chairs opposite a different engineer/researcher.
- The progression of the game is explained: From the moment the gong is heard, each researcher/engineer talks for exactly seven minutes with the group next to her. After six minutes the gong is struck reminding the participants that one minute remains. After seven minutes, the gong is again struck and each group moves to the adjacent station, (moving clockwise or counter clockwise).

Please note!

- Each group of pupils talks at four or five stations, according to the time allocated and the pupils' interest.
- The operator strikes the gong and the conversation starts.
- After six minutes the operator strikes the gong and reminds the participants that one minute remains.

- After seven minutes, the operator strikes the gong to conclude the discussion.
- Each group rises and moves to the adjacent station (decide in advance if movement is clockwise or counter clockwise).

Summary, 5 minutes

The pupils are gathered and asked:

- *Did you discover something new or surprising in the activity?*
- *Did you encounter an area of science/technology you did not know previously?*
- *Did you hear something today that caused you to think differently about STEM professions and gender?*

CONCLUSION

An interactive game with smartphones (the Kahoot application), 15–20 minutes

Please note!

For this part of the activity, each participant needs a smartphone and there is need for internet connection.

The closure of the event summons a trigger to expose the participants to the stereotypical perception and to generate curiosity over statistics regarding the professions of STEM and gender.

This part will be conducted by a representative from the world of industry, or the teacher, or the instructor (hereinafter the operator) dependent on the place where the activity takes place.

The pupils will be told that in this activity they will have to use their smartphones and the Kahoot application to answer a few questions about the professions of STEM and gender.

Please note!

A detailed explanation of the Kahoot application can be found on the link: getkahoot.com

- Follow this link. The game will be projected on the screen.
- The pupils are asked to connect to the "Kahoot" application (write the word Kahoot in Google and connect to the application (kahoot.it), and type in the number (pin code) appearing on the screen.
- One can see the names/nicknames of the pupils who are connected to the game on the screen.

Please note!

The first part of the game is a survey in which it is important for the voting to be anonymous and secret. It is important to tell the participants that the response is personal, and it is important for each to answer according to his/her personal feeling.

- The moment the screen shows that all the pupils are connected to the game, the START key should be pressed.
- The pupils will answer ("agree", "disagree", or "no opinion") three survey questions:
  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.

- The results of the participants' voting can be seen after each question.
- After responding to the survey, the operator will say that now, after expressing their opinion, we will see some data from the field.

Please note!

In the next game the pupils will have to answer seven questions regarding the extent of success of females compared to males in tests in STEM, the ratio between the number of females and males studying STEM subjects in school and in the academia, the number of male workers compared to the number of female workers in R&D in STEM occupations, and so on.

This time, in contrast to the previous game, it is a competitive game. The pupils' names who answered the most questions correctly will be displayed on the screen.

- The operator will press the following link. The game will be projected on the screen.
- The pupils will connect to the game code that will appear on the screen.
- The operator will press the START key and the game will begin.
- The questions that will appear on the screen (one after the other) are:
    1. The ratio between the males' and the females' averages in national tests scores in Science and Technology is:

A small gap in favour of females; A small gap in favour of males; No difference between the scores; A big gap in favour the females.

2. What is the ratio between the number of female and male pupils in computer sciences in high school?

   50% females 50% males; 68% males 32% females; 82% males 18% females; 40% males 60% females

3. The ratio between the number of female and male pupils in the academia for a PhD in engineering is:

   60% males 40% females; 23% males 77% females; 50% males 50% females; 77% males 23% females

4. The proportion of women in the senior academic faculty in 2011 was:

   2.7%; 35.1%; 77%; 11.2%

5. The ratio between the number of male and female workers in Hi-Tech industries in the R&D departments is:

   65% males 35% females; 90% males 10% females; 50% males 50% females; 40% males 60% females

6. What is the ratio between female and male engineers in computer sciences in Africa and South America?

   A small gap in favour of males; A big gap in favour of females; A small gap in favour of males; The same number of males and females

7. Marie Curie won the Nobel Prize in: Physics; Biology; Chemistry; Physics and Chemistry

- At the end of the game it will be possible to see who won, i.e., who knew (guessed…) the data from the field on gender and science.

Please note!

The questions should be adapted to the data suitable to the country. Should the event be held in school, data can be added that relate to the school. Should it be held an industrial framework, data pertaining to the gender situation in that society can be added.

Subjects for discussion:

- *Did the answers to the questions, i.e. the data from the field, surprise you? Why?*

  Listen to the pupils' comments.

  We have seen from the data from the field that females do as well in tests as males, i.e., the assumption is that the ability of females is similar to that of males.
- *If this is the case, why do you think there is a difference in the ratio between the number of females and the number of males studying/working in STEM?*

  Listen to the pupils' comments.

  Say that the current situation is that women are not represented adequately in some areas of STEM, and that the main reason for this does not lie in their lack of compatibility or their ability, but in the social cultural impact. There is a different expectation of men compared to women regarding areas of study and career.

One piece of evidence for this is the existence of cultures in which the two genders are represented and succeed equally. In the western world, for example, the participation of women in computer sciences is particularly low, while in eastern cultures, Eastern Europe, South America and Africa, they are represented equally in this discipline (and sometimes the percentage of their participation is even higher than that of their male colleagues).

- *So how can one alter the situation?*

  Listen to the pupils' comments.

Summarize and say that it is primarily important that both the boys and the girls know the data – both regarding the females' ability and the statistical data that show that although females can do as well as males, fewer of them study and work in STEM areas. Furthermore, it is important to arrange for the boys and girls to meet women who work in these areas as role models, to refute common stereotypical thought regarding women and STEM.

It is important for women to work in STEM areas for several reasons:

- The value aspect of social equality in an advanced society.
- The importance of creating a society that encourages diversity. In solving complex problems in every sphere, including in Science and Technology, it is important to hear a broad variety of opinions and approaches from women, men, diverse sectors etc.
- The potential embodied in a particular society cannot be realized if 50% of it is not fully realized

GENDER INCLUSION CRITERIA

INDIVIDUAL LEVEL

- The activity presents a broad range of subjects from STEM areas and a variety of careers in which one can work after studying these fields.
- All the pupils have the opportunity to express their opinion in the Kahoot game by using their own cell phone.
- Most pupils feel comfortable participating in an informal conversation with a small number of participants.
- The instructions to researchers and engineers emphasize the contribution of their research or work to society and not only the details of the research itself. Presentation of these different aspects allows a wide range of learners to be involved in the conversation.

INTERACTIONAL LEVEL

- The activity includes diverse formats of activity that facilitate diverse interactions amongst the participants: a discussion in the plenum and participation in an informal conversation in a small group.
- The activity includes a presentation of young female researchers and engineers, who serve as a role model for the female pupils. Male researchers and engineers are more familiar to the pupils, and therefore it is necessary to mainly present women. In any case, male researchers and engineers can be integrated in the activity, as long as a numerical balance between men and women is maintained.

INSTITUTIONAL LEVEL

- At the end of the activity statistical data are presented that describe the gender situation in STEM in school, in the academia and in industry. The pupils are asked to express their opinion on ways to alter the existing reality.
- During the discussion the engineers or the researchers can relate the fact whether their company/university has a gender policy or not.
- The area in which the activity is conducted is adapted to holding a large number of conversations in small groups. It is important to assure a large, spacious space that can contain several conversations simultaneously in an informal atmosphere.

SOCIETAL/CULTURAL LEVEL:

- The activity includes exposing the participants to female researchers and engineers from areas and careers in which women are inadequately represented. This exposure in fact introduces to the participants a less known aspect of STEM areas.
- During the conclusion of the activity the pupils are exposed to the importance industry allocates to increasing the number of pupils in STEM areas, who will be part of the reserve from which the employees will be recruited in the future.
- Presenting statistical data regarding gender and STEM in a manner that surprises and arouses thought.

- Presents the different representation of females in the STEM subjects – there are subjects (in school, in academia and in industry) where there is greater representation of females, such as biology and chemistry, compared to professions where this is particularly low, such as in computer sciences and physics.

LEARNING OUTCOMES

At the end of the lesson:

- Pupils should be able to choose an area of study based on broader familiarity with a variety of subjects and new types of career.
- 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.

YOUR ROLE IN RESEARCH

INQUIRY INTO CHEMICAL REACTIONS

AT A GLANCE

Age Group	13 – 16 years old
Format	Meet a STEM professional
Duration	60 – 90 minutes

OVERVIEW

An authentic way to interact with materials, chemical substances and specimens. Boys and girls perform an experiment, typical for the industry/research institution they are visiting and in line with the institutions stated aim. They test the characteristics of common substances, they are directly involved in an inquiry process. They use this experience in a discussion on the profession and roles within the industry/research institution and will be able to see the link to the larger picture of the societal context wherein this activity fits.

OBJECTIVES

- Provide a way to practically engage with STEM content and material.
- Create the condition for participants to alternate between the specific details of a task, and its more overarching implications.
- Enthuse a diverse group of young people for scientific research/topics.
- Introduce working with an inquiry process.

- Give a look into the working life of a scientist.
- Get acquainted with the different roles within the visited industry/research institution.
- Introduce the societal context of research.
- The experiments proposed in the activity stimulate wonder and surprise with the students.

SUGGESTED SCENARIO

Open days for families, orienteering days for secondary schools, workshop for school groups.

TARGET AUDIENCE

Age	13 – 16
N. participants	25 – 30
N. facilitators	3 – 4
Type of audience	Students

FORMAT

Meet a STEM professional.

TOPICS COVERED BY THE ACTIVITY

This activity relates to the science curriculum for chemical reactions of BTB (bromothymol blue) diluted in distilled H_2O, $CaCl_2$ and $NaHCO_3$. The essence of the test is an acid/base reaction, with BTB as an indicator.

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

During a discussion, with the performance of an experiment, the link is being made to the context and an example where the students can relate to.

DURATION OF THE ACTIVITY

60 – 90 minutes.

RESOURCES

MATERIALS

Short guideline for the facilitator	Annex 1	1
Short guideline for the students	Annex 2	1 per working station
Re-sealable zipper bags, 1 Liter, max. 1 ½ Liter		3 per working station
20ml bottles of BTB (bromothymol, acidity indicator) diluted in distilled H_2O, with pipette	 or 	1 per working station
Black pots with $CaCl_2$ (calcium chloride)		1 per working station

White pots with $NaHCO_3$ (sodium bicarbonate/baking soda)		1 per working station
Measuring cups small	 or 	3 per working station
Measuring spoon		1 per working station
Pen or pencil & paper		2 per working station
Mortar (if needed)		1 per working station
Lab coats		1 per student
Lab glasses		1 per student
Paper towels		1 per working station

USEFUL LINKS, VIDEOS, ARTICLES

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

SETTING

We need 1 working station/table per 3/4 participants.

Choose the facilitator and scientists with care.

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

Brief the students teacher to prepare the students before they come and visit:

- A short talk about the industry and the scientist and his/her field can be enough.

Make sure the space where you receive the students has the possibility to do the experiment and have a group discussion.

DESCRIPTION AND TIME SCALE

GROUP MANAGEMENT

In general the facilitator encourages participation by all students, make sure that students don’t get stuck, encourages questions and discussion, makes the transitions of what this

experiment shows and what that tells us in the larger view of the socio-scientific role of the specific institution, makes an active link to diversity where possible

The students will be working in groups of 3/4 all the time with clear instructions.

Part 1 of the activity in this guideline is an example and should be an activity that the industry/research institution chooses themselves (see setting).

Part 2 of the activity is what brings a sur-value to the industry/research institution.

INTRODUCTION

Introductions, 5 minutes

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

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

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

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

DEVELOPMENT OF THE ACTIVITY

Part 1: The experiment

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

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

Guided experiment, 15 minutes

Scientists sometimes need to follow very specific guidelines/already established procedures to conduct an experiment to discover and understand the specific characteristics of specific substances. For example when they want to perform the same test on different products. This is what we are going to try out first:

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

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

- 3 zipper bags
- a bottle 50ml BTB diluted in distilled H2O
- a black pot with CaCl2
- a white pot with NaHCO3
- 3 measuring cups
- 1 measuring spoon
- a mortar (if needed)
- a paper and pen
- paper towels.

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

- (If needed) grind the chunks of CaCl2 with the mortar.
- Take 1 zipper bag.
- Put three teaspoons of NaHCO3 and one teaspoon of CaCl2 in the zipper bag.
- Fill the measuring cup with 10 ml. BTB in H2O and place it upright on the bottom of the bag.
- Close the bag and try to squeeze out the air, while the measuring cup stays upright.
- Shake the bag and see what happens.
- Write down all your observations.

The students collect observations.

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

When mixing CaCl2, NaHCO3 and BTB in zipper bags, we can see and feel different phenomena (from the outside of the bag):

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

We continue without discussing the observations.

Open experiment, 15 minutes

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

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

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

The students collect observations. The facilitator moves between groups.

CONCLUSION

Part 2: The discussion, 20 minutes

Discussion of the results & findings of each group.

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

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

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

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

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

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

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

- *What does a(n average) day look like?*
- *Who does (s)he work with?*
- *What are the different activities that are typical to her function?*
- While going into this, (s)he explains what is being done in laboratories:
    - substances that do not exist in nature are being produced
    - substances that do exist in nature can be purified
    - producing chemicals (legally or illegally)
    - research into materials (like research into radioactive materials and yet undiscovered elements)
    - there are also a range of laboratories that do all kinds of analyses (for example analyses of soil samples or household cleaners).
- *What do you think we do in this kind of laboratories?*

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

Quality Laboratory

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

Hospital Laboratory

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

Forensic laboratory

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

Construction Physical Laboratory;

Some examples of research are:

- wind nuisance and wind loads on and around buildings in the wind tunnel
- sun and shade on and around buildings
- air- and waterproofness of facade elements
- sound insulation of walls, doors and facade elements
- fire resistance of structural parts.

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

GENDER INCLUSION CRITERIA

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

INDIVIDUAL LEVEL

- Encompasses a variety of different ways of engaging students by doing an activity, using discussing both in a groups as well as in small groups and showing different contexts where research can take place (different kind of labs, different roles).
- Involves activities that include a variety of problem solving and research methods such as selecting variables, conducting observations, making deductions and documentation.

- Uses activities that incorporate a clear context so participants understand what their role in research could be.
- Reflects on which previous knowledge and experience participants have.

INTERACTIONAL LEVEL

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

INSTITUTIONAL LEVEL

- Explains the subject of research of.
- Includes thinking about what kind of an impact the organization itself has – in the discussion the workshop leader discusses with the group what different roles scientist can have in society.

SOCIETAL/CULTURAL LEVEL

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

LEARNING OUTCOMES

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

- **Teachers or facilitators**

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

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

- **Students/participants**

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

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

PARTNER DETAILS

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Hypatia PROJECT

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

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