A motivational programme to

promote girls' engagement in STEM

Content

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Introduction

This guide is designed to assist primary and secondary school teachers in encouraging and supporting girls in STEM education. Girls and women are well-known to be underrepresented in STEM fields, and societal and cultural biases can discourage girls from pursuing interests in maths and science (OECD, 2017). This guide aims to address these issues by providing teachers with strategies and resources for encouraging girls to take more science, technology, engineering, and maths classes, as well as making STEM education more accessible and inclusive.

Numerous studies have found that mathematics and science are perceived as male domains, with scientists being predominantly male. The World Economic Forum's Global Gender Gap Report (2021) reflects these stereotypes, with informatics having the lowest proportion of women at only 10,4 %, and chemistry and life sciences having the highest proportion of women at 43,7 %. Furthermore, according to UNESCO data, only 35 % of all female students in higher education study science, technology, engineering, or mathematics, and only 28 % of researchers worldwide are women. Moreover, globally, information and communication technologies (ICT) attract very few female students (3 % of all students), as do natural sciences, mathematics, and statistics (5 %), and engineering, manufacturing, and construction (8 %).

Stereotypes that are ingrained in children's minds from an early age can be used to explain why there is an imbalance in the gender balance. DAST (Chambers, 1983) studies have shown that students from kindergarten through high school perceive scientists as being male. In a study in which students from kindergarten to fifth grade were asked to draw a scientist, only 28 images of a female scientist were found out of 4,807, and all 28 were drawn by girls. According to this study, girls are more likely to limit their occupational choices because they perceive certain occupations as inappropriate for their gender. Underrepresentation of young women in STEM education has a negative effect

on their future career paths and results in countless missed opportunities for achievement and discovery in those fields. The implications are even more severe for girls who face socioeconomic or other disadvantages.

> In order for women to succeed in STEM fields as well, we must position them for success as society evolves and as future careers diverge from those we are accustomed to today. This includes providing girls with access to and opportunities to learn about STEM studies and career paths, as well as encouraging and expecting girls to join the STEM workforce. This can be provided by the appropriate STEM approach in early education settings such as primary and secondary schools, which ensures diversity, equity, and equal access to materials for all students regardless of gender, age, race, or socioeconomic background.

In summary, the purpose of this guide is to provide primary school teachers with the tools and resources they need to encourage and support girls in STEM education. In this guide, we will present motivational approaches and best practices from European countries to engage girls in STEM from partner countries, examples of activities to stimulate girls, such as hands-on exercises, role-playing, storytelling, simulations, and initiatives with a focus on girls, and different events involving real female scientists from local surroundings acting as role models to stimulate engagement in girls.

1 Motivational approaches to engaging girls in STEM

(best practices)

Image 1: Girls smiling. [Photograph]. Canva Stock.

STEM (science, technology, engineering, and math) education is critical for our society's future, and yet girls and young women are underrepresented in these fields.

While there has been progress in recent years, there is still much more that needs to be done to engage and motivate girls to pursue STEM subjects and careers. This article will examine some of the best practices for encouraging girls to participate in STEM courses and pique their interest in STEM classes (Keane et al., 2022).

First, it is important to show the variety of STEM opportunities available to girls.

Schools can accomplish this by incorporating lessons about the contributions made by women in the STEM fields and by highlighting the diverse range of careers that can be attained through STEM education. **This can help girls find the ideal fit for them and recognize the real-world relevance of STEM subjects.** Presenting female role models from STEM fields to girls sends the message that anything is possible. This piques their interest in STEM careers and allows them to imagine themselves working in these fields.

Another effective approach is to **encourage STEM investigations and hands-on activities.** This can be done as part of the curriculum or as extracurricular activities, through individual projects or larger project-based learning programmes that connect girls with real-world issues in their communities. This can help them see the value of STEM education and the impact it can have on their communities.

Image 2: Performing a hands-on experiment. [Photograph]. Canva Stock.

Using real-world situations and problems to solve increases girls' interest in STEM. The ability to visualize the possibilities for working on these topics, how they might be implemented in practical settings, and whether or not they might be important for their futures are key factors in engaging girls in STEM.

Providing STEM mentoring opportunities is also crucial. To see the possibilities available to them, girls must connect with successful women in STEM careers. This can be accomplished through long-term cooperation with female STEM professionals who can answer field-related questions and provide guidance and support, as well as through the use of female STEM role models.

Schools can cooperate with institutions outside of the classroom, such as museums, zoos, youth organisations, and STEM clubs. These groups can provide workshops and other activities that offer girls more opportunities to experience STEM fields and develop their skills and knowledge.

Image 3: Empowering girls to spark interest in STEM fields. [Photograph]. Canva Stock.

The gender gap remains, owing primarily to stereotypes held by the STEM field, which is supposed to be more oriented towards men than women. Young women are more likely to pursue STEM careers if they are not influenced by stereotypes and believe that everyone has an equal opportunity to pursue a career in this field. This means that, in addition to fostering STEM enthusiasm, it is necessary to help young women gain self-confidence in their abilities, both in STEM and in other fields, and to provide them with equal opportunities to achieve their goals as men.

1.1. Factors with a positive and negative impact on the choice of liking or disliking STEM

According to the research conducted by Sáinz, M. (2020), the key elements that influence a girl's choice to pursue a profession in STEM can be explained by the cause-and-effect connections between societal, personal, and motivational factors.

This example is related to mathematics because it is the foundation of science education in higher education, regardless of STEM orientation. These are expectations for mathematical success, enjoyment of mathematics, the importance of mathematics knowledge, its usefulness, and gender stereotypes about mathematical ability.

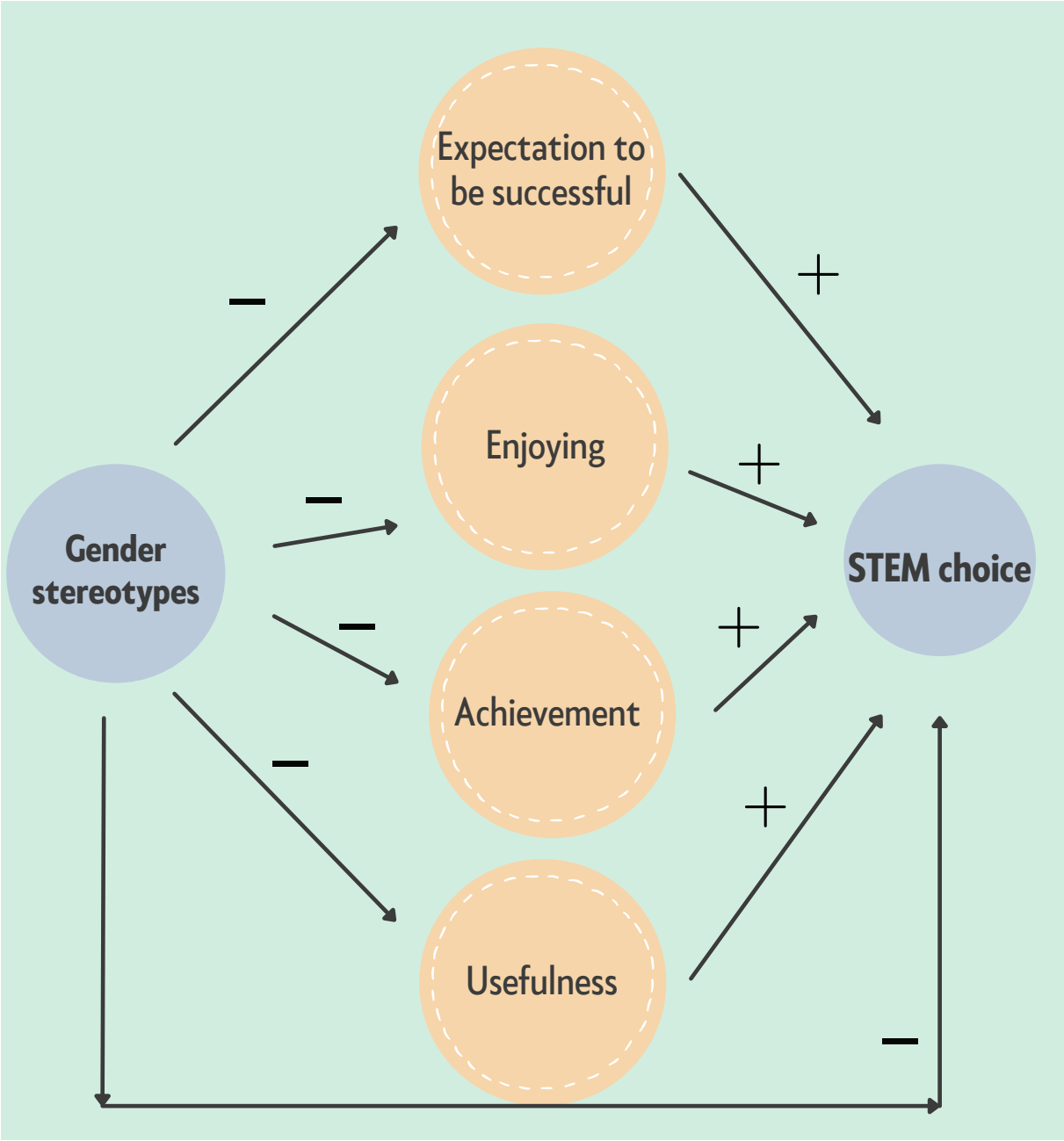


Image 4: The theoretical model's positive and negative impacts on the choice to like or dislike STEM. Source: Sáinz, M. (2020)

Gender stereotypes have a negative impact on the motivational factors that influence whether or not a girl pursues STEM. We must therefore offer girls sufficient opportunities to meet people, particularly women, who have worked in or are working in STEM so that they can connect with them and see that they, too, have the ability and potential to do so.

It is critical for girls to recognise the true significance and necessity of a particular profession or profile and to identify with it, as well as the purpose of some research or knowledge, which is usually hidden and goes unnoticed when the problem is unknown and only a brief review of the information is conducted. We can inspire girls and ignite in them the desire to be curious and learn STEM subjects by revealing to them the purpose and countless opportunities hidden in the STEM field.

1.2 Role models – the most efficient approach to engaging girls in STEM

A wide range of efforts centered on role models have been launched around the world to encourage girls to pursue careers in STEM fields (Sáinz, 2020). The success of a role model intervention, like any other intervention, is dependent on a number of factors, including the intervention's scope, the theory that informs it, the tools used in its design, implementation, and evaluation, the involvement of educational agents, its sustainability, and so on (Sáinz, 2020).

For instance, Breda et al. (2018) discovered that the intervention reduced the prevalence of stereotypes among girls compared to girls in the control group. Their interest in STEM increased by 20–30% compared to the control group. Furthermore, from a starting point of 28 %, the likelihood of mathematically successful girls enrolling in STEM programmes increased by 50 %.

The programme reduced the gender gap in enrolment in elite STEM programmes among these top-performing females by one-third, from 22 to 14 %. In contrast to the prior study, ours adds to the body of knowledge by investigating the effects of a two-step role model intervention on female students' perceptions of gender stereotypes regarding women's STEM abilities, as well as their motivational outcomes (i.e., expectations of success, enjoyment, and importance) and interest in STEM fields. Changes can be observed in the means as well as in the relationships between the model's variables. As a result, it is reasonable to expect that girls will be more motivated than previously to pursue STEM-related courses such as mathematics after interacting with STEM role models in terms of success, enjoyment, and importance.

TIMSS knowledge assessment and analysis of boys and girls

TIMSS, or Trends in International Mathematics and Science Study, is an international assessment of fourth and eighth grade student achievement in mathematics and science that has been tracking trends since 1995. Boys slightly outperform girls in mathematics among European fourth grade students, but science scores are more evenly distributed between genders.

The TIMSS trends over the last 20 years indicate that inequalities between genders are disappearing, particularly in science, where girls are performing much better than in the past. In 1995, boys outperformed girls in math and science in the vast majority of countries. The situation drastically changed in just 20 years; in 2015, only 3 of the 15 countries had better results for boys. There is no discernible difference between genders, whether they are in the fourth or eighth grade. (TIMSS, 2019)

The study reveals that knowledge trends in STEM fields between genders do not differ as much as they used to, which is encouraging and leads to gender equality. This is especially true for science, which can be explained by the fact that it is an applied science and thus more appealing to girls than mathematics, which belongs to the theoretical sciences.

This is consistent with the findings of a study by Microsoft among young girls in Europe. Although Microsoft research shows that girls are aware that they are equally capable as boys in the STEM field (Image 2), they argue that if men and women were equally represented in STEM professions, they would be more likely to choose to work in a STEM field (Image 3). This demonstrates that, despite all claims and attitudes about how women can do it all, activities and initiatives are still required to increase girls' interest in STEM career paths as long as the gender gap exists in the STEM workforce (Microsoft, 2017).

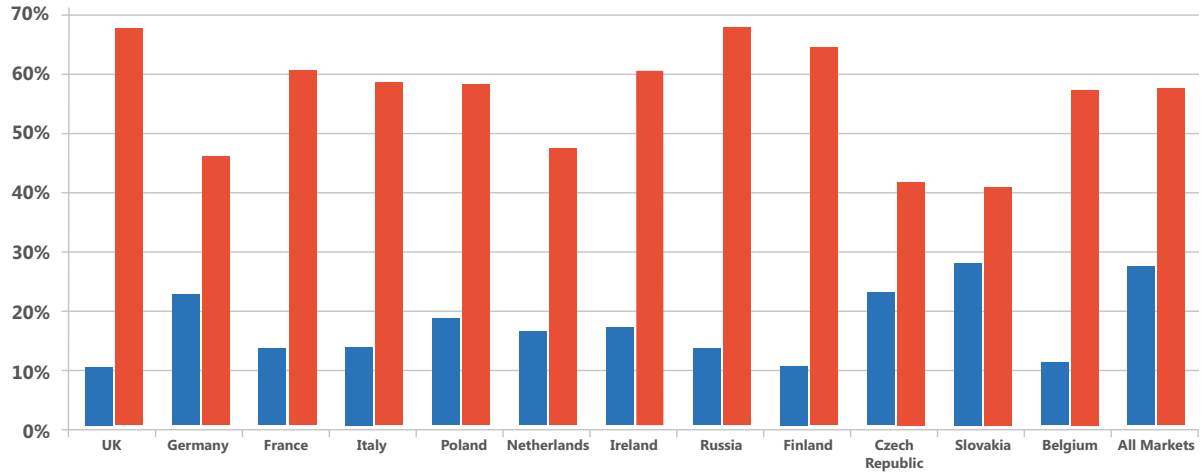


Image 5: The percentage of girls who agree with the statement »I will never be as good in STEM as boys« is shown in blue, while the percentage of girls who disagree is shown in red. Source: Microsoft, 2017

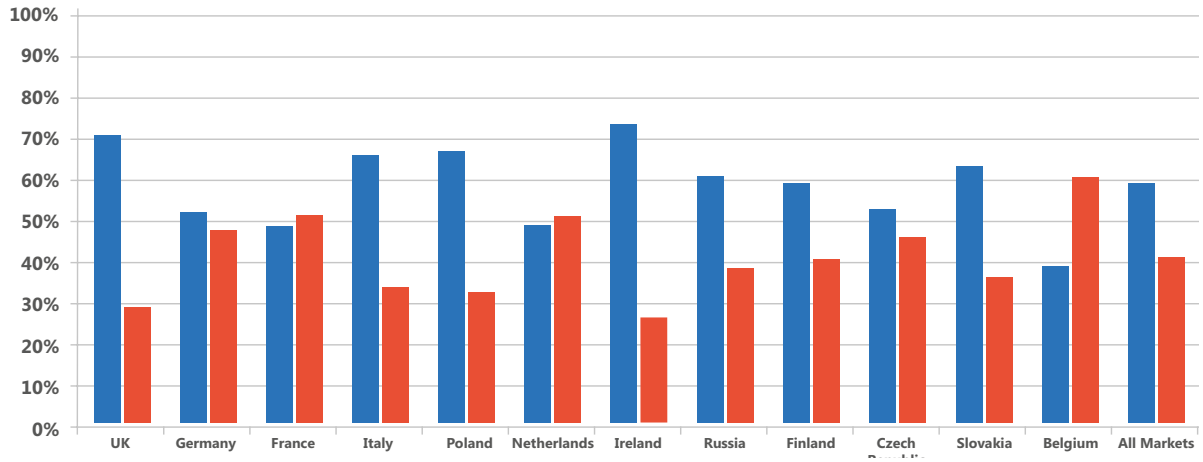


Image 6: The percentage of girls who agree with the statement, "I would more likely pursue a STEM profession if men and women were equally employed in STEM fields," is shown by the blue column, while the percentage of girls who disagree is shown by the red column.Source: Microsoft, 2017

In conclusion, there are a variety of ways to encourage girls to participate in STEM courses and to grow interested in STEM subjects. By highlighting all of the aforementioned motivating practices, we can create a more inclusive and engaging STEM education system that empowers girls to pursue their interests, achieve their full potential, and choose the STEM path.

On the following pages, you will find descriptions of best practices used in European countries to motivate and engage females in STEM and science.

1.3 Best practices collected from project partner countries

Girls' empowerment is a relatively new phenomenon in the European public sphere. According to data gathered from project partner countries, at least one major state-level initiative devoted to encouraging girls and women to pursue STEM studies and careers can be found in the last decade.

According to the TIMSS survey results, European countries do not rank first in terms of student achievement in mathematics and science, both in the fourth and eighth grades of primary school. Many Asian countries, for example, are far higher ranked. As a result, it is critical to improve STEM teaching approaches, such as science and mathematics, and make them more innovative and stimulating.

The most crucial components of empowerment programmes for girls and women are inspiration, encouragement, and the elimination of gender stereotypes.

Best practice No. 1: Inspiring the Next Generation of Girls through Inclusive STE(A)M Learning in Primary Education (IN2STEAM)

The project, which was funded by the Erasmus+ programme, was published in 2019 and put into practice in five European countries: Italy, Poland, Greece, Cyprus, and Turkey. Young children in primary school, with a focus on girls, and primary school teachers were the target demographic.

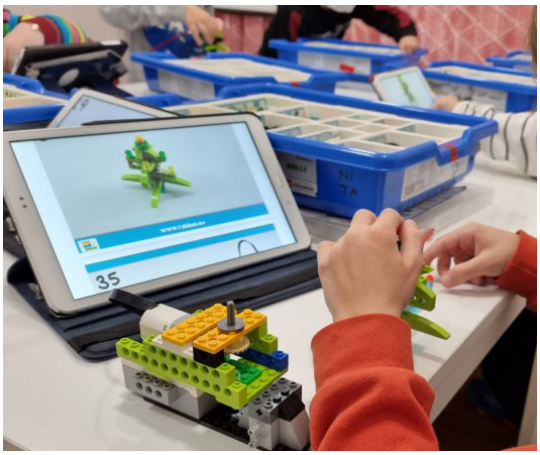


Image 7 and 8: IN2STEAM Project [Photograph]. IN2STEAM | Inspiring the Next Generation of Girls through Inclusive STE(A)M Learning in Primary Education. Retrieved 04. 02. 2023.

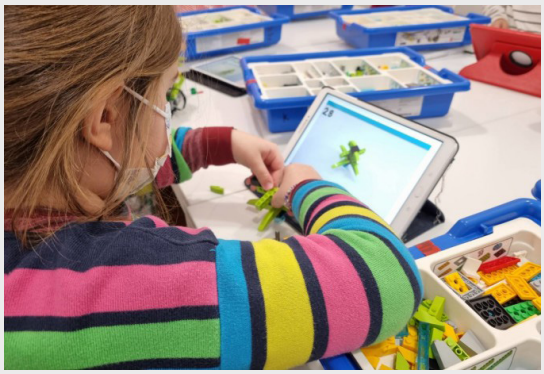
As a 21st-century education strategy, the project aimed to improve children's basic STE(A)M (creativity, critical thinking, and problem-solving) skills, as well as teacher competence in effectively teaching interdisciplinary art and science concepts in a real-world context, in order to foster more creative and collaborative learning environments in primary schools.

IN2STE(A)M attempted to integrate the Arts into STEM disciplines in order to facilitate creative expression, innovation processes (as part of the various methodological approaches presented: inquiry-based learning, Design Thinking, Creative Thinking, and so on), and student communication.

All of these methodologies and related skills, such as critical thinking, problem solving, teamwork, communication, and all other interpersonal skills, are actually regarded as "key competences for lifelong learning" that must be acquired by everyone (during lifelong learning) in order to ensure personal fulfilment, health, the ability to pursue new career paths, and social inclusion.

Thus, the inclusion of the arts can encourage more and more girls to enrol in courses, give them the opportunity to explore original and fun ways to interact with science, improve their confidence and self-esteem, and counter the unfavourable stereotypes about girls in STEM.

IN2STEAM aimed to improve, encourage, and foster an innovative educational approach that integrates STE(A)M learning (applying art design principles to science education) in primary education through gender-inclusive methods and resources in order to promote a positive change in attitudes towards non-stereotyping educational choices and attract more girls into STEM fields.



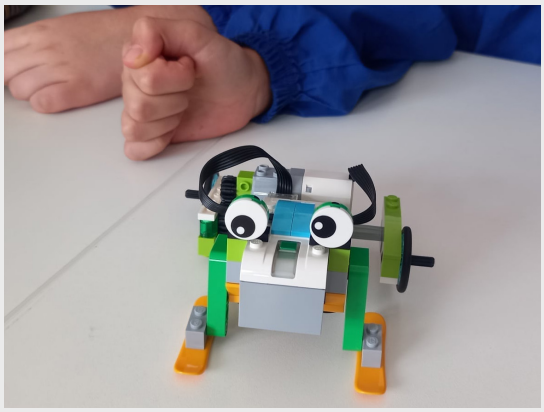


Image 9, 10 and 11: IN2STEAM Project [Photograph]. IN2STEAM | Inspiring the Next Generation of Girls through Inclusive STE(A)M Learning in Primary Education. Retrieved 04. 02. 2023.

The project was successful in promoting the value of STE(A)M education by increasing the motivation and participation of young girls in STEM fields of study, as well as facilitating a broader understanding of the professional development needs of STE(A)M teachers for the promotion of 21st century skills in primary school children.

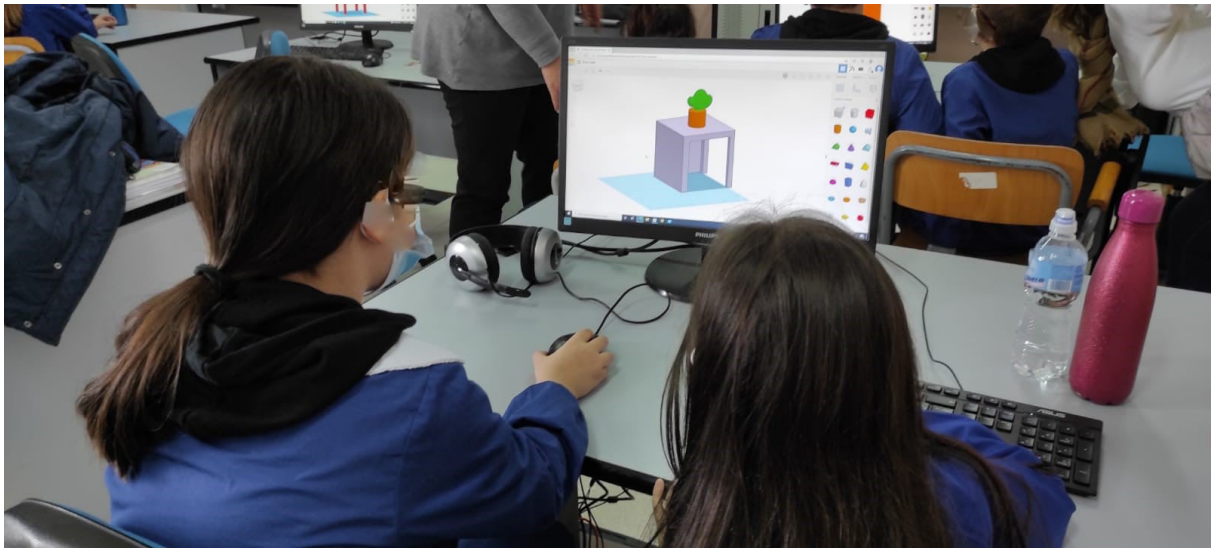


Image 12: IN2STEAM Project [Photograph]. IN2STEAM | Inspiring the Next Generation of Girls through Inclusive STE(A)M Learning in Primary Education. Retrieved 04. 02. 2023.

About the project

English version

More information about the project can be found at https://in2steam.eu/, including The Digital Teacher's Toolkit (DTT), which contains all of the methodological approaches and lesson plans designed to incorporate Arts into STEM disciplines while maintaining an emphasis on technical and scientific topics, as well as other outputs.

Best practice No. 2: "Future Heroes Latvia" Girls Leadership Programme

Although the programme is not entirely dedicated to the STEM field, the topics covered by the programme contain many skills and knowledge that are necessary and critical to increasing girls' and women's interest in the STEM workforce and thus are suitable to be presented as best practices in this field.

Image 13: "Future Heroes Latvia" Girls Leadership Programme [Photograph].

Future heroes typically build a global network of partners to empower and invest in women for more diverse and inclusive leadership in the future. As a result, English is the primary language in use.

As of today, the show has been running for two seasons, 2020/2021 and 2021/2022. It was carried out by the National Centre for Education of the Republic of Latvia in collaboration with the British Council in Latvia and SEB Bank, and it is aimed at 14- to 17-year-old girls who want to be more self-aware and courageous. The programme is fully implemented in Latvia, but similar activities were carried out in Estonia by the 'Future Heroes Estonia' programme at the same time.

Future Heroes is an experience-based and role-model-led growth mindset driven leadership and entrepreneurship development programme empowering the next generation of female leaders and change-makers. Its goal is to help girls aged 14 to 17 realise their full potential and make a positive difference in the world. The main goal of the programmes is to educate and empower 50 young female youngsters - future leaders and change agents - to strengthen their self-awareness, empathy, persistence, and other life skills through inspirational workshops and practical activities that will result in inspirational business or social projects.

The following activities were carried out as part of the programme:

Inspirational workshops.

The first season of the programme featured a number of free workshops, all of which were held in English and were usually held on Saturdays from 10:00 to 17:00. These successful leaders (mainly female) from Latvia spoke of their experience and **provided valuable knowledge on the topics of:**

- Ideation and Teambuilding
- Tech and Entrepreneurship
- Voice and Will
- Practice and Pitch
- Digital Impact and Media Literacy
- Financial Literacy and Fundraising
- Leadership and Problem Solving
- Choices done
- Choices about other topics and experience sharing from more than 20 skilled experts, including skills coaches .

Entrepreneurship and social projects

Programme activities include designing and developing own business or social ideas, as one of the programme's focuses includes revealing entrepreneurship's potential for impactful actions.

3Ljeans, also known as "Life Lease Love Jeans," is one of Future Heroes Latvia's most outstanding projects.

The project brings together five young girls who practise and promote sustainability by recycling old jeans and transforming them into fashionable bags. The concept has commercial potential, but for now, girls are prioritizing showcasing their own handcrafted bags through a social campaign. One of their campaigns included presenting Christmas tree decorations made of jeans to the 'Zemgale' social care centre. The 3L Jeans concept has received recognition and awards from SEB Bank, one of the Baltics' leading banks.

The Future Heroes programme also provided an opportunity for SEB Bank to highlight their values, particularly women's equity in the business. Ieva Tetere, the manager of SEB Bank, led one of the programme workshops.

Mentorship

Ten mentors were introduced to help guide teams of girls through their programme experience. Mentors, according to the participants, were an essential part of their development path because they provided inspiration and support in problem solving, as well as inspiration for new accomplishments by participating in larger projects.

Awards

The first season of the programme was carried out in 2021, with the award ceremony taking place in June of that year. The awards were organised as an event for winners by a small team of organisers and winners.

Networking

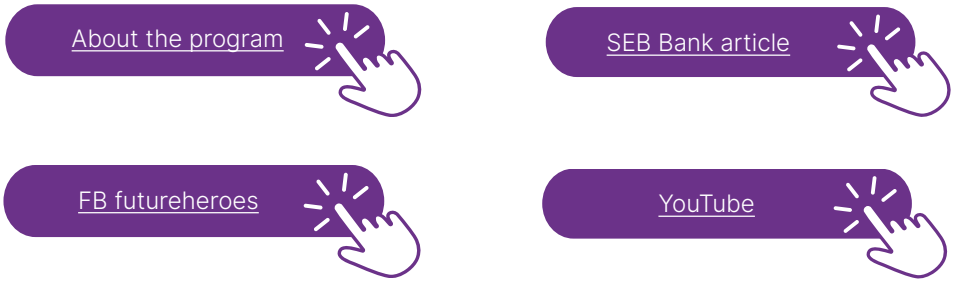
The programme gives girls the opportunity to be a part of Sisterhood Without Borders, including female participants, mentors, and supporters. **Along with Estonian Future Heroes, more than 250 adolescent girls participated in the Sisterhood Without Borders network on a global scale.**

The program's activities took place every Saturday and were implemented online, making them accessible to girls from all over Latvia. The challenges for similar programme implementation are more associated with finding motivated and inspirational women leaders in STEM who are committed to long-term activities throughout the mentorship period of several months. The Future Heroes programme can be replicated with a STEM focus by introducing female role models in science, information technology, engineering, and other fields.

The development of entrepreneurial ideas should be encouraged within the STEM fields, with a focus on sustainable technology, services, and circular economy topics.

Even if the main focus is on STEM, general life skills should be promoted and developed through leadership programmes such as Future Heroes.

To do so, a network of successful women in STEM should be gathered and maintained to ensure the long-term viability of STEM-focused Future Heroes.



Best practice No. 3: GEMS (Girls, Engineering, Mathematics and Science)

This best practise was developed in 2019 by the Engineering Lyceum of Vilnius Gediminas Technical University (Lithuania) and is now being implemented in a few Lithuanian schools, including the foundering Lyceum.

The programme targeted girls aged 13 to 18 and encouraged their interest in engineering, mathematics, and science, as well as developing girls' leadership and entrepreneurial skills and providing equal opportunities for the whole school community.

Image 14: GEMS programme [Photograph]. GEMS (Girls, Engineering, Mathematics and Science) programos pristatymas bei veiklų gairės – VGTU inžinerijos licėjus (vgtulicejus.lt)). Retrieved 04. 02. 2023.

The practise was carried out between 2020 and 2021 and included the following activities:

- The institution organized meetings with high-ranking women from a variety of backgrounds to build trust among girls;
- carried out additional engineering sessions for girls, strengthening their engineering competencies;
- participated in entrepreneurship projects in order to strengthen creativity, girls' mathematical and entrepreneurial competencies;
- organized leadership seminars, trainings in order to form a modern, critically thinking personality.

Apart from the fact that more girls have been drawn to study at the Engineering Lyceum of Vilnius Gediminas Technical University, where they can deepen their knowledge in STEM, the school is eager to share its positive experiences with other educational institutions throughout Lithuania. There are no specific conditions that must be met in order to replicate the practise.

Image 15: GEMS programme [Photograph]. GEMS (Girls, Engineering, Mathematics and Science) programos pristatymas bei veiklų gairės – VGTU inžinerijos licėjus (vgtulicejus.lt)). Retrieved 04. 02. 2023.

In actuality, a large portion of the program's activities can be completed online, allowing the girls to learn, ask questions, and participate in a secure environment.

As previously stated, the programme was launched in 2019, shortly after the quarantine was declared in Lithuania. Because of this, live meetings have been cancelled, however all activities have been relocated to the online environment.

Image 16: GEMS programme [Photograph]. GEMS (Girls, Engineering, Mathematics and Science) programos pristatymas bei veiklų gairės – VGTU inžinerijos licėjus (vgtulicejus.lt)). Retrieved 04. 02. 2023.

When girls see successful examples and role models to look up to, the decision to pursue STEM education becomes less complicated.

According to the information provided by the funders, the first idea for implementing such a programme was motivated by the fact that very few girls chose to study at the Engineering Lyceum of Vilnius Gediminas Technical University. The funders' goal of increasing the number of girls attending their school was accomplished through the support of this programme.

More info

YouTube

Best practice No. 4: We will become engineers! The Selection of the Slovenian female engineer of the year

The project began in 2012 and is still ongoing today. It was founded on the initiative of three individuals: prof. dr. Janez Bešter, M. Sc. Anton Petrič, and M. Sc. Edita Krajnović. It is designed for students in their final years of primary and secondary school and is being implemented in various parts of Slovenia.

Image 17: Engineer of the year [Photograph]. https://inzenirka-leta.si/ Retrieved 04. 02. 2023.

The purpose of the initiative "We will become engineers!" is to promote engineering, technological, and natural science professions, as well as innovation, among female and male students from leading Slovenian high schools. The goal is to promote talent development and inspire young people to be creative and innovative in technical professions, which will lead to increased added value and competitiveness, as well as other 21st-century knowledge and competencies.

It brings together renowned engineers, top managers, faculty researchers, ambitious students from technical and natural science faculties, representatives of start-up companies, and various penetrating and creative individuals, many of whom are female role models for the students.

In addition to presenting career opportunities in the technical and scientific fields, they also share their life experiences with young people and encourage the integration of business and engineering knowledge.

The project includes more than 70 organisations and has already reached out to over 5,600 young people across the country.

Image 18: Engineer of the year [Photograph]. https://inzenirka-leta.si/ Retrieved 04. 02. 2023.

The project's goal is to encourage young people to consider what they are good at, what makes them happy, and what the environment necessitates. The results are reflected in increased interest in technical and natural science professions.

Simultaneously with this programme, an event is being held to select the Engineer of the Year for women in engineering, as well as other activities such as collaboration with high schools through workshops, presentations to inspire creativity and innovation, and an updated website with extensive interactive content (videos, materials, etc.). Applications and board games were also developed to assist students with career orientation and to spark interest in STEM studies and professions (KAMBI app, KVIZUM app, etc.).

More information about the project can be found at:

More info 

Will be engineers 

Engineer of the year 

1.4 Recommendations with the main elements of a successfull motivational approach

The best practises described above are excellent examples of how we can ensure equal treatment of girls and boys in STEM fields. It is crucial to show girls what they are capable of and to teach them how to use all of the tools and materials that appear “boyish” at first glance.

We must work to prevent stereotypes from intensifying and to inspire future generations of STEM professionals!

Follow the following main guidelines to **make** your **motivational programme** for the inclusion of girls in STEM fields **successful**, **inspiring, and** completely **suitable for girls:**

- **Make STEM experiences relevant to girls’ lives (Civil, 2016).** Engage girls in STEM-related activities that are based on their interests, knowledge, skills, culture, and personal experiences to make STEM relevant and real to them. This increases girls’ sense of belonging in STEM and aids in the development of their STEM identity.
- Planning ahead of time is essential for **setting clear goals and expectations.** To boost motivation, convey them clearly to each participant individually.
- **Tailor motivational approaches** to the girls’ shared interests, strengths, and weaknesses. The motivational programme should be tailored to the participants’ ages and backgrounds (academic, social, etc.). Discuss your options with your group to come up with something that works for everyone.
- **Encourage girls’ autonomy** by allowing them to investigate questions and solve problems using STEM practises on their own (Civil, 2016). Encourage girls to participate in hands-on, inquiry-based STEM activities that

include techniques used by STEM professionals. Allowing girls to direct their own STEM education and participate in worthwhile STEM projects would strengthen their identities and redefine how they perceive STEM. Encourage girls to take ownership of their work and make decisions, as this leads to increased engagement in their project.

- **Promote the collaborative, social, and community-focused nature of STEM** (Leaper, 2015) by creating a supportive environment that values collaboration, creativity, and teamwork. In order to increase motivation and interest and eliminate the myth that STEM careers require solitary work, it is important to emphasise the social nature of STEM fields.

Image 19: Successful girl studying [Photograph]. Canva stock.

Girls benefit from a nurturing environment that allows them to form relationships and develop a sense of community.

- **Effective communication:** acknowledge those present for a good attempt and offer constructive criticism for failure when performing an activity. You are allowing them to grow and develop their skills and abilities by doing so.
- **Introduce girls to different female role models** from various STEM career trajectories to help them perceive potential futures and establish resilient STEM identities (Leaper, 2015). Strong role models can increase girls' interest in, positive attitudes towards, and affinity for STEM fields. These

can be female researchers who have made significant historical discoveries or active, younger women who have entered the world of science and impressed with innovative solutions to current problems.

- **Empower girls to take charge of their own success** by giving them the tools and resources they need to succeed.

In order to encourage girls to engage in STEM, two key areas should be encouraged:

1. To recognize and reject prejudices in STEM fields (Civil, 2016) as well as the pressure to conform to gendered norms. Potential stereotype obstacles will be removed by assisting girls in making connections between their diverse cultural and social backgrounds and STEM fields.

2. To accept hardships, overcome obstacles, and gain confidence in STEM fields (Blackwell et al., 2007). Supporting girls' problem-solving approaches and letting them know that their abilities can develop with practise can help them focus on and respect the learning process. Encourage girls to adopt a growth mindset, which is the belief that intelligence can be acquired through hard work and education.

2 Girls stimulation exercises, storytelling, role play, simulations, and initiatives examples

Image 20: Hands-on experiments are engaging for both boys and girls [Photograph]. Canva stock.

2.1. EXERCISES: Lesson plans for hands-on experiments:

2.1.1. How can hands-on lesson plans motivate girls?

Hands-on experiments can be especially motivating for STEM and science students because they allow for active participation and a tangible understanding of the subject matter. Active participation is important because it allows individuals to engage with the material on a deeper level. People who actively participate in the learning process tend to retain more information and have a better understanding of the subject matter. Active participation also enables individuals to develop problem-solving and critical thinking skills, both of which are required for success in STEM fields. Furthermore, active participation can foster a sense of ownership and investment in the material, which can boost motivation and engagement. Moreover, active participation allows for immediate feedback, which assists

individuals in correcting misconceptions and improving their understanding of the subject.

> Experiments also allow students to see real-world applications of the concepts they are learning, which can make the material more relatable and interesting.

This is especially important for girls because it allows them to relate the problem to the real world, which motivates them to find a solution. Hands-on experiments improve students' collaborative skills, which can aid in the development of a sense of community and support in the classroom. This can be especially beneficial for girls who may not have as many role models or peers in STEM fields, and who are sometimes the target of stereotypes that STEM is not suitable for girls.

2.1.2 How to implement hands-on experiments in your classroom

The teacher should select an experiment. You can conduct two experiments with older and more experienced students. Group the students into teams of no more than three or four. The teacher first introduces the students to what they will be learning today and informs them that they will be working independently. The teacher gives a brief introduction to the experiment's topic based on the related STEM field and the students' ages.

> It is critical to tailor the entire activity to your group so that the students can participate to the best of their abilities and everyone can be actively involved in the experiment.

Try to assume the role of an observer and a helper rather than the one who is experimenting with the students while they are just watching.

> Learning is most effective when students arrive at their own conclusions.

Allow the students to think for themselves, collaborate, ask questions, and reach their own conclusions with your subtle guidance. Even things that adults consider obvious and self-evident must be taught to students.

2.1.3. Examples of hands-on experiments

1. CATAPULT

STEM field: Physics, Engineering

Duration: 1 hour.

Recommended age: 10-15

Difficulty: Easy.

Introduction: A catapult is a ballistic device primarily used to launch stones, spears, and other projectiles a greater distance. Students will build the device out of household items and see how far and how high they can launch the ball with it.

What will the student learn?

Students will learn how the catapult transfers different types of energy to launch the ball and how to regulate and adjust the catapult to make the highest or longest throw.

Research question:

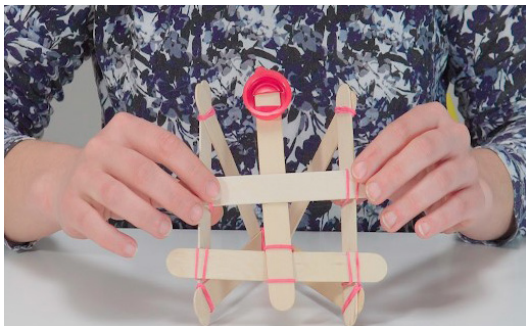
How do you make your ball travel the farthest?

Step-by-step instructions:

Make two triangular shapes out of popsicle sticks. Create a »V« shape with two popsicle sticks and connect them with rubber bands on one side. By using rubber bands and a second popsicle stick, you can shape it into a triangle. Repeat with three new popsicle sticks.

Materials:

- A rubber or plastic bottle cap
- 20 Popsicle sticks
- A ball (table tennis ball or ball made of paper)
- 15 rubber bands (smaller)
- Paper cups
- A knife
- A chopping board.



Now, using one popsicle stick and two rubber bands, connect both triangles.

Fasten the back of the catapult with a rubber band.

Place the cap on a different popsicle stick. Attach it to the catapult using the rubber band.

Put the catapult to the test. Make a paper cup tower and try to knock it down with the ball.

Try to throw your table tennis ball as far as you can. Can you do it with only the catapult? For better results, try adding some popsicle sticks.

Safety and troubleshooting: Some adults should assist with the line cuts into the rubber cap. This can be done ahead of time and given to the students already prepared.

More info

Explain the experiment: When you prepare a catapult for launch, you transfer energy to it. This energy is stored as potential energy in the catapult and is used to launch it. When you lower the wand, the stored potential energy is converted into kinetic energy and transferred to the projectile, which then flies into the air. The more force you achieve with a catapult, the more force the ball receives. If we want the projectile to fly as far as possible, a catapult at a 45º angle is recommended. If the angle is less than 45°, the projectile will fly higher but not very far. If it grows in size, the projectile will fly low and fall to the ground sooner.

2. GLOWING BUG – LED FLASHLIGHT WITH A SWITCH

STEM field: Physics, Technology, Engineering

Duration: 1 hour.

Recommended age: 10-15

Difficulty: Medium

Introduction: This experiment introduces students to the electrical circuit and how it can be assembled from basic elements. Students will build a working LED light circuit with a switch.

What will the student learn?

- to explain and assemble a working electrical circuit
- to explain when the light is turned off (when the circle is not closed)
- to make a simple switch

Research question:

Can we add a switch to turn on or turn off the LED light?

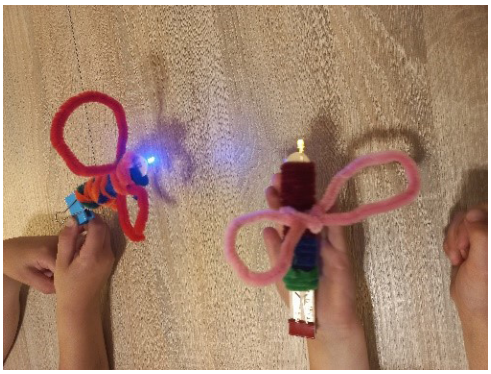
Materials:

- 1 LED light
- permanent marker
- popsicle stick
- scissors
- 1 coin battery CR2032 3V
- medium binder clip
- copper tape (recommended) or aluminium foil or wires
- insulating tape
- pipe cleaners of different colours

Step-by-step instructions:

Set up the LED light. It has two legs, the longer of which is a positive (+) leg or anode, and the shorter of which is a negative (-) leg or cathode. With a permanent marker, colour the longer leg.

Prepare the popsicle stick. Cut off the rounded end of the stick with the scissors.



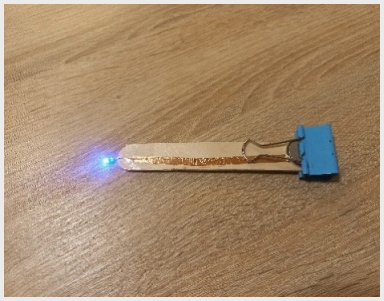
Place the LED light on the upper (rounded) side of the popsicle stick. Legs should be placed on each side of the popsicle stick.

Using the cooper tape, carefully tape below the LED bulb leg and down to the bottom end of the popsicle stick. Repeat on the opposite side of the stick with a second strip.

Attach the binder clip to the bottom of the popsicle stick, making sure it touches all of the copper strips on both sides.

Take the battery and place it on one side of the binder clip. When it's working properly, secure it with insulation tape at the top.

If you unclip the binder clip, are the lights working? It acts as a switch.



Create a bug with a shiny LED eye out of pipe cleaners.

First, **use insulation tape to protect the copper tape** on the popsicle. Wrap the pipe cleaners in a circle to make a head, a torso, and wings. To access the switch, leave the bottom section open.

Have fun with your shining bug! Try to make the lights flash or just turn it off.

Explain the experiment: all light bulbs need a closed electrical circuit for their operation. We can implement the switch in the circuit. The binder clip is working like a switch because the electric circuit is not connected anymore when the binder clip is removed.

Safety and troubleshooting: pTry all the LED lights and batteries if they are working properly. When placing the battery be aware to turn it in the right position (+ or -). For successful results, all the parts of the electric circuit should be well connected, make sure you are precise. The copper strips should be taped firmly, precisely, and as aligned as possible. If the LED lights still do not work, remove and replace the parts one by one trying to find out, what caused the problem.

More info

3. CLEANING AN OIL SPILL

STEM field: Environmental sciences, Biology, Physics

Duration: 1 hour

Recommended age: 10-15

Difficulty: Medium

Introduction: Students use various materials to attempt to clean up an oil spill in the water. The experiment teaches students about environmental issues that could result in an oil spill in water, as well as why and how an oil spill is best cleaned.

What will the student learn?

Students learn about the properties of oil and which materials are best for cleaning it and preserving natural habitats.

Research question:

Which material is most effective to clean an oil spill?

Step-by-step instructions:

First part: Can we mix water and oil?

Fill the plastic cup with oil.

Stir in one spoonful of colouring powder or a few drops of fat-soluble food colouring.

Fill a second glass with approximately 200 ml of **water.**

Pripomočki:

- 2 glasses
- 5 transparent cups
- 1 dcl of vegetable oil
- fat-soluble food colouring (powder or liquid)
- if you have the colouring powder, you will need a small spoon
- teaspoon
- 0,5 l of water
- few drops of dishwashing detergent
- 4 small plates

Testing material:

- 1 full spoon of:
- cotton wool
- wood chips
- flour
- foam - Deurex Pure chemical absorbent, if it is available
- optionally: feathers, pieces of napkin, paper...
- Permanent marker
- Paper towels

Add 4 teaspoons of coloured oil to the water.

Where is the oil? On the surface. Try to stir it with a spoon. Can it be mixed with water?

Use a teaspoon to transfer the oil from the water to a new glass. Were you successful? Not really, because we removed water as well as oil.

Return the oil and water to the first glass.

What happens if we use an emulgator, such as dishwashing detergent?

Perform an experiment. Stir well after adding one tablespoon of dishwashing detergent.

The oil can now be mixed with water, resulting in small droplets of oil in the water. However, the oil stays in the water and can cause damage.

Second part: Which material is most effective in removing oil from water?

Arrange four clean cups in a row.

Label the cups with the numbers or names of the testing materials: flour, cotton wool, wood chips, and foam.

Place the plates with matching testing material in front of the cups. Pour 50 ml of water and 3 teaspoons of coloured oil into each cup.

It is time for the test. Fill the cups with the testing materials. A spoon can help you immerse the testing material. After one minute, transfer the testing materials from the cups to the plates.

Examine the cups. Is there any oil left in the cups? Which material, in your opinion, is the best to use for cleaning or removing oil from water?

Explain the experiment: Scientists discovered that using absorbents—substances that absorb oil—is the best way to clean up an oil spill in water.

Attempting to "halve" as much oil and as little water as possible using various test substances reveals

- Cotton wool absorbs water and collects a little oil on the surface.
- Sawing even causes a disaster because it sinks to the bottom and is hard to retrieve from the water. So the water we want to purify becomes even dirtier.
- The oil sticks to the feathers, but they don't pick up much – we can discuss what this means for live birds if the oil sticks to the feathers.
- The foam absorbs all of the oil, does not sink, floats on the surface, and is easily removed from the water. Mentors' piqued interest: 1 kg of foam can absorb 6 litres of oil and is the first choice of environmental engineers when dealing with actual oil spills. It can also be reused.

Safety and troubleshooting: the foam used is a special chemical absorbent designed to remove oil from water, most commonly in sea spills. Look for it at your local hardware store. If you are unable to obtain it, the experiment can be carried out with the other three materials or with the addition of additional materials of your choice.

More info

2.2. Storytelling

2.2.1. How can storytelling motivate girls?

Storytelling can motivate girls in STEM because it allows them to connect with the material on a personal level. Girls who hear success stories in STEM fields can see that there are role models who look like them and come from similar backgrounds (Morais et al., 2018). This can help to overcome gender stereotypes and make STEM fields more accessible.

Storytelling can help students develop critical thinking and problem-solving skills by encouraging them to analyse and evaluate the stories they hear.

Image 21: Storytelling develops critical thinking and problem-solving skills. [Photograph]. Canva Stock.

2.2.2. How to motivate girls in a classroom using a storytelling approach?

Some examples of storytelling that can be used to motivate girls in STEM fields include introducing profiles of successful women in STEM fields. For example, Marie Curie, Ada Lovelace, and Rosalind Franklin; and more recent figures such as Dr. Mae Jemison, the first African American woman astronaut, or Dr. Chien-Shiung Wu, the Chinese-American physicist who made significant contributions to the Manhattan Project. Teachers can introduce these historical figures to their students by sharing biographical information about them and discussing their contributions to their respective fields.

The teacher can also use visual aids, such as videos or images, found on the internet or in books, to make the material more engaging.

After introducing these historically significant women in science through storytelling, the teacher can implement various activities, such as leading class discussions, assigning group projects in which students research and present on a specific woman in STEM, solving a quiz with details about the presented female role model, or something similar. To avoid the gender gap in activities, we propose actively involving all male and female students. We suggest a few examples below.

2.2.3. Examples of INSPIRATIONAL STORIES ABOUT FEMALE SCIENTISTS with connected activities

1. The trailblazer – MARIE CURIE

STEM field: Science, Chemistry

Duration: 45 minutes

Recommended age: 10-15

Difficulty: Medium

Introduction: Students will learn information about Marie Curie's life and contributions to science through listening to the story and conducting research, which they will use to create a mind map.

What will the student learn?

Students will learn about Marie Curie and develop critical thinking skills, as well as search for information, create a mind map, and present their findings in front of the class.

The story:

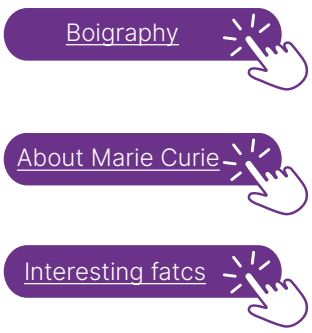
Once upon a time, in a small village in Poland, a young girl named Marie Curie was born with an insatiable thirst for knowledge. Marie was determined to become a scientist despite societal and cultural biases that discouraged girls from pursuing higher education. She spent every spare moment studying, reading books, and experimenting with science.

Marie realised as she grew older that she needed to leave her village and pursue higher education in order to fulfil her dreams. She travelled to Paris, the city of lights and the epicentre of scientific research.

She managed to get into college and put in endless hours of study time in an effort to be the best student in her class. She met her husband, Pierre Curie, who was also a scientist, and they decided to pursue their research in radioactivity together.

They faced numerous challenges and obstacles because the field of radioactivity was still relatively new and unexplored. They had to work with dangerous radioactive materials and were chastised by their peers for their unconventional methods. But Marie and Pierre were determined to make a breakthrough. They worked tirelessly, day and night, and their efforts eventually paid off. They discovered two new elements: radium and polonium.

Their discovery was revolutionary, and Marie Curie became the first woman to win a Nobel Prize and the first person to win two Nobel Prizes in different fields. She was a pioneer for women in science, and her work laid the groundwork for many important discoveries in the field of radioactivity. Her story has inspired generations of young girls to pursue their dreams and overcome obstacles, just as she did. Marie Curie's legacy lives on as a shining example of what can be accomplished through hard work, determination, and a love of science.



The activity: the goal of the activity is to use a mind map to discuss the information gathered. Individually, in groups, or with the teacher's guidance, students can create their own mind maps, or they can collaborate on one that has been written on the board as a class. Include her accomplishments and contributions to science, and ask students to connect her work to current scientific discoveries. The author or authors should present the mindmap to the class (regardless of whether the activity is done in groups or individually, as determined by the teacher).

2. The dark lady of the DNA – ROSALIND FRANKLIN

STEM field: Physics, Chemistry, Biology

Duration: 45 minutes

Recommended age: 10-15

Difficulty: Medium

Introduction: Students will learn about Rosalind Franklin by listening to her story and conducting research in order to present her life and work achievements in front of the class.

What will the student learn?

Students will learn more information about Rosalind Franklin while also enhancing the research, presentation, communication, and presentation skills necessary to present their research to the class.

The story

Once upon a time, a little girl was born in London, England, in 1920, named Rosalind Franklin. She grew up to be a curious and adventurous young woman, as well as a brilliant scientist who attended Cambridge University and later King's College in London. Her specialty was X-ray crystallography, a technique used to study the structure of molecules, beginning with coal and progressing to tiny structures found in living nature such as viruses and DNA. She was a renowned scientist in her own right, a fiery character who made as many friends as enemies in her tragically short life and career. She was an avid traveller who spent time walking throughout Europe and travelling throughout America, collaborating with scientists.

Franklin's X-ray photographs of DNA were so clear and beautiful that other scientists, including James Watson and Francis Crick, used them to figure out the structure of DNA. Rosalind was thought to be only a few steps away from solving the mystery of DNA herself.

Rosalind's contributions to the discovery, however, were not recognised at the time, and she did not share the Nobel Prize in Physiology or Medicine awarded to Watson, Crick, and Maurice Wilkins in 1962. They couldn't have done it without seeing some of Rosalind's incredible X-ray photographs of DNA, which had been passed on to them without her knowledge.

Crick and Watson are the cornerstones of DNA discovery, but Rosalind was the keystone. Rosalind never let her love of science be discouraged, despite experiencing discrimination and not being given credit for her work. She went on to make numerous other important discoveries in her field, including the structure of viruses. She was unaware of the harm they were doing to her while taking X-ray photographs, even leaning over the camera with no protection. She fell ill and died when she was 38 years old.

Rosalind Franklin's story serves as a reminder that women and other underre presented groups have made significant contributions to science throughout history, but their work has not always been acknowledged or recognised. Her contributions, as well as the discovery of the double helix structure of DNA, were pivotal in understanding the genetic code and the science of genetics.

Activity: research project – assign students to research Rosalind Franklin's life and work. Form groups of no more than four students. Students must conduct research on the internet or in other resources to prepare a report or presentation. To hone their language and presentation skills, students can give presentations in front of the class. If they don't have time to do so in class, they can write reports for homework at home. Students can create a digital presentation or poster, or a paper poster. If students have the necessary knowledge, they can prepare a video presentation.

Britannica

Interesting facts

Biography

3. JANE GOODALL

STEM field: Biology, Ecology, Environmental sciences

Duration: 45 minutes

Recommended age: 10-15

Difficulty: Medium

Introduction: Students will learn about Jane Goodall, her life, and her work through stories. Then, inspired by Jane Goodall's work, they will observe the chosen animal in its natural environment. They will compile their findings into a report.

What will the student learn?

Students will learn how to conduct scientific observations and research, improve their problem-solving skills, and learn about Jane Goodall's life and mission.

The story

Jane Goodall was born on April 3, 1934, in London, England. She was ten years old when she decided she wanted to go to Africa, live with wild animals, and write books about them. Back then, girls in England did not have those opportunities, so everyone laughed at her and told her, "Jane, dream about something you can achieve."

But she understood that if she truly wanted something, she must work hard, seize every opportunity, and never give up! Jane dropped out of school at the age of 18 to work and save money for her trip to Africa. At the age of 23, she arrived in Kenya by boat and met Louis Leakey, a well-known scientist. She was hired as his assistant after he was taken aback by her enthusiasm and expert knowledge. In 1960, Goodall established a camp on the shores of Tanzania's Lake Tanganyika.

She conducted in-depth research on chimpanzees in their natural habitat. It took months for Goodall to gain the chimps' trust, but her persistence paid off.

Goodall's observations changed many people's perceptions of chimps. She saw a chimpanzee make a tool that it later used to get food. According to scientists, only humans could indeed create tools. She discovered that chimps eat both meat and vegetation. Last but not least, Goodall noted that every chimp had a unique personality and range of emotions. Despite many challenges and obstacles, including the academic world's unwillingness to admit the truth about chimps—that they are more human-like than we previously thought—Jane never gave up her passion for studying and understanding them. Her research has influenced how we think about animals and their intelligence, as well as the conservation of chimps and their habitats. In 1977, she founded the Jane Goodall Institute for Wildlife Research, Education, and Conservation. The Institute improves people's, animals', and the environment's lives by protecting chimps and inspiring people to conserve the natural world we all share.

Activity: Students must conduct an experiment related to Jane Goodall's work, such as observing an animal species (one animal or a group of them). Students should observe animal behaviour and traits that define their way of life (sleeping, feeding, moving, etc.). They must record their observations and write a report based on them. Observed animals can be chosen by students or by teachers. For students to conduct experiments safely, teachers should provide guidance and resources. The activity can be done in groups or individually. Research can be conducted using various internet resources, by observing real animals in their natural habitats, or by observing pets in your local area. The teacher should consider her or his class's interests and abilities before deciding which animal to use and guiding the students through the observation process.

Britannica Substack article Weekend article Wikipedia

2.3. Roleplaying

2.3.1. How can roleplaying in the STEM fields encourage girls interest?

Roleplaying is an effective tool for engaging students in STEM classes. Roleplaying can help spark interest in STEM fields by allowing students to imagine themselves as scientists, engineers, or mathematicians. This can help dispel stereotypes that STEM fields are only for men and make STEM fields appear more accessible and relatable to students.

Interactive roleplaying activities can also allow students to use their imaginations and express their own interests and desires.

Because the activities are unique and engaging, students are more likely to remember them, which can aid in material retention. Roleplaying can encourage students to actively participate in the learning process, which is critical for retention and comprehension of STEM concepts. Overall, roleplaying can be an effective tool for motivating students in STEM classes by allowing them to actively participate in the learning process, connect with the material on a personal level, and see themselves in STEM roles.

It is a flexible and enjoyable approach to teaching STEM subjects that can engage students and create a more positive and memorable learning experience.

Image 22: Roleplaying is always an engaging activity for students. Source: Canva stock.

2.3.2. How to perform roleplaying effectively

There are several key steps that teachers should take in order to effectively perform roleplaying in STEM classes:

Before beginning the roleplaying activity, it is critical to define the learning objectives and how they relate to the curriculum. This will help ensure that the activity is relevant and meaningful to the students.

Assign students roles that are clearly related to the learning objectives. Make certain that the roles are diverse and inclusive, and that they are not constrained by stereotypes.

Provide students with the resources they need, such as background information and materials, to help them understand the roleplaying activity's context and setting.

Set clear guidelines and expectations for the roleplaying activity. This can include things like time limits, rules for interaction and communication, and expectations for the end result.

Encourage students to actively participate in the roleplaying activity by asking questions, providing feedback, and facilitating discussions. After the activity, have the students evaluate and reflect on it. This can include a discussion of what was learned, what worked well, and what can be improved for future activities.

2.3.3. Examples

ROLEPLAYING – INTERVIEW WITH A SCIENTIST

STEM field: optional **Duration:** 1 hour **Recommended age:** 10-15 **Difficulty:** easy	**Introduction:** Students will be given cards with information about their roles. The activity is carried out in pairs, with one student acting as an interviewer and the other as a researcher. The interviewer's role is to create the questions, and the researcher's role is to properly and meaningfully respond to them.

What will the student learn?

- Develop critical thinking and problem-solving skills
- Improve communication and collaboration skills
- Inspire creativity
- Promote self-expression
- Foster empathy
- Improve research and information literacy

Activity:

The teacher must prepare the cards with the necessary information for the roles that the students have created above in advance. They can be printed or handwritten in such a way that the students can choose their role at random. When they have all been assigned a role, they must find their matching pair, which is put together by one interviewer and one researcher. In the next 15 minutes, students must prepare an outline for their questions (interviewers) and key points for their career story (researchers) so that they can create answers to the interviewers' questions. Regarding where the interview will be published and who the target

audience is—for a science magazine, a national journal, a blog for children, or a school website—the questions should make a point of interest.

Furthermore, if you have the equipment needed to create videos, you can do the activity in groups of three, with one researcher, one interviewer, and one video maker or cameraman who will record and then edit the video. This will make your activity more interactive and interesting for students. When students are prepared, they can conduct interviews in 15–20 minutes by themselves. If time allows, students can switch roles.

Profession	Aerospace engineer
Educational path:	I have a degree in engineering.
Working area:	I would like to work on a space station, but for the time being, I am employed at a space training facility.
Short description :	The spacecraft is designed, built, and tested by aerospace engineers, who go through each stage several times to ensure that the final product will function properly and be safe.
Soft skills:	Problem-solving, critical thinking, accuracy, space orientation

Prepare your story: what is your name, where do you work, how old are you, and what are your skills and interests? On a piece of paper, write your story (or at least its key points).

Interviewer:

An interview will be published in a science magazine, should be interesting for experts, working in science area.

The person you will interview is:

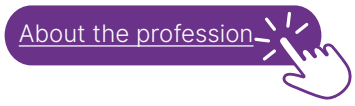
Profession	Aerospace engineer
Educational path:	I have a degree in engineering.
Working area:	I would like to work on a space station, but for the time being, I am employed at a space training facility.
Short description :	The spacecraft is designed, built, and tested by aerospace engineers, who go through each stage several times to ensure that the final product will function properly and be safe.
Soft skills:	Problem-solving, critical thinking, accuracy, space orientation

Prepare your questions and write them down on paper.

Students will form pairs and then conduct interviews.

Example 2: researcher

Profession	Microbiologist.
Educational path:	I have a degree in microbiology and a PhD in bioscience.
Working area:	I work in a laboratory that is part of the University Clinical Centre. I am in charge of conducting investigations on human patient samples and performing various tests to detect disease-causing organisms in different tissues.
Short description :	A microbiologist's general role is to identify microorganisms, track them in various environments, test samples, and develop new medicine, vaccines, and other methods to prevent disease spread. A microbiologist also oversees laboratory experiments and procedures. At work, I frequently use a microscope and other tools to identify fungal, viral, and bacterial infections caused by pathogenic microorganisms.
Soft skills:	Problem-solving, attention to detail, communication skills and analytical skills.



Prepare your story: what is your name, where do you work, how old are you, and what are your skills and interests? On a piece of paper, write your story (or at least its key points).

Interviewer

An interview will be published in a science magazine, should be interesting for experts, working in science area.

The person you will interview is:

Profession	Microbiologist.
Educational path:	I have a degree in microbiology and a PhD in bioscience.
Working area:	I work in a laboratory that is part of the University Clinical Centre. I am in charge of conducting investigations on human patient samples and performing various tests to detect disease-causing organisms in different tissues.
Short description :	A microbiologist's general role is to identify microorganisms, track them in various environments, test samples, and develop new medicine, vaccines, and other methods to prevent disease spread. A microbiologist also oversees laboratory experiments and procedures. At work, I frequently use a microscope and other tools to identify fungal, viral, and bacterial infections caused by pathogenic microorganisms.
Soft skills:	Problem-solving, attention to detail, communication skills and analytical skills.

About the profession

Resources

Prepare your questions and write them down on paper.

2.4. Simulations

2.4.1. How can simulations help raise interest for STEM in girls?

Simulations are another innovative teaching tool that promotes diversity and inclusivity. As a result, given that both genders can participate equally in them, simulations are especially well suited to raising the interest of girls. By providing students with a variety of simulations and learning opportunities, girls from various backgrounds and with diverse interests can find something that appeals to them, promoting a more inclusive and diverse STEM community.

Simulation-based learning places students in situations where they can apply their classroom knowledge.

Simulation training has long been a part of school and professional learning curricula; however, it is constantly evolving as technology advances. Different types of simulation-based learning can be implemented in school

Image 23: Students expressing their creativity through simulation. Source: Canva Stock.

classrooms, depending on the learning outcomes that the teacher wishes to achieve. All of the cases have some key elements in common that make this learning approach positive and effective. Simulation learning frequently mimics real-world systems and settings, which can help students understand the value and practicality of STEM fields in their daily lives. The learning is interactive by utilising various types of technology (AR, VR, digital simulations), equipment (flight simulators), or doing hands-on learning activities to mimic the work of real scientists.

This type of interactive learning is interesting and entertaining, which can foster a positive attitude towards STEM fields and inspire students to learn more about them. Furthermore, simulations frequently require students to exercise their critical thinking and problem-solving abilities, which can promote the development of these skills as well as their sense of self-assurance. The final factor, which is critical for engaging girls, is encouraging creativity. Students can express their creativity through simulations, which also inspire them to think creatively and come up with novel solutions.

2.4.2. How can the teacher use simulation in the classroom?

Integrating simulations into your class provides students with a hands-on learning experience that improves students' perceptions of knowledge:

- Hands-on experiences are usually more engaging because they require the student to be actively involved rather than simply sitting and listening.
- Hands-on experiments allow students' innate curiosity to surface. This enables the students to approach the experiment with great enthusiasm and interest, as well as to be persistent in their implementation.
- By involving all of the senses in the hands-on experience, the gathered knowledge is more firmly anchored in the students' memory and enables them to understand the learned concept rather than simply memorise it.

- When a real-life problem is introduced into the experiment, students can relate to it. They feel more motivated because they feel like real scientists or researchers. If we define an example of a problem that specifically interests girls, their commitment and dedication are unquestionable, as they will be excited to participate and thus gain new knowledge and confidence that they can carry out the activity themselves, and they will also step confidently into a field that is familiar to them and in which they will feel strong.

Here are some more examples of simulations that can be used in classrooms with students instead of hands-on experiments:

- immersive virtual or augmented reality simulations that allow students to explore and interact with scientific concepts such as the world of molecules or the universe,
- computer-based simulations of real-world systems, such as disease spread or climate change,
- programming and robotics challenges that allow students to build their own robots,
- engineering and science projects that can be completed in a laboratory or at home,
- games, such as role-playing, that simulate real-world scenarios, such as running a business or designing a city.

Each teacher is aware of the options in his or her class and which topics require additional activities. To raise students' interest and engagement while also providing them with innovative and successful learning activities, simulations can be an excellent choice.

2.4.3. Example

Students will simulate the work of a scientist in the cosmetic industry, where soap can be made from basic ingredients. This activity may be more appealing to females because they are more familiar with cosmetic products than males.

MAKING SOAP IN YOUR CLASSROOM AS A REAL SCIENTIST IN THEIR LABORATORY

STEM field: Biology, Chemistry, Physics

Duration: 1 hour

Recommended age: 10-15

Difficulty: Medium

Introduction: in this experiment, students will make their own liquid soap and learn about the saponification process and reaction. They may relate the properties of soap to the destruction of germs and viruses. They can also talk about how the ingredients used to make soap can harm our skin.

Research question:

Is it possible to make soap at home?

What pupil will learn?

Students will learn why it is necessary to wash their hands and how soap removes fat. They will learn how to make soap at home and will be able to practise their motor skills and precision.

Materials:

- Materials:
- 2 styrofoam pots
- a weighing boat
- a wooden stick
- a wooden clip
- a 100 ml glass
- a plastic ball, 4 cm in diameter
- a vegetable soap (base for casting)
- coconut oil
- etheric oils
- Mica – colour pigments for soap
- a water heater
- a scale
- paper towels
- a spoon
- an IR thermometer (optionally)
- a string

Step by step instruction:

1. We watch the video and comment on it: What would happen if we would not wash anymore?
2. Why do we use soap? To remove grease and dirt from the skin. How does soap appear? In solid, liquid, fragrant form ... even in ancient Egypt, they used something similar to soap for washing.
3. We can make soap at home by combining selected fragrances and colours and packaging it for use as needed.

Video

1. **Lay out everything you need on the table.** Styrofoam pots should be placed inside each other for better insulation.
2. **Weigh 10 g of the pouring base soap** into the weighing boat and pour it into a 100 mL glass beaker.
3. Then, in a weighing boat, **weigh 2 g of coconut oil** and pour into the same 100 mL glass beaker.
4. When all of the children are seated at their tables and their cups are ready, the mentor **pours half of the hot water into the styrofoam pots.** BE CAREFUL NOT TO SPILL HOT WATER! An IR thermometer can be used to measure the temperature of water.
5. **Place glass beakers in a hot bath** with a wooden clip and mix with a wooden stick.
6. **The mentor adds 2 drops of essential oil to the mixture** if the child requests it. After that, stir everything together until it connects and flows smoothly.
7. **Place the ball halves on a paper towel.** Pour half of the cup's contents into one half of the cup (hold the clip or wrap it in paper because the cup is hot).
8. **Fill the remaining prepared soap in a glass,** add the pigment, and stir it in slightly.Pour the remaining contents into the other half of the ball.

9. **Allow some time for the mixture to harden.** The halves are quickly joined together to form a ball. When the ball is closed, it must be heard to "click." Following that, the ball is shaken.
10. **Run the ball under cold water** if you want the soap in the ball to crumble as soon as possible.
11. Wipe the beads clean and **thread the string through the holes.** When the soap has completely hardened, we will be able to open the ball and use the solid soap in it.

Describe the experiment: Grease is removed using soap. A non-polar part of soap binds to fat, while a polar part of soap binds to water. It is produced through the saponification process, which involves heating fats with Na or K hydroxide. We are also familiar with other detergents and detergents that function similarly to soap but contain a great deal more chemicals, making them both more potent and environmentally damaging.

Safety and troubleshooting: If the soap begins to harden in the beaker before you finish mixing, the water in the styrofoam cups has most likely become cold. Remove the glass beaker from the water, pour the water from the cups, and repeat the process of adding hot water. To avoid coagulation, do this as soon as possible.

Additional resources

Aditional resources

Video

2.5 Initiatives

2.5.1. How can initiatives help raise girls' interest for STEM?

Engaging girls in STEM—both getting them excited about STEM subjects in school and guiding them to more often choose a STEM career—will be successful only if a comprehensive approach is taken to address the situation in which girls are still underrepresented in STEM jobs.

Girls are still underrepresented in STEM jobs.

We need more young girls and women in STEM fields than ever before as the world around us becomes more technologically and digitally advanced. Because there are far more STEM job openings than there are men who can fill them, they will be crucial employees in the jobs of the future.

The most successful initiatives for girls to make schooling and careers in STEM fields easier and more exciting are designed to support girls in a variety of fields.

The success of these initiatives depends on a variety of factors, including financial support, support from schools and community organisations, involvement from girls and their families, and other factors. When these programmes are thoughtfully designed and implemented, they can help to promote the diversity and inclusivity of these disciplines while also increasing girls' interest in STEM.

2.5.2. How can schools and teachers apply it to their environment?

Schools can play a critical role in implementing STEM initiatives for girls. Schools, in collaboration with community organisations, can create a supportive environment that encourages girls to engage in these subjects and pursue their STEM interests.

By incorporating STEM subjects into the regular curriculum, you can help to increase girls' exposure to these fields and make them more accessible. To accomplish this, STEM clubs and after-school programmes can be successful; they can be focused on one STEM field or more, depending on the demand and interests at your school.

After-school programmes give students more flexibility in their learning approaches and STEM-related topics.

It is also critical to have access to resources and technology. Students can develop the digital skills necessary for any future career by having it available to them and using it.

The next critical input is to provide girls with mentorship and support from female STEM professionals, as well as to collaborate with STEM companies and organisations. This can encourage girls to pursue their interests in these fields and help girls gain confidence by providing them with examples of real-life careers. School can encourage students to participate in science fairs and competitions, which can help to build their skills, foster their interest in STEM subjects, and increase their exposure to these fields.

2.5.3. Example of initiative – Organisation of a science day

Presentation of the Science Day program

Science Day is a programme that ultimately ends with an event. The programme begins with Day 1 and concludes two weeks later with Day 2, which includes the science conference. This is the program's final event, attended by all students, each with their own science poster. The poster-creation process will take two weeks. Parents, other students, and invited guests will attend the science conference to learn about the findings of the students' research.

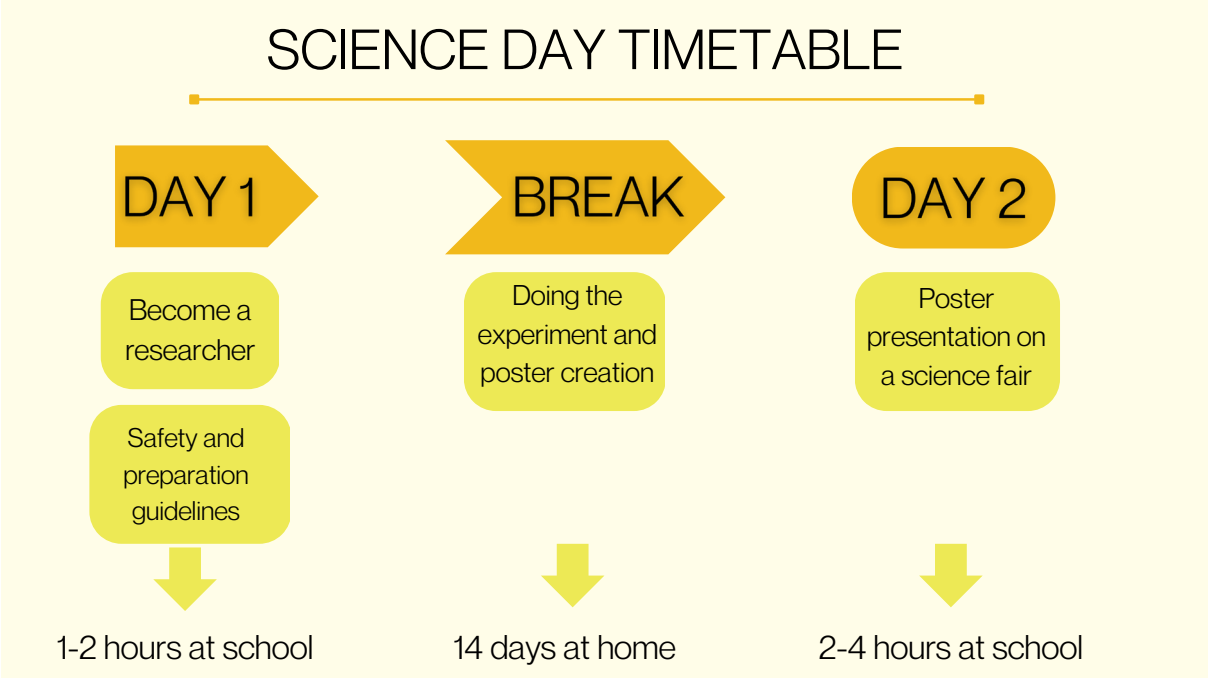


Image 24: Science Day timetable. [Graph]. Copyrighted: GoINNO Institute.

The implementation of Science Day has been scheduled for the first learning day, with the culmination taking place in the second day's late afternoon. Teachers can decide on the implementation and then apply it to the rhythm of their school.

Day 1: Become a researcher, as well as safety and preparation guidelines

On the first day of science, the teacher will present an outline of the entire programme to help students understand how their work over the next two weeks will progress towards the final goal - the science conference and presentation of their work.

The simplest way to get students excited about the science conference is to conduct one or two experiments with the class. The teacher can choose from the experiments included in this guidebook.

Following the hands-on activity, the teacher presents the outline of a science poster. The simplest method would be to create an example science poster based on an experiment conducted with students in the class.

Students will better understand the structure and how research is conducted in a real scientific setting this way. However, this can also be accomplished through simple experiments using the same workflow and methodology.

The experiment is then selected by the students. They can look up ideas on the internet or perhaps they already have some. The experiment's main goal is for students to think about the problem. All materials must be easily accessible - either from the kitchen or from a grocery store for a low cost. Students should be encouraged to seek out experiments on their own. If the student becomes stuck, the teacher can present a few ideas from this guidebook.

The teacher should collaborate with students and guide them, but should not make decisions for them. Allow them to select the experiment that interests them.

14-day break

Students will carry out the experiment at home over the course of the following 14 days and create a science poster. During the 14-day period, the teacher should be available at all times to help with potential issues and setbacks. Students can bring their science posters to school a few days prior to Day 2 of Science Day, where they can discuss any improvements with the teacher and, if necessary, make any last-minute changes.

Day 2: The Final Event – The Science Conference

The second day of the event is intended to simulate a real scientific conference that the researchers would attend. Students present their research at a science conference. As true scientists, they will present their scientific posters to the public during the afternoon event.

DAY 1

1. Hands-on: A brief introduction to the experiments (optional)

Duration: maximum of two school hours with a 5-10 minute break. Examples can be found in the second chapter of this guidebook's activities. The teacher should select one of the experiments presented in this guidebook. You can conduct two experiments with older and more experienced students. Group the students into teams of no more than three or four. The teacher begins by explaining to the class what they will learn today and notifying them that they will be working independently. The teacher gives a brief introduction to the topic of the experiment based on the STEM field and the age of the students. It is critical to tailor the entire activity to your group so that the students can participate to the best of their abilities and everyone can be actively involved in the experiment. Try to take on the role of observer and helper rather than the experimenter with the students simply watching. Allow the students to think for themselves, cooperate, ask questions, and reach their own conclusions with your subtle guidance. Even things that adults consider obvious and self-evident must be taught to students. Learning is most effective when you arrive at your own conclusions.

2. Become a researcher

Duration: 1 hour.

To present the experiment at a science conference with a poster we need the correctly approach and answer the research questions. In the next section, we will show you how a poster should look like in the case of one of the experiments presented in Module 1. The poster contains key claims based on the scientific research approach used by real scientists. It is not so important what the student will research, he must begin to solve the problem in a scientifically appropriate way. In this way, the student will acquire the knowledge that he/she will develop during the experiment and furthermore develop problem-solving skills.

The scientific experiment to be presented on the science poster must include:

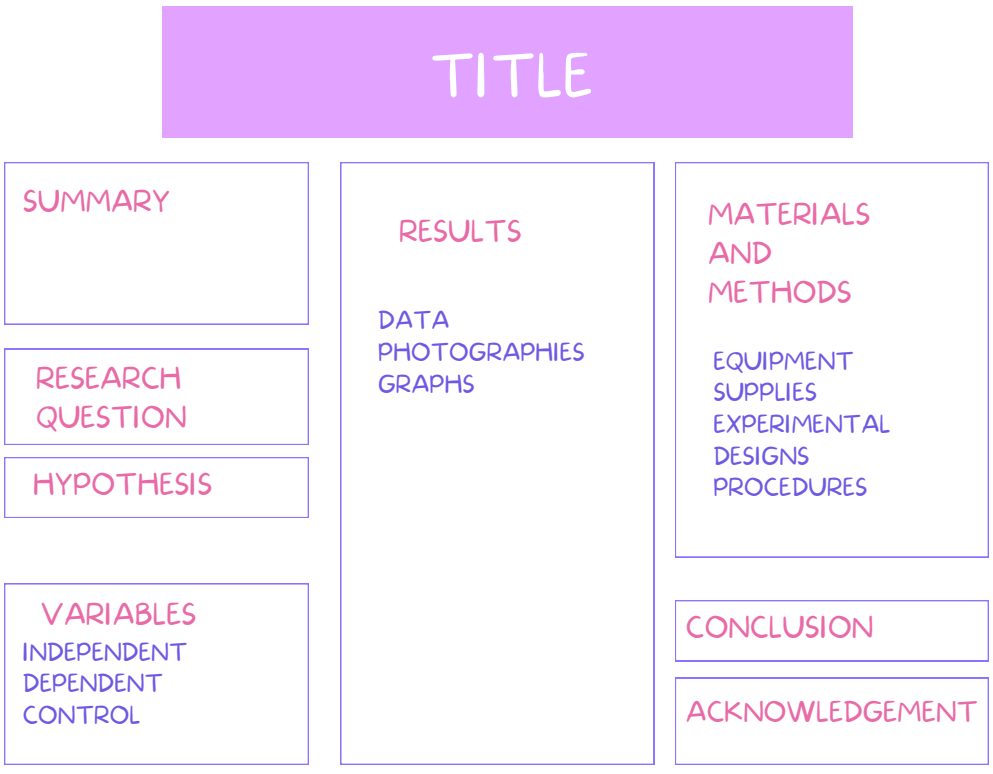


Image 25: A science poster template. [Image]. Copyrighted: GoINNO Institute.

The information on science fair project posters is usually the same, but the titles of the headings and the order in which the information is presented may differ. The poster should be interesting to both the science fair judges and visitors.

1. **Title:** The title should be an accurate description of the project. The title is usually centred at the top of the poster.
2. **Synopsis:** This section is also known as the "background" or "introduction." This section introduces the project topic, explains your interest in the project, and states the project's purpose.
3. **Research question and hypothesis:** Clearly state your hypothesis and/or question. In most cases, the hypothesis is the answer to your research question.
4. **Results:** data, photos, charts, and graphs: Data and results are not the same thing. The term "data" refers to the actual numbers or other information obtained during your project. Data is frequently displayed in the form of a table or graph. The Results section explains what the data means. For better audience engagement, try to include colour photographs of your project, project samples, tables, and graphs.
5. **Materials and Methods:** List the equipment and supplies you used in your project, as well as the experimental design and procedures you used to complete it. You can also include photographs here.
6. **Conclusion:** The conclusion focuses on the hypothesis or question as it compares to the data and results. What was the answer to the question? Was the hypothesis proven correct? What did you learn from the experiment?
7. **Acknowledgements and references:** If you wish to express your gratitude, do so here. Also, if you need to cite references or provide a bibliography for your project, this is the place to do it. References can be cited on the poster or printed out and placed beneath the poster.

In the example of a science poster-with the experiment

"Glowing bug with LED light" (the lesson plan for this experiment can be found above), we want to find out if and how the switch can be applied in the electrical circuit and if the light will react to different positions of the switch.

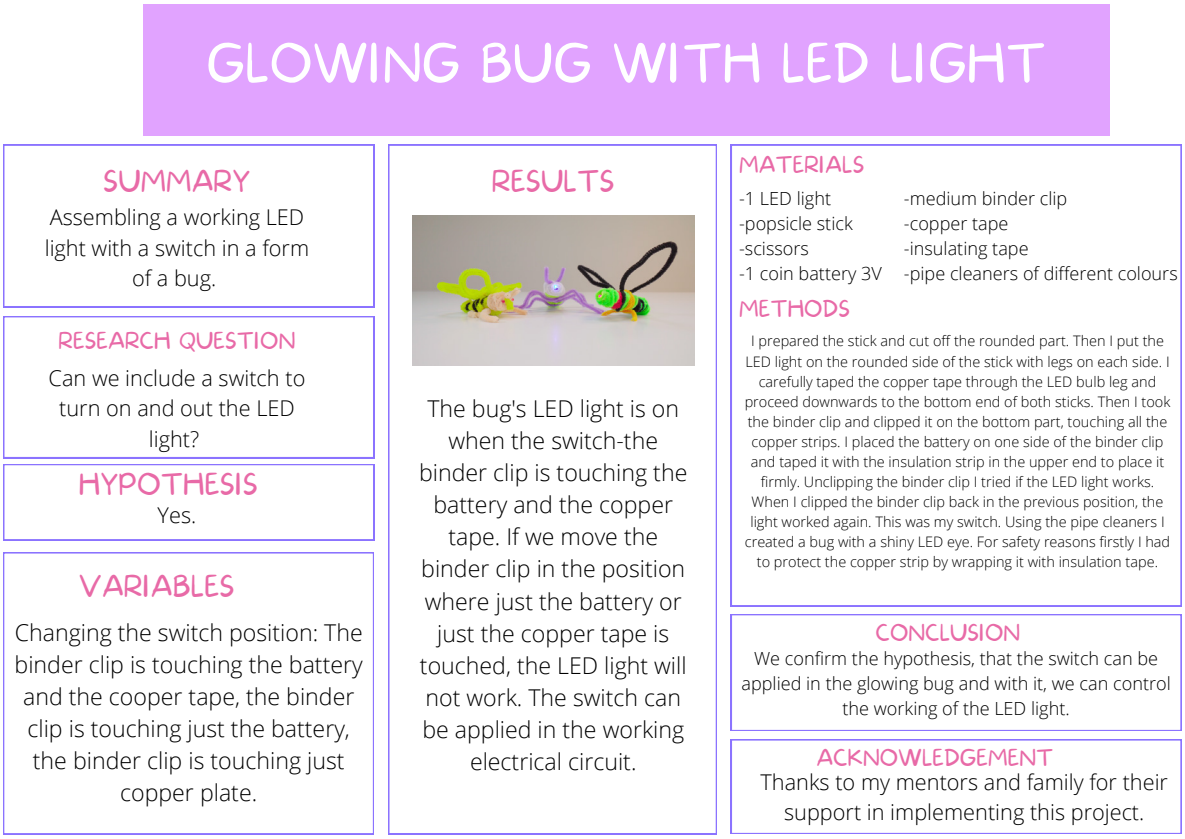


Image 26: Example of a science poster-with an experiment. [Image]. Copyrighted: GoINNO Institute.

3. Safety and preparation guidelines

Duration: 1 hour.

The students will use computers to find an experiment to do at home. Keep in mind that they require an experiment in order to present a poster, and it should be simple and safe to conduct at home (using familiar materials they can find at home or at a usual grocery store). They will inform the teacher of their plan, as well as the materials required and the scientific question that must be answered

experimentally. The teacher will assist them in making this decision and, if necessary, will upgrade the experiment to ensure that it is safe to perform at home. If the student is truly stuck, the teacher can offer examples of experiments from Module 1. Allow the students to select the experiment that most interests them, as they must be the most enthusiastic about it.

Explain what plagiarism is and is not, as well as how to use published projects as a starting point for them to explore further, tapping into their own creativity and problem-solving skills. Encourage your students to find a topic that interests them and use their own abilities to think, plan, and create the experiment.

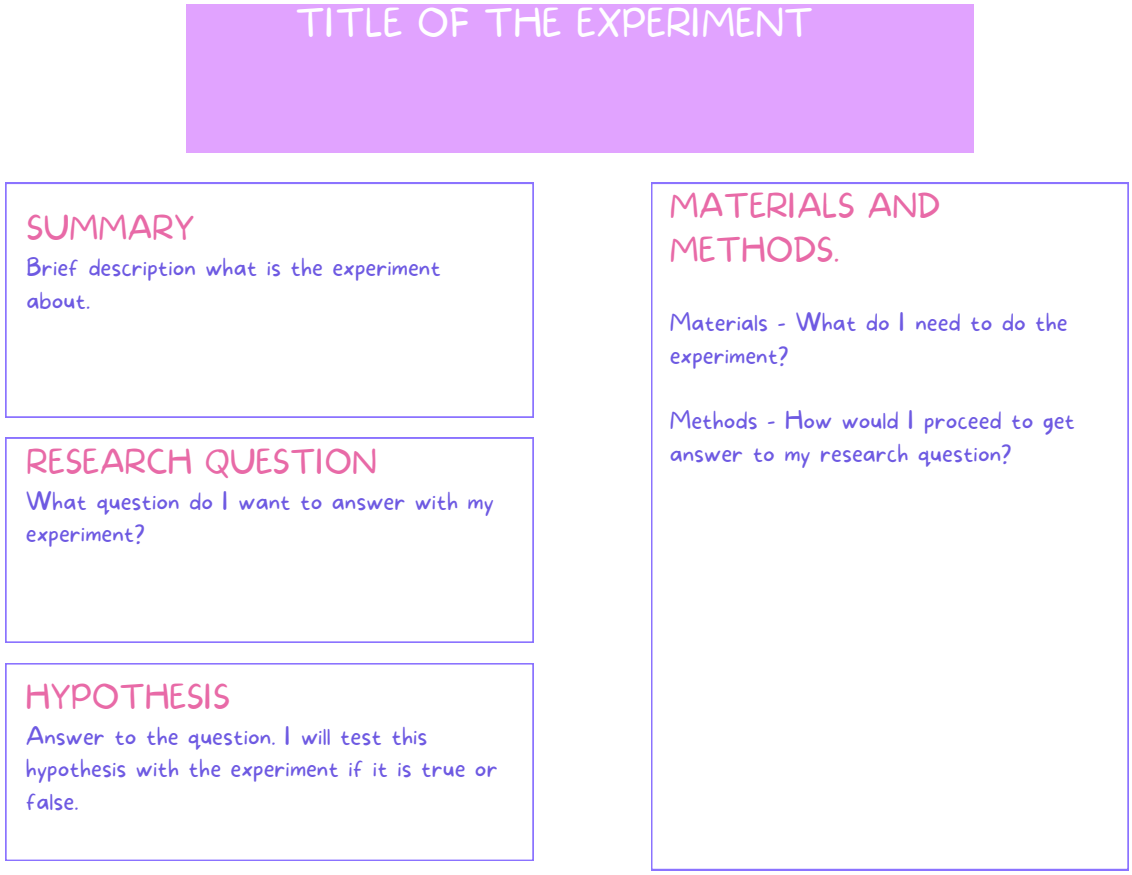


Image 27: A science poster template with an explanation of topics. [Image]. Copyrighted: GoINNO Institute.

You can assist your students with this template to make choosing experiments easier. When they have filled out all of these gaps, they are ready for their

homework: conduct the experiment to test the hypothesis and create the science poster containing this information.

After the students have chosen their experiments, we must inform them about the display board and any accessories they may require to create their poster. It is recommended that the display board be completed early so that the student can visualise how many rooms they have for text, photos, charts, and so on.

Additionally, they will require various tapes, glue sticks, and mounting products for creating layouts or model buildings, as well as measuring, cutting, and pasting tools to create a professional-looking display board during poster production. Make good use of decorating and colouring tools to create an appealing display board.

We recommend a three-fold white project board measuring 80 cm in height, 100 cm in length, and 40 cm in width.

14-days break

During the 14-day period, the teacher should be available at all times to assist with potential problems and setbacks. Students can bring their science posters to school a few days prior to Day 2 of the Science Day so that they can discuss any improvements with the teacher and, if necessary, make any last-minute changes.

DAY 2

The Final Event – A SCIENCE CONFERENCE

Duration: 2-4 hours.

It is now time for students to present their work at the science conference. As true scientists, they will present their scientific posters to the public during the afternoon event. Each student must prepare a poster, some materials, and a short speech for his or her conference presentation to the public and the science fair judges.

The event provides a one-of-a-kind opportunity to showcase your school's work to the general public and influential people in your community. Invite the mayor and representatives of your city hall, as well as representatives of important organisations and companies, to broaden your network of acquaintances and forge new collaborations with your school.

1. IMPORTANT POINTS TO FOLLOW TO ACHIEVE INCLUSIVENESS FOR ALL STUDENTS

Intended for: teachers, organisers

Introduction:

Because science fairs are ideal for inspiring and empowering our next generation of innovators, the following principles must be followed:

The fair must be specifically designed to be inclusive and serve all students equally, regardless of the amount of outside or in-class support they receive during their projects.

Students **should be given the option of "competing" against other students** and having their evaluation or placement of their work made public.

All students who participate in a fair **should be interviewed and evaluated based**

on their learning experience and **demonstration of 21st century skills** (such as problem-solving, critical thinking, inquiry, and so on), and they should **be given constructive feedback** to help them grow.

To ensure that students have a positive and successful project experience, **the fair organiser must effectively and clearly communicate to students,** parents, and teachers the expectations of the students' experiences as well as the framework for success.

2. How to organize a science conference?

Intended for: organisers

Introduction

The preparation process is critical in order to create an event that will be remembered by both students and visitors. In the following section, we will explain the process of organising a science day for teachers or other school staff who will be in charge of organising a science fair.

When you begin planning the motivational science day programme, you should also plan the final event. To ensure that there is enough time for everything, it is critical to define some details in advance and then begin conducting other planned activities accordingly.

When?

60 days before the final event.

Determine the date and location of the event first. Reserve it accordingly, whether it is a space in the school, the school atrium, or one of the outdoor public spaces in your area. When the weather is nice, it is fun to organise the event outside; just make sure that the event can be properly held or postponed in case of bad weather. The space should be large enough, such as a gym or a large hall, and there should be enough tables in the room. If there are none, you must bring them from somewhere else.

Create a team of assistants. You cannot organise the entire event by yourself. You are not required to organise the event yourself. Seek help from the start and surround yourself with people who will assist you, both in preparation and on the day of the event. They might well be teachers, coworkers, students, or parents who are just intrigued. Even on the day of the event, every hand is needed because the organisation is a demanding and large task.

Plan a budget for essential activities. Plan the entire event, from start to finish. We can give you some pointers on how the event can be used and which activities can be included. However, the final decision on involved activities must be made with your own perspective on the event - how many people will be involved, how much time you have, and how much money you have. If you have extra funds, you can use them to provide refreshments for invited guests, small favours for participants, or even larger prizes for the best scientific poster presentations as determined by the jury. You can try to get some sponsors to help you raise your budget.

When?

30 days before the final event.

Plan the event's details, including where, when, a detailed schedule, and an invitation list.

A sample science fair timetable::

14.00-14.30: Organisers are setting up the venue.

14.30-15.00: Student registration and poster placement.

15.00: The science fair begins.

15.30-17.00: Judging of science posters.

17.30: The final award ceremony, which includes the announcement of the best science posters from the science fair and the presentation of participation certificates to each participant.

If there are more than 20 science posters to be judged, the schedule must be adapted; additional time must be allowed for registration, preparation, and judging. If you do not want to judge the science posters at your science fair, the extra time is not required, even if the number of posters exceeds 20.

Create brochures or digital invitations and invite the participants you want to attend. The invitations to participate must also be sent to the judges. Ensure that the participation is confirmed by the judges.

Teachers begin preparing students by implementing the aforementioned modules in order to achieve their ultimate goal - the presentation of their scientific

work at the science fair. All programme modules can be completed in 14 days, but if you need more time, you can request more. Modules are designed so that they can be completed all in one day or in two days with a 14-day break. You can use them however you see fit in your school.

Prepare supplementary activities. Now is the time to invite an expert or an important person. Additionally, a presentation on STEM topics or another activity you want to have at the event for additional content needs to be planned in great detail at this time.

Judges should be recruited and properly prepared. Provide clear instructions and information about the projects presented at the event to the judges: how old are the students, how skilled they are, what types of projects are they willing to do... Judges must communicate with one another in order to be prepared to judge properly and fairly.

Recruit volunteers: More volunteers will be required in the final month. Plan the work and divide it among them, communicate and collaborate with one another, and resolve the work that needs to be done step by step.

Do and check the final checklist: It is beneficial to create a checklist for the tasks that must be completed during the fair's organisation. We hope that by now, the majority of the check-ups have been completed.

When?

Day of the Fair: It's time for action!

Example of the timetable and tasks involved:

14.00–14.30: The venue is open to the organisers, who set up the space (tables and chairs) for the students with science posters, number the spots for easier judging, and prepare/mark the path for visitors to walk around. Remember to set up the stage for the final award ceremony as well as the registration table near the entrance.

14.30: Students arrive, register their posters at the registration table, and receive the number of their presentation spot. Set up their posters.

15.00: The science fair begins. Posters should be all set up until that time, when the invited community can walk around the posters, and students should be available to answer questions and present their experiments and findings.

15.30–17.00: The judges start the judging. They determine the total number of points for each assessed quality using a judging form. The winning poster is the one who receives the most points. If there are more people with the same number of points, they should all be called on stage and given the winner's certificate.

17.30: Final award ceremony. Announcing the results of the judging scores and awarding the winner certificates to all participants on stage If you have invited an important stakeholder or community member, now is the time to introduce her or him.

18.00: The science fair concludes, students take their posters home, and organisers take care to leave the space as tidy and clean as they found it.

3. A Science Fair Judge's Handbook

Intended for: judges

Introduction:

The Science Fair judge can either make or break a student's interest in STEM. It is critical for judges to be familiar with the context of science fairs and which aspects of science fair projects should be evaluated. All too often, the judges are far too critical of students' projects and lack a clear understanding of what level of work is appropriate for the grade levels they are judging. Sometimes judges are true experts in their fields, but they lack a connection with school students, resulting in an inappropriate assessment. Recruit professionals in your community who have connections to your school's grade levels and give them clear instructions on how to assess students' projects at the fair so that the students have a positive and educational assessment experience.

Judges' goals:

1. Encourage students to tell you about their experiences.
2. Objectively assess students' creativity, communication, problem-solving, and collaboration (team projects) abilities.
3. Science and engineering practises.
4. Provide both positive and constructive feedback.

Tips for conducting a dialogue or interview with the student:

1. Begin on a positive note by introducing yourself and warmly greeting the student.
2. If students' results are inconclusive, this is not a problem as long as they have considered how they might improve their approach in order to obtain "correct" results.
3. Never make disparaging remarks about students or their projects.
4. Ask encouraging questions to help students explain what they learned from their science project.

Judges' questions:

- Could you tell me about your project?
- How did you come up with the idea for your project?
- What was your favourite part of your project?
- Was anything surprising to you?
- Could you please explain this chart to me?
- What would you change if you were to do this project again?

Positive reinforcement:

Comment on what you believe are the most compelling elements of their project and presentation. You could, for example, use Nice, Good, Great, or Outstanding before any of the following:

- .... work/job!
- ... project topic!
- ... creativity!
- ... problem-solving
- ... developing your procedure!
- ... defining the variables and constants!
- ... of photos/tables/graphs, as well as display board organisation!
- ... communicating your project during our discussion!

Evaluation and recognition of skill development:

Reward students for their skill development. Judges can create assessment criteria that evaluate skills like creativity, problem-solving, communication, and teamwork. All of the criteria can be rated from 1 to 5, with 1 representing poor execution and 5 representing excellent execution. The student who receives the most points from all of the judges is the winner.

Distribute the assessment criteria to students so that they can use them as a guide.

The judges must be informed about the assessment criteria so that they can ask questions that help students explain their skill development.

4. Students' goals for presenting their science research and posters

Intended for: students, teachers, organisers

Introduction:

Students must be prepared to share the knowledge gained during the experiment and poster presentation. They can find advice on how to prepare for and behave at a scientific conference here.

The student is required to **place the poster on his table.** On the paper and table, the organiser can write the **name of the student presenting and the title of the research.** Also, the **number of the poster** is encouraged to be written to avoid confusion and to allow the judges to easily remark their assessments

The science **fair student must stand beside her/his poster the entire time and actively present it to the public.** Any student should be prepared to answer questions and discuss her/his research with the participants at any time.

The **student must enjoy her/his presentation while creatively exploring her/his genuine interest in a scientific context.** It is critical that they develop the critical thinking skills required for project planning, design, implementation, and evaluation. In addition, students must clearly communicate what they have learned to the public and the judges, both verbally and nonverbally.

3 Events in which female scientists can take part

Image 29: Female expert working in construction as a civil engineer [Photograph]. Canva Stock.

3.1. Why is it important to include female scientists in actual events and activities?

Role models serve as inspiration for students, sparking interest in learning and exploring STEM disciplines, as well as a desire to pursue a future career in the STEM field (Morris et al., 2021). Students must first understand what is achievable.

> Identifying a role model at a young age can help students find the motivation to explore the possibilities of working in a similar field.

If the presentation of role models is done properly, it can help engage more students, who typically perform poorly in STEM fields (girls, students with difficult socio-economic backgrounds, students with learning disorders, etc.). Promoting a diverse range of role models is critical to closing the diversity gap that persists in these areas (Keane & Linden, 2022).

In our project, we created a total of 12 infographics depicting female role models and researchers in various STEM fields. Involving partners from Lithuania, Latvia, Slovenia, and Cyprus in the selection process, we selected three of each nation's most inspirational female scientists from STEM-related professions. Three infographics featuring national representatives have been translated into the language of the country. The infographics are available at the end of the guidebook for teachers to use to inspire girls to pursue careers in STEM.

3.2. How do I find an expert?

Collaborate with organisations dedicated to increasing the participation of women in science.

Also, the internet can be useful; in some countries, there are platforms with data from scientists, so you can contact local experts directly if they are ready to help.

Sometimes educational institutions have collaborating researchers, and you can ask if there is someone who can come to your school and present her/his STEM profession to your students.

Perhaps you can ask students directly if any of their parents, relatives, or friends are a good match for what you are looking for.

Image 30: Female expert working as a mechanical engineer [Photograph]. Canva Stock.

3.3. How to Find a Professional Who Fits Your Class

Here you will find information on how to invite an interesting female role model working in STEM to present her work as a scientist, researcher, engineer, biologist, and so on, in order to inspire students. This could help spark their interest in pursuing a career in STEM. Find an expert who will fit in your classroom to present herself or himself and engage students.

Search for:

- **Females and males.** Try to cover both genders equally, as female role models may be harder to find, but they are much more appreciated by girls. This is critical for improving girls' attitudes towards and interest in STEM.

Image 31: Female role models who are students' own age are more motivating [Photograph]. Canva Stock.

- **Individuals actively engaged in STEM fields** (engineering, mathematics, programming, computing, medical sciences, environmental sciences, life sciences, physics, chemistry, and so on).
- **Individuals with inspiring stories to share.** We want to demonstrate to the students that anyone can become an expert in some field and do and create significant things in their lives. If possible, choose people from diverse backgrounds, cultures, and genders to demonstrate to students what can be accomplished despite our nature and circumstances.
- **People working in various areas of STEM** demonstrate the breadth of STEM fields as well as the most possibilities and ideas for STEM future careers.
- **Young people, regardless of age.** This allows students to connect with role models and see how they can begin creating their own story right away.

3.4. Examples of events with female experts

3.4.1. Laboratory visits

Field trips are always welcome for students because they promise new experiences, knowledge, and getting to know their local expertise organisations. A trip to the lab is one method a teacher can use to give students an introduction to the STEM field. Scientists working in laboratories may offer to see and present their work in their working environment, the laboratory. If you want to bring the experience even closer to girls, try to find a female researcher to lead your tour.

The teacher should start by looking for laboratories in his or her area that give elementary or secondary school students tours of their labs. If the teacher is unable to locate a laboratory that offers guided tours, he or she may attempt to contact the laboratory. Send an e-mail to the laboratory or call their phone number. Introduce yourself briefly and inquire whether they offer guided tours of their laboratory for your schoolchildren.

There are a few things to consider before choosing which laboratory to visit:

- The size of your student group. This is something you and the tour guide agree on ahead of time.
- If necessary, arrange for transportation to the laboratory for students and teachers.
- Consider what you want to teach the students by visiting the laboratory. Prepare an outline of the points that are important to you and discuss them in advance with the leader of the laboratory tour to find common points that will suit both the teacher and the guide and will best present the learning conclusions to the students. Check out what the laboratory has to offer and whether students can participate actively (e.g., in some experimental activity).

Image 32: A female expert working in the laboratory who is presenting her workplace to students [Photograph]. Canva Stock.

After you have clarified all outstanding questions about the lab visit with the laboratory tour guide, you must also prepare your students for the visit so that they recognise the added value of their visit. Introduce them to where they will go, what they will see, and what they will do there. You can link the activity to one of the learning objectives you want to achieve and prepare the lesson before visiting the laboratory. Remind them ahead of time about laboratory behaviour and rules; in such working environments, these are critical for the safety of all participants as well as the overall climate of their visit.

3.4.2. DEMONSTRATION – Expert visit to the school

In the first part of their visit, the expert can present themselves, their life story, and how they became experts in the STEM field. They can include some interesting and amusing details about their schooling or work experience. It is critical that students relate to the expert and see the realistic concept among them. In addition, the expert can present his work, perhaps showing students a component or object that he or she uses on a daily basis at work.

The second part of the activity includes a discussion of the questions raised by the students. Optionally, the teacher may review the questions to see if they are appropriate before the students begin asking them and then choose a few that he or she feels are best suited for discussing STEM fields and professions with the invited guest. The number of questions the guest will answer is determined by his or her eloquence and the nature of the question. We recommend that you prepare a maximum of ten questions, which should be carefully chosen.

3.4.3. Career orientation with female role models

A female local expert can participate in a discussion with children about their career interests. To help the expert guide the discussion, we have prepared a few questions. Make a special note of topics such as the gender gap in applying to some studies or pursuing a career in (as in STEM), the belief that some professions are more for men and more for women—what do students think and why do they think like this?—do they choose the profession they really like and love to do or do they choose it for some other reason, and which (for example, the study is too difficult, getting a job with this profession is a rare opportunity, my parents want me to do this job...

The infographics presented can provide the expert with ideas for discussion in addition to her work and experience.

Are the students interested in the professions that have been presented? Which one? What specifically are they interested in—innovations, laboratory work, programming, doing really super technology stuff that no one can even imagine? All students can write their thoughts on a sheet of paper in the form of a diagram and then present their perspective on their orientation in front of the class. An expert can lead a discussion about students' opinions while embracing, encouraging, and respecting them. She can also contribute to the aforementioned professions.

Image 33: A female STEM expert visits a school [Photograph]. Canva Stock.

3.4.4. Inviting parents to school – a STEM expert mom presents her profession to students in the class of her / his child

We already mentioned that the teacher can ask the students if one of their parents is employed or works in one of the STEM fields. This includes everyone from engineers to scientists to programmers to doctors. You can invite the parent to come to the school and present their profession. Children will thus be able to connect more easily with a profession or someone who performs this profession because they know that, like their mother or father, he is also a mother or father to their classmate.

It would be wonderful if one of the mothers could present her profession. This will demonstrate to girls that it is possible and not unusual for a woman to combine family life and a career in STEM.

This will help us break down the stereotypes that still exist, such as the idea that a woman who chooses a career cannot choose to start a family, and that some young women, even if they are enthusiastic about STEM, will be discouraged from studying because they, too, want to start families. During such a presentation, the students are likely to bond with the researcher and thus remember the presentation well. At the same time, they gain new knowledge about STEM fields and professions and can become excited about them, which is our goal for the next generation of students.

Image 34: A mom presenting her profession in her daughters' class. [Photograph]. Canva Stock.

3.4.5. Inviting an expert to participate in your school's science day

When organising a science day or science fair at your school, you are welcome to invite various STEM experts to the event to introduce themselves briefly to the students and thus give them the opportunity to ask them questions.

Personal contact has a significant impact on students' perceptions of the expert, demonstrating that he or she is still a person and not someone who is unreachable.

STEM experts can also take part in the evaluation of the students' posters, the award ceremony, or conduct an experiment with them if time and space permit. Because it is an afternoon event, it is more likely that one of the local science experts will respond to your invitation. The invitation should be sent in advance, at least a month or two before the event, so that experts can make plans to attend.

Image 35: A female STEM expert presenting an award at the science fair [Photograph]. Canva Stock.

Conclusion

In recent years, there has been a growing recognition of the importance of increasing the proportion of women in STEM disciplines. Despite several efforts to encourage girls to pursue careers in science, technology, engineering, and mathematics, women remain underrepresented in these fields. Teachers play an important role in shaping young girls' futures and developing their STEM potential, and a motivating approach can greatly encourage girls to pursue their talents and find lucrative jobs in STEM.

A motivational strategy is to create a welcoming and inclusive classroom environment that fosters a love of STEM and inspires girls to reach their full potential. This begins with addressing unconscious biases and dismantling gender stereotypes that limit girls' opportunities and aspirations. Teachers can utilise a wide variety of hands-on activities and real-world projects to demonstrate the relevance and influence of STEM in everyday life as well as the diversity of STEM occupations. Teachers can utilise a wide variety of hands-on activities and real-world projects to demonstrate the relevance and influence of STEM in everyday life as well as the diversity of STEM occupations. A motivating strategy must include female role models.

Girls can learn that employment in STEM disciplines is possible and accessible by being exposed to successful women in these fields, whether they are women who have made historically significant discoveries, or women who are actively involved in current research. This will motivate and inspire girls while dispelling the myth that STEM is a male-dominated field.

Giving girls the opportunity to develop their talents and apply what they have learned in real-world situations is another way to encourage them to pursue STEM-related fields. Teachers can use multidisciplinary projects, design challenges, and problem-solving activities to help students apply their knowledge in meaningful

ways. This will encourage girls to pursue STEM careers and instill pride in their work and accomplishments.

Teachers can support the growth of a growth mindset in their students by encouraging a culture of learning, resilience, and perseverance in them. Girls should be encouraged to take risks, face challenges, and view failure as an opportunity for individual development. Teachers can help female students develop a positive attitude towards STEM and overcome obstacles by emphasising the value of perseverance and hard work.

To sum up, encouraging girls to pursue STEM education is critical for advancing gender equality in the workplace. Teachers can play an important role in inspiring and encouraging females to pursue their talents in STEM by creating a pleasant and inclusive classroom climate, incorporating hands-on activities, supporting female role models, addressing unconscious biases, and encouraging a development mindset. Supporting the education and development of girls in STEM can assist in removing gender barriers and creating a more diversified and equitable future. By implementing the promotion strategies in this guidebook, teachers can make a significant difference in the lives of girls and contribute to a future in STEM that is more diverse and egalitarian.

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Appendix: Female role models infographics


I CAN BECOME LIKE...
URŠKA IVANUŠ
SUPERPOWER: ELIMINATE THE CERVICAL CANCER IN SLOVENIA
She is on a mission to eliminate the incidence of cervical cancer in Slovenia, leading a project for the renewal of the screening information system. She educates and raises awareness about cervical cancer and its prevention.
...IF I STUDY MEDICINE.
Urška Ivanuš, MD, PhD
University Clinical Center of Ljubljana
Co-funded by the Erasmus+ Programme of the European Union
iSee
WWW.ISEEAPP.EU


I CAN BECOME LIKE...
LINDA MEŽULE
SUPERPOWER: USING ALGAE TO FILTER WASTE WATER
She is on a mission to find sustainable ways to ensure access to safe drinking water. She has also contributed to developing a technology that allows the transformation of any green biomass into biofuel.
...IF I STUDY BIOLOGY.
Linda Mežule, PhD
Riga Technical University
Co-funded by the Erasmus+ Programme of the European Union
iSee
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I CAN BECOME LIKE...
MĀRA PUDĀNE
SUPERPOWER: HELP PEOPLE DEALING WITH EMOTIONS USING ROBOTICS
AI
She is developing effective artificial intelligence systems to simulate a group of artificial humans who interact with each other and make it as close as possible to human communication. This would help people with emotional challenges.
...IF I STUDY COMPUTER SCIENCE.
Māra Pudāne, PhD
Riga Technical University
Co-funded by the Erasmus+ Programme of the European Union
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I CAN BECOME LIKE...
ILGA GEDROVICA
SUPERPOWER: USING INSECTS AS ENVIRONMENTALLY FRIENDLY FOOD
She is in a mission to find innovative food studies the potential use of insects and other animals as a sustainable and environmentally friendly alternative for livestock animal protein in the human diet.
...IF I STUDY AGRICULTURE.
Dr.sc.ing. Ilga Gedrovica
Latvia University of Agriculture
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I CAN BECOME LIKE...
BIRUTĖ MARIJA FILOMENA GALDIKAS
SUPERPOWER: CONNECTING ANIMALS AND HUMANS TO PRESERVE THE ENVIRONMENT
For over four decades she has worked closely with the orangutans and lectured to thousands of people throughout the world, to understand them and preserve their rapidly diminishing natural habitat.
...IF I STUDY BIOLOGY.
Prof. Dr. Birutė Marija Filomena Galdikas
National University in Jakarta, Simon Fraser University in Canada
Co-funded by the Erasmus+ Programme of the European Union
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I CAN BECOME LIKE...
URTĖ NENIŠKYTĖ
SUPERPOWER: FIGHTS AUTISM BY STUDYING BRAINS
She investigates how the human brain decides which connections in the brain network should be removed and which are kept. Identifying this would be a huge step towards curing diseases such as autism and schizophrenia.
...IF I STUDY BIOLOGY.
Dr. Urtė Neniškytė
Life Science Center at Vilnius University
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I CAN BECOME LIKE...
VIOLETA VOGEL
SUPERPOWER: ORGANIZE DATA TO HELP PATIENTS IN HOSPITAL
She is an Artificial Intelligence expert who is currently mainly involved in monitoring and processing statistical data using AI in the medical and marketing spheres.
...IF I STUDY COMPUTER SCIENCE.
Dr. Violeta Vogel
Inselspital University Hospital in Switzerland
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I CAN BECOME LIKE...
KYRIAKI MICHAILIDOU
SUPERPOWER: USING STATISTICS TO FIGHT CANCER
She aims to identify reasons why some women develop breast cancer and some do not. She uses her statistical and mathematical skills to help solve complex health problems.
...IF I STUDY MATHEMATICS.
Kyriaki Michailidou, PhD
The Cyprus Institute of Neurology and Genetics
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I CAN BECOME LIKE...
CHRISTIANA PAPAMICHAEL
SUPERPOWER: ASSURING FUNDING AND EQUIPMENT FOR SCIENTISTS
At first she was running clinical trials trying to test new medicines, vaccines and methods around the world, now she manages the research operations. Following STEM opens doors to endless possibilities to make a real contribution to people's lives.
...IF I STUDY NEUROSCIENCE.
Christiana Papamichael, PhD
Cyprus Cancer Research Institute
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I CAN BECOME LIKE...
MARILENA PAPASTAVROU
SUPERPOWER: PROTECT THE ENVIRONMENT THROUGH ACTIONS
She works as an environmental officer in the national Nature Protection sector. She assisted to secure funding for the protection of the Natura 2000 network and a program for promoting a waste reduction in Cyprus.
...IF I STUDY ENVIRONMENTAL SCIENCE.
Marilena Papastavrou, PhD
Department of Environment in Cyprus
Co-funded by the Erasmus+ Programme of the European Union
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