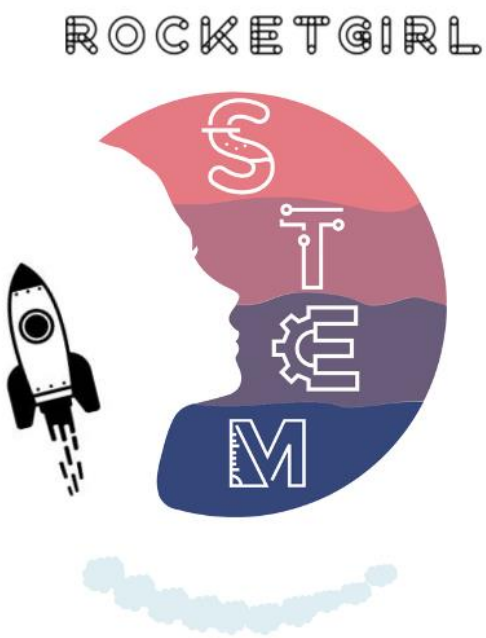
E-portfolio Do STEM like a Girl Project

RocketGirl consultancy Firm



Date: 15 October 2021

Name: Margarita Mudde Cruz, Lily Pepper, Uliana Rybina, Leon Fischer

ID: i6181784, i6241653, i6274953, i6289653

Tutor: Manuela Heins

Course Coordinator: Manuela Heins

Course: COR1003 Science, Reasoning and Human progress

Faculty: University College Maastricht

Number of words: 9086

Dear Fatimah,

You approached us to find a way to close the gender gap in STEM careers. You mentioned that you regret the lack of diversity in the STEM field because you frequently notice being the only woman in your daily work life. In your interpretation, the issue starts in children's early development through an early internalization of stereotypes. You believe that elementary schools already contribute to thinking of science as a gendered field. This influences boys' and girls' interests and achievements in school (Assessment Manual, 2021). Based on our interpretation of the case, we propose an intrapreneurial project to address the issue. The solution you are looking for is RocketGIRL.

RocketGIRL will be a new brand of the existing engineering company you work for. Next to the products you sell, RocketGIRL would be a new service in the company's arsenal, functioning as a sub-brand. It is still closely linked to the mother brand (Fatimah's workplace) but distinct in what it offers and to whom. The brand will offer workshops, teacher training, and school-related products to increase young girls' interest in STEM.

Introduction

Of the total number of people working around the globe, women make up 47% (Arabia, 2021). There are however certain fields in which they are heavily underrepresented: these fields are science, technology, engineering, and mathematics - the so-called STEM jobs. In these sectors, only 29% of the workforce are female and looking at the higher position jobs, women only make up 19% of STEM company board members and only 3% of CEOs in STEM companies are female (Arabia, 2021). Since 2020, 18% more women have become board members in STEM companies (Arabia, 2021). Still, the current number is way too low, and the process of this getting better is too slow.

The reasons for the lack of women in STEM start early. Many 12-18-year-old women have internalized the belief that men are more suited for STEM fields. They have internalized this view from an early age, and preventative solutions would come too late for them to have a significant impact (Good et al., 2007; Wang & Degol, 2017). Therefore, the first level aims to reduce the stereotypes they have already internalized. Workshops explicitly aimed at young girls are supposed to eliminate girls' fear of STEM and rekindle their interest. This implies specific methods to address females' intrinsic belief of STEM not being 'a girls thing'. Therefore, the workshops will address this problem first before diving into the subject matter.

These numbers show very clearly the need to address the lack of women in STEM. Through the imaginary case of 'Fatimah the female engineer', we propose a solution to bringing more women into the field. Through the fantasy brand RocketGIRL, we offer a path to decrease stereotype thinking in younger generations, while simultaneously addressing bias in education. Thus, RocketGIRL is a two-level approach to the problem. This E-portfolio is supposed to introduce the idea behind the brand. First, we will explore literature on gender bias in STEM to establish the relevance and justification for measures. Afterwards, we explain the structure of the products RocketGIRL would offer to address the stereotypes. Lastly, we go into depth with each level and what they entail

Factors affecting girl's interest in STEM

Women for the past centuries have always been thought to be inferior to men. These internalized beliefs in society will now be investigated through major sociological factors.

Before taking an approach in changing something, we first need to understand the essence of the problem.

Firstly, arguably the biggest factor are stereotypes on gender and bias. Beyond the fact that workshops have shown to be effective methods to increase academic performance in stereotyped groups, the decision to introduce more girls to STEM through workshops has to do with a phenomenon called “stereotype threat” (Inzlicht & Ben-Zeev, 2000; Tsui, 2000). Stereotype threat describes a situation in which a group of individuals that have been attributed certain stereotypes are reminded of these stereotypes and the possibility to live up to them (Inzlicht & Ben-Zeev, 2000). Only belonging to a stereotyped group is enough to become a victim of stereotype-induced poor performance. In practice, it means that females tend to perform worse than men when confronted with a stereotyped subject because it reminds them of their alleged inferiority in the subject.

Statistically speaking, this stereotype threat is contradictory as girls potentially are gifted in both math and verbal abilities, meaning that it is more balanced, while boys are more gifted in math compared to verbal abilities. People with one dominant capability tend to concentrate on it more by continuously trying to improve in it and most likely even choosing it as a career path. In this case, it would be boys as explained above. Girls, in comparison, having relative cognitive strengths in both the math and the verbal sector, have a lower probability of directly diving into a math-concentrated career (Park et al., 2007). These differences between boys and girls develop in early to late childhood, which is a crucial time regarding the fact that this also is the phase in which school starts. As it goes on throughout all of childhood until the pupils are adolescents, the schooling circumstances they are accustomed to may increase these differences between boys and girls regarding cognitive results (Valla & Ceci, 2014).

Especially STEM counts as a stereotyped field, thanks to the by-now outdated argument that women’s cognitive abilities make them inferior at studying this field to men. However, we reject this hypothesis on the ground that it is much more likely that gender-biased education leads women to perform worse than men in STEM subjects (Good et al., 2007). Despite this argument not being accepted anymore, it still convinces enough people who consequently teach STEM with a gender bias and activating stereotype threat in women. Therefore, women experience stereotype threat in STEM-related tasks and systematically

perform worse than men (Good et al., 2007; Inzlicht & Ben-Zeev, 2000; O'Brien et al., 2020). This theory becomes more explicit through the solutions to stereotype threat, which are essential for bringing more girls into STEM careers.

Furthermore, a study by Johns et al. (2005) showed that teaching women about the stereotype they face led them to significantly improve their performance on a math test and score as high as men. Before being aware of it, they performed worse than men. These results have important implications for our solution. It shows the necessity of making girls aware of the bias and stereotypes common in the STEM field before expecting them to enter the field. By telling them that their fear of science and under-performance are not the result of cognitive differences but stereotypes in the area, we hope to show them that their fear is unnecessary. We hope that girls will not just be reminded of the stereotypes in STEM and thus decrease their performance. Instead, we hope they will recognize it as the bias that it is and, as research showed, improve their performance by defeating it internally. This justifies our approach to first offer a workshop on gender-bias awareness in STEM. Additionally, an important effect to mention is the Matilda effect. The Matilda effect names the way women are systematically suppressed and denied of contribution in research in the STEM field (Knobloch-Westerwick, S., & Glynn, C. J. , 2013). Their work is instead attributed to their male colleagues. As such women are largely underrepresented and their works and successes in science, technology, engineering, and mathematics do not get enough, if any, recognition. The name 'Matilda' comes from the US women's rights activist Matilda Joslyn Gage, who was the first to describe this phenomenon at the end of the 19th century (Knobloch-Westerwick, S., & Glynn, C. J. , 2013). Most importantly, the effect is meant to point out how patriarchal the history of science is and the need to raise awareness and reveal the role models that all young girls need in order to increase their probability to follow a STEM field.

Secondly, despite substantial progress in education and promotion of STEM activities for girls, women still occupy only 24 percent of STEM jobs in the United States (Heaverlo, 2011). Teachers have an influence to foster curiosity and promote the interests of young girls in STEM. However, a study in 2007 found that 5th grade students attending education in the bay area, known as San Francisco, Oakland, and San Jose only received a minimum of one hour of science teaching per week, and some teachers did not engage in any STEM education (Heaverlo, 2011). Additionally, studies show misjudgement of how able girls

are in mathematics in comparison to boys although there are hardly any performance differences and a lack of motivating them as often as boys to get into math or science subjects (Tiedemann, 2000). Girls can in turn pick up this thought and internalize it, experiments exist that detected this thought containing six-year-old girls, showing at what little age it can be picked up. Boys on the other hand showed a higher rate of linking math to the male gender than girls (Miller et al., 2015). Even though it might not be an intended decision from many parents and teachers to spread the above stated message, it can still have an impact on girls at a very young age, normalizing STEM to be and stay a subject for males.

Thirdly, on a sociological level it is important to include parents into the perspective as they, like the educational institution, can have a big influence on the children's actual mathematical performance when they present their own opinion on exactly how each gender should perform in math. If the parent's opinion is more stereotypical, so boys being better and more interested in it than girls, they tend to transfer this thought to their image of their own children and as research has shown, their children are very likely to take over their parent's perception of math ability (Jacobs & Eccles, 1992). According to surveys, females enjoy STEM activities, but four out of ten think they do not get enough hands-on experience. This is where both teachers and parents must work together to create a safe environment that fosters girls' interest in STEM. Many parents, particularly those who have not had formal education in STEM disciplines, are unsure about how to instruct and expose their daughters to these professions. This is problematic as at the age of 15, both boys and girls are confronted with selecting to profound their knowledge in the STEM fields or choose another specialization. Thus, it is prime to foster greater support at home. Additionally, a recent study (source) found that high school girls that have chosen to advance with higher level STEM subjects often have parents, family members and friends that provide more career support. Thus, an active role to combat both parent-held stereotypes and create an active responsibility to promote STEM curiosity in girls is necessary.

Fourthly, to come back to relative cognitive strength, it can be summed up that woman, having a more balanced math/ verbal ability proportion, also have a wider set of occupations to choose from than just STEM. While relative cognitive strengths again are very individual issues, a factor that is more to be seen from the society's view, which goes into the stereotype direction further are field specific ability related beliefs. In detail, one form of ability-related

beliefs is key in the study of women in STEM: incremental beliefs. These basically state that abilities are not something fixed but that they can be adopted throughout life by putting practice and effort into them. These do not really go well with gender stereotypes, as the bigger the stereotype, the less incremental beliefs exist. In fact, it is perfectly normal for individuals to be involved into work that they think they already are able in to a certain degree and thus can get better in rather easily. Taking this concept over to STEM, it would mean that people studying it and men would have better built incremental beliefs in contrast to women and people not studying STEM (Moe et al., 2021).

Field-specific ability beliefs can be referred to fields including STEM as well as fields that do not. It has been shown that many think of work that is dominated by males to be requiring intelligence that can not be learned or acquired but that is already supposed to be present from the beginning, when compared to female-dominated fields (Meyer et al., 2015). As STEM is a male-dominated topic, girls with a fixed mindset thinking that this is actually true are withheld from going into it. They either get dragged down by the false fact that intelligence is required to already be present in order to pursue in STEM or they think that females generally are a group of people who have a lower probability of being able to succeed. As a person's mindset and whether it is a fixed or a growth one can play a big role in explaining the gender gap in STEM, it needs to be examined where it comes from. School and the way teachers believe in how learning works can be shaping their pupils' mindset. When a teacher rewards ability rather than effort, this will have an impact on the pupils' academic performance. As an experiment showed in which one group was taught effort over ability and the other one ability over effort, the first one had much higher results in fun, persistence and performance throughout the tasks they have been given than the second one (Mueller & Dweck, 1998). Using the same method on girls, teaching them the growth mindset method of effort leading to success in mathematics, this would eventually lead to them choosing STEM as a career path later on, if the circumstances are given.

Case Analysis

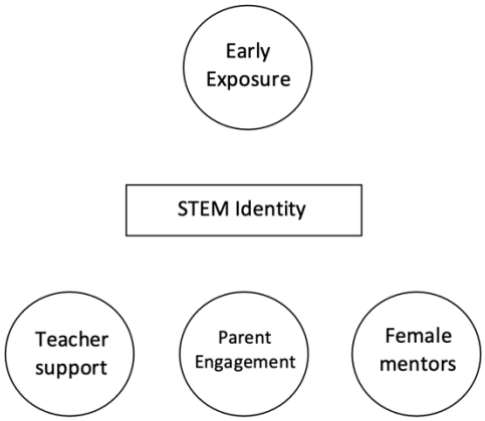
We strive to eliminate the internalized belief in females that STEM careers are only for men or that they would not be as good at it. The internalization roots in the way girls are taught science in school, through biased teachers, male examples in school materials, and

insufficient promotion of STEM to girls. This prevents them from pursuing careers in those fields, limiting their opportunities in life and reinforcing gender inequalities in society.

As reasons for stereotypes in STEM are manifold, RocketGIRL will have various approaches to solve the issue. In that sense, the brand will consist of several services and products. We structured them according to what problem level they aim for, and they each target different audiences. There are two levels:

1. “Damage Control”, or “RocketGIRL Workshops.”
2. “Prevent Future Damage.”

RocketGirl envisions a world where girls and their interests are celebrated, valued and promoted by taking a two-fold approach of parents and teachers to intervene at an early stage in life, exposing their children to STEM to create a STEM identity for girls that spark



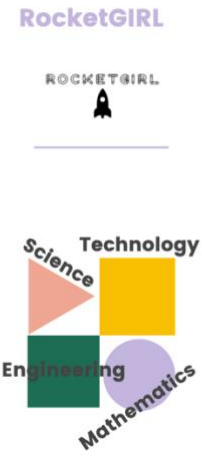
curiosity. A model that we encourage is the following:

<u>The solution (s)</u>

The following section will give a short description and justification for each of the levels if required. The content description of the workshops will follow later.

RocketGirl Workshop First Level: “Damage Control”

There will be three modules in the RocketGIRL workshops. The first module is a workshop called “Girls can do science, too”. It explores and raises awareness on stereotypes to let girls overcome their internalized antipathy. The second module is an introduction to STEM. It consists of several workshops stretched over a few days. Over the second module, tutors will introduce participants to each field of STEM and possible careers that they can choose from. Last, the third module will be a specialization in one of the subjects. The students can choose which one they find most interesting and follow the module in their own time. The specializations will go beyond basic knowledge and strive to put girls on the same level as boys in their school careers to fill potential gaps in knowledge and build up their confidence.



Now it is also important to mention who will be participating in which module. Firstly, the workshops are for students in middle or high school. These would already have been victims of biased education and thus have internalized the stereotypes (Good et al., 2007). Further, the first two modules address both male and female students, and the third one will be exclusively for girls. This decision considered the positive impacts of raising boys’ awareness of stereotypes and the adverse effects of teaching boys and girls together regarding specialized STEM knowledge (Inzlicht & Ben-Zeev, 2000). The review of existing studies and literature will explore the exact reasoning for this choice.

Another critical aspect of the implementation of the workshops is the timing and setting. The first two modules should take place in the context of STEM-themed weeks. This way, it is likely to get more girls to participate while creating a stimulating atmosphere. Possible dates would be those around the International Women’s Day or the International Day of Women in Mathematics/Engineering. However, since the setting is in schools, it is up to the administration to decide when such weeks should occur. The third module would be independent of the theme weeks, and instead, it would take place on afternoons or weekends

so that girls participate in their free time. Alternatively, schools could offer them instead of regular science classes, to bring girls on the same level as boys.

RocketGIRL should offer the workshops primarily through schools to reach the highest possible number of students and enable everyone to participate, regardless of socio-economic background. Moreover, we want the workshops to be free of cost for all participants. Because that would mean that schools carry the cost, we want to negotiate with the respective education ministries to enable subsidies to schools for the funding of workshops.

RocketGirl Workshop Second Level: Prevent future damage

The second level is an effort to prevent the internalization of stereotypes in the first place. In an optimal scenario, it will make the first level superfluous in the future. In other words, while the first level aims at treating the 'stereotype disease', the second level wants to eradicate it before it ever occurs.

The second level consists of two main approaches. First, there will be training for teachers to make them aware of their own implicit bias towards girls when teaching STEM classes. They shall eliminate unfair treatment in answering questions, grading, and endorsement of potential and interests. The training should target all teachers of STEM subjects in primary and secondary schools to achieve the highest achievable decline of biased teaching possible.

Lastly, by offering the third module only to girls, we want to provide them with a safe environment where they will not experience stereotype threats. Even if our first workshop effectively makes them more aware, we think it helps to first build up their confidence in their own skills through girls-only groups.

Damage Control-RocketGIRL Workshops

In this section follows an outline of what the workshops will entail. You can imagine it as sort of a 'script' for the tutors of the workshops to guide them along the content. However, the exact content is up to the educators and what they think is the most fitting for the participants. The only important thing we believe is that is is guided along the general structure of the workshops.

For the first workshop the participants will be introduced into the stereotypes holding girls back from entering the STEM fields. It should include some interactive sessions, but the ones below are just suggestions.

For the second module we provide more detailed instructions. Each field of STEM will be introduced according to the same recipe. It will deal with an interesting, exciting question for the participants to solve, through their own tasks and experiments. Here, interaction is particularly important to achieve interests and engagement of the participants.

It should further include a discussion of famous women in that field and their contribution to it. This is a very important part, because women are often neglected in the discussion on the history of science.

The specialisation module is still up for development. It will be the task of specialists and educators to develop them, as we are not specialised in the STEM fields themselves. It would then be your task, Fatimah, to find these specialists and convince them of your cause. You will have our full support.

1. Module one: Girls can do science, too!

The fixed mindset many girls have that keeps them from going into STEM careers is what is to be challenged through the first workshop. It is called "Girls can do science, too" and aims on

girls between the age of 12 and 18. It however includes both boys and girls and forms the first workshop of RocketGIRL. During the STEM-themed week it would be on Monday and the children would be divided into three groups by their age: 12 and 13, 14 to 16 and 17 and 18 years. Depending on the group, the structure of the workshop changes. Every group should ideally consist of 15 people, with a close to equal gender distribution. The exact structure of this proposal is outlined below for each group.

Group 1: children aged 12 and 13 (duration: approximately 120 min)

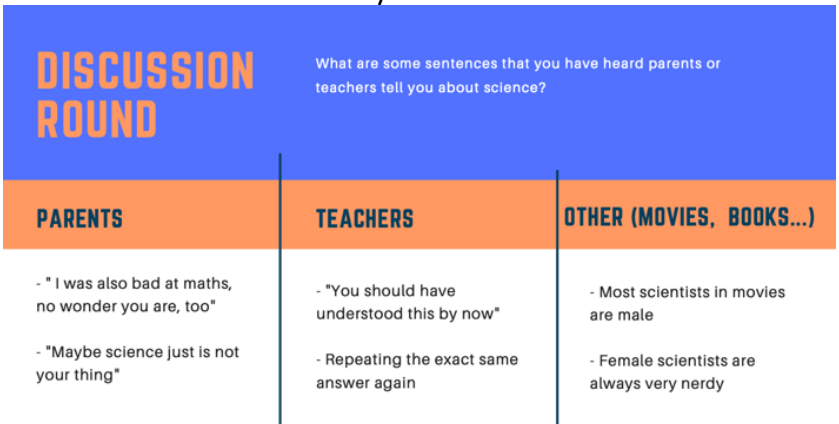
1. The instructor welcomes the group, telling them his personal connection to the topic. E. g. if it is a male, the father told him at the age of 12 after he asked for a dancing course that it is nothing for boys. If it is a female, her mother told her that she needs to look out for a husband as soon as possible and not waste too much time on education after school. The instructor must explain that he or she suffered from their parents' reaction.
2. Now the instructor calls for an introduction round. He points to a previous prepared pin wall with four cards hanging there:

a. "My name"
b. "Do I know what STEM means? What do I already know about this workshop?"
c. "My dream job"
d. "What do I think about STEM? Do I like it? Why/Why not?"

3. Everybody fills out his or her four answering cards and sticks them to the board, introducing him- or herself through reading out their cards loudly.
4. The filled in cards b (outlined above) need be revised by the instructor to see the group knowledge level about STEM. He then needs to explain what STEM jobs are to the extent that is needed. There will also be a discussion on what the participants wrote on card d. Everyone says how they feel about STEM before they know the reasons for that. The discussion ends with the instructor saying: "Let's find out why you feel this way".
5. Three groups with five kids are formed. Each group prepares a little role play, picturing a family sitting at the dinner table at home: father, mother, son, and daughter. Also, the mother's sister, the aunt, is a guest for dinner. She just returned

from a science award competition before dinner, where she was the winner, and she is still into her proud and happy emotions from it.

6. The group of roleplay 1 is to prepare a little play of parents that are influencing their children in a direction of typical male and female roles. The aunt (played by the instructor) talks about her award and how much she loves science. The following example can be given to them: The daughter says: “I want to be like you one day, auntie. I’d love to fly to the moon when I’m grown up and I want to know everything about rockets.” The mother looks at her and says: “Flying to the moon is something only men can do. It is way too dangerous and only boys like rockets.” The father agrees and the brother laughs at her.
7. The instruction for the group of roleplay 2 should play a family where the parents both are very encouraging and open-minded for gender-untypical professions and don’t believe in gender-specific jobs. The same example can be used but with tolerant and encouraging responses from the parents towards the aunt and more importantly, to the daughter.
8. Group 3 should play a family where the parents are a mixture between group 1 and 2, one of parents being for and the other one against gender-untypical jobs.
9. It is important for the kids to set the roles before playing and talk about each person’s in-game mindset. If needed, the walking-by instructor can give more input.
10. After about 15 minutes of preparation time, each group plays in front of the other eight kids.
11. After the three plays, there is a snack pause, if required.
12. A circle of chairs is set up, discussing the question: “Which girl is most likely to fly to the moon?” Since each participant was either in the role of an actor or a spectator, there should be a vivid discussion, moderated by the instructor.
13. The instructor asks the whole group what they think would happen if they’d say the example sentences of the role play at home. What would the discussion look like at their dinner tables? This is voluntary for the kids to answer.



Group 2: children from the age of 14 to 16 (duration: approximately 150 min)

- Same structure as the workshop for group 1, except from the following modifications:
- Before the preparation of the role plays, the instructor points out the importance of thinking about forming an own opinion towards the dinner table situation while still staying in their individual acting role.
- In the post discussion, the pupils should additionally reflect on whether the appearance of the aunt and her story and emotions have an impact on the later choice of profession and if the discussion at the dinner table would have been conducted in the same way if the dinner guest would have been 'Uncle Tom' returning from the same science award competition. This raises awareness for the problem.

Group 3: children aged 17 and 18 (duration: approximately 180 min)

- Same structure as the workshop for group 2, except from the following modifications:
- In the post discussion, one further question is raised: How strong is the impact of the parents' way of upbringing their children regarding girls in STEM careers?
- Also, a final question is given at the end of the workshop to 'take home': What can I do now and later in life (being a parent or an aunt/ uncle or just a grown up) to encourage females in pursuing in STEM jobs?

2. Module two: Introduction to STEM

The aim of this introduction Workshop is to familiarize the students with the basics of the different STEM fields. We will discuss every separate field of STEM, each standing for one of its letters: science, technology, engineering, and mathematics. Each section will start with some background on the field, including what it investigates and an example of topic. The

participants will also discover famous female scientists who changed the world in their field at the end of each section.

Below, you can now find the general structure the STEM introduction will follow. This structure applies to each of the four topics. Furthermore, we added example workshops that are ready for use! There is one each for Science, Technology, Engineering, and Mathematics. You are free to use them for implementation, or simply for inspiration and come up with your own ideas. To give you a short overview these are the questions that we will discuss for each field. Of course, we are aware that the participants are already familiar with standard questions from school, so we chose questions that are more exciting for them.

Structure of Introduction to STEM workshops:
The basic structure will be the same for all age groups (the same ones as from the first module). Any parts that are only for specific age groups are marked accordingly.

Opening Phase

1. The instructor welcomes the group back on the second day of the theme week. While everyone settles in, he/she asks how everyone if everyone is excited to enter the world of STEM.

2. The instructor and the group are already familiar to each other, so instead of an introduction round, there will be a little warm-up exercise, to set the stage for STEM. This exercise divides the participants into four teams, each representing one part of STEM (for instance: Team Biology, Team Mathematics). Every team goes to one wall of the room, where they find a table on a hanging poster. Further, they find post-its with STEM related terms hanging on the wall with no order. The winner is who manages to distribute all terms to their correct STEM field. This little competition is supposed to wake them up and get their head into a 'STEM mindset'.
3. Before going into the individual fields, the instructor should give a little presentation about what STEM is and mention the lack of women in it. This can be a very short overview, just to give the participants an idea about what they will learn.

Introduction to each STEM field

1. Each topic starts with a presentation by the instructor, including some basic knowledge about the field and the posed question. This way, the participants learn an example what the field entails. The presentation should leave some questions open, for the participants to explore and debate. It should not be too long, as the interactive element would be lost, and the students might lose their attention.
2. After the presentation, the interactive phase starts. To make it more diverse, we picked different options for each field.
    a. Science:
        - Debates (age 14+)
        - Experiments (ages 12-14)
    b. Technology: Coding a LEGO Maze.
        - Basic coding exercises

c. Engineering
   - Building constructs, such as buildings or bridges in a competitive setting

d. Mathematics
   - Fraction and statistics game

3. After the interactive session, the instructor introduces women in the respective STEM field. It should be mentioned what general role women played in that field, and what individual women's achievements were. This way, especially the female participants feel more acknowledged and realise that STEM is not a purely male field. There should also be a connection made to the first module, and how gender bias caused women's exclusion from STEM for a long time.

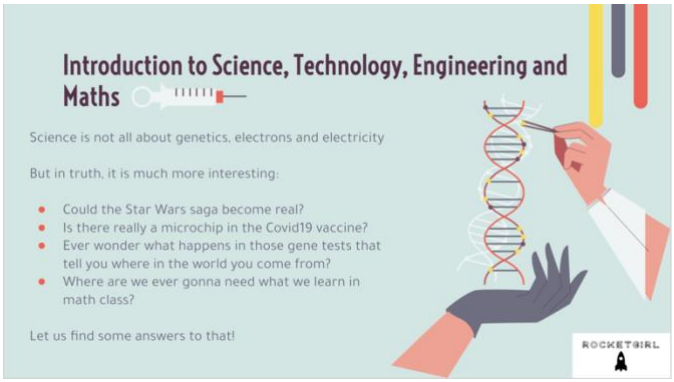
Closing Phase

1. The module ends with a reflection exercise. There will be an open discussion about what the participants learned, what they liked, and what they disliked. Thereby, the instructor also received feedback on the module.
2. Lastly, we want to know the effect the introduction to STEM had on the participants, especially the girls. The instructor should refer back to the cards the participants filled out in the beginning, which asked what the they thought about STEM. By comparing the new answers to the old tasks, the participants reflect on their learning process and how their opinion may have changed. Any changed opinion is a success for RocketGIRL and our mission.

Workshop Templates

Introduction Phase

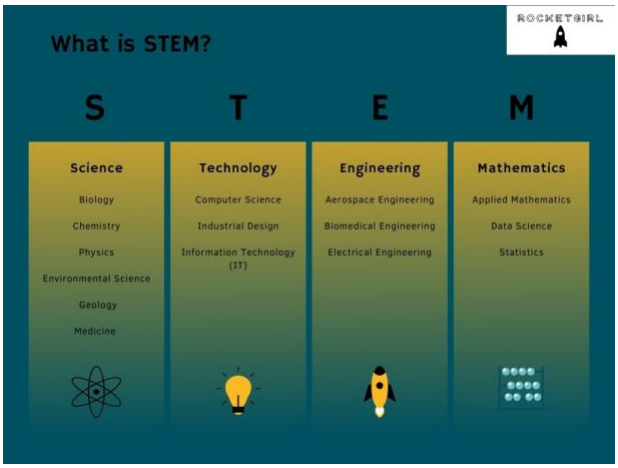
Science includes biology, physics, chemistry, and environmental science, and explains how our world works on different levels. Biology and ecology (another name for environmental studies) are the sciences of life and our planet. Chemistry explains states of matter and changes in the composition of substances. Physics is known as a science of fundamental laws of the universe and everything in it (Mason, n.d.)



Mathematics is a language that is 'spoken' by all STEM fields, including engineering and technology. Technology which consists of computer science, industrial design and information technology is used to create, automize, retrieve and process information. Then, engineering shows how science can be applied to build magnificent machines, items, processes, computers, bridges, or houses.

Introduction to each STEM field

STEM is more than genetics or algebra. In fact, it covers many different interesting questions. Some of these we will discuss today;



Science:

What can we do to stop climate change?

Technology:

Can computers think as we can? Do robots have intelligence?

Engineering:

How does the liquid crystal display work?

Mathematics:

Is the same pattern followed everywhere in your life?

→ Presentation Slide, hand out to students

1. <u>Science</u>

Science may be the by far broadest field within STEM. To start off with more clarity, participants are encouraged to discuss what they already associate with science. This will facilitate the discussion of the four fields the workshop considers, biology, chemistry, physics, and environmental science. For the discussion, students can create a word cloud, where each can contribute terms that are then discussed with the group.

Instructor Presentation

Now that we have some more clarity about what science is, I want to introduce you to a specific discipline within science. This is a very special discipline, because it consists of many different scientific disciplines. This field might be particularly interesting for many of you who are invested in the Friday's for Future movement and the discussion about climate change. I am talking about environmental science

Environmental science investigates how to live sustainably. It explains how animal populations, ecosystems and biosphere are interconnected and what we should do to conserve our planet. To find answers to their questions, scientists need knowledge of biology, physics, and chemistry. So, you see, environmental science is a great example of how complex science actually is!

To improve the world's problems, there are 17 sustainable development goals that were set by the United Nations in 2015. If we achieve all of them by 2030, all people will be living in peace and balance. It is possible to contribute to them from many spheres: ecology, gender equality, civil and science engineering, food technology, medicine, and all fields of science that were discussed above (Global Goals, 2021). Every person can do small steps such as using reusable products or self-education to reach 17 goals, even you. Nowadays, many scientists are working to achieve them.

Workshop Activity

Age 12-14: Oil Spill Experiment

This is the perfect opportunity to teach younger participants about science's role in climate. That is why they will now create their own oil spill. First, they mix oil, water, and some plastic feathers in a bowl. Afterwards, they should try to remove the oil with tissues or spoons. They will soon realise that removing the oil after it has been spilled, is not that easy. This way they easily learn about the impact of oil spills on the environment, in a scientific way!

Age 15+: Debate

Science covers many topics that are not just academically, but also socially relevant for the participants. Therefore, the interactive element for science should be a discussion or debate. The participants are split into teams, each team defending on side of the argument at stake.

Women in Science

Science is not only for men! You probably already know Marie Curie, who was a famous chemist. She conducted the first research in radioactivity (The Nobel Prize, n.d.). Lise Meitner was a nuclear physicist who discovered the first long-lived isotope of protactinium (Britannica, n.d.). The 109th element of the Periodic Table is named after her. Additionally, according to Childers (2019), Vera Rubin was an astronomer who pioneered the work of galaxy rotation rates. Her work provided the first evidence of black matter existence.

Lastly, Elizabeth Blackburn is a molecular biologist who won the Nobel Prize in 2009 for discovering mechanisms of chromosome protection by telomeres and telomerase enzymes. In other words, she found out how to stop chromosomes from being destroyed; and her discovery can slow down ageing processes (The Nobel Prize, 2009).

For 15+: Careers in Science

Science is the most notorious STEM field for the lab coat-and-microscope cliché. But it also requires a lot of active fieldwork, where you go out into nature to see what is going on. These environmental scientists over here are a good example of that! And in the end, they are doing nothing else but putting their knowledge about biology and chemistry into practice (UNCF, n.d.)!

2. Technology

Instructor Presentation

You all hear the term IT, right? But do you know what it is? In simple terms, IT specialists work with codes inside computers. They can build a sophisticated website, design a computer game, or create a movie. Together with mathematicians, they create simulation models that help scientists make predictions and discover more things about quantum physics or molecular biology.

It is common to be surprised about promotions on your computer. Remember speaking to a friend about dogs and then suddenly receiving advertisement about dog food? Such advertisements make us think that computers can hear us and think. But do not be afraid, they cannot. IT specialists program their applications to follow three simple rules written by Isaac Asimov. That prevents robots and computers from 'thinking' and 'planning a rebellion'.

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its existence as long as such protection does not conflict with the First or Second Laws (Asimov, 1950).

Furthermore, it is challenging to copy human intelligence. Usually, robots are programmed to do specific tasks, but they "do not understand" why they are doing them and what they are doing. Nowadays coders hope to find out more artificial intelligence. It is a part of computer science that makes computers imitate how people think and work. For example, it is used for speech recognition, self-learning, and targeting in marketing. Yet, scientists cannot fully imitate the human brain. So, as of now, robots, computers, and other systems cannot think like us.

Workshop Activity: Coding with LEGO maze

With only some LEGOs and paper, the participants will learn to code. The instructor will set up little LEGO mazes for the participants, that they must solve through 'coding'. Students set their figure at the start of the maze. For each step they want to take, they have to use 'commands' written on little pieces of paper. For instance, if they want to turn left, they use the piece of paper saying: 'turn left'.

After successfully completing the maze, the participants will have created a line of LEGO code (Michelle, 2016).

Women in Technology

Did you know that computer sciences were started by females? Ada Lovelace can be referred to as a first programmer because she wrote how a specific engine could do transition calculations. Basically, in 1842, she discovered how computers can do calculus (Britannica, T. Editors of Encyclopaedia, 2021). Margaret Hamilton wrote a code to make the flight to the Moon possible (Ledward, 2020). Furthermore, thousands of women were writing codes during the Second World War to break the codes of the enemy and were hackers. And Adele Goldberg was one of the 80 people who developed a programmed language, Smalltalk-80. She presented this language to Steve Jobs and inspired him to create the first Apple computer (Ledward, 2020).

For ages 15+: Careers in Technology

Time to let go of another cliché. Computer specialists do not just sit in front of a computer day and night, eating pizza and playing video games in the free time. Some of them maybe, and if you like that, perfect! But there are also many other stories to it. Because technology is interconnected with so many areas of life, you can be sure to never be bored. You will work together with many people to solve new and exciting problems the world faces. If anything, technology is the career of the future (Zaleski, n.d.).

3. Engineering

It is a common joke not to understand what engineers do. They build computers, bridges, houses, work with electronics and design everything around us. Engineering is often combined with other spheres of STEM, for example bioengineering, chemical engineering or even space engineering. Today, we will focus on chemical engineering to understand how liquid crystals displays (LCD) work. LCD technology is used in monitors. It helps us to see colours and even YouTube Videos. Below you can find a simple explanation of how it works.

Liquid crystals are substances consisting of metals and liquids. If voltage is applied to the crystals, they rotate in order not to repel each other. It is also possible to pass light through them. Scientists were aware how to change the direction of the light and developed a tool to do so – polarimeter. It can rotate light in different directions. We also know that everything we see is light, so we can manage pictures that our display shows us by transmitting light through liquid crystals and rotating them. (Massachusetts Institute of Technology, 2011). So, in case you were not aware yet, you just learned how your phones work!

Workshop Activity

While this is an extremely basic experiment, it can still foster understanding for engineering. The participants will build jellybean buildings. All they need are jellybeans and toothpicks. However, simply asking them to stick them together would be too easy. Instead, the instructor puts them into teams, and they compete. The challenge is to build the biggest jellybean-toothpick construct they can, without making it collapse. There will of course be a time limit, to underline the importance of carefulness within engineering. If they work to fast, or are not working with the team, the construct will collapse. This way, the participants learn about engineering as a matter of detail-orientation and teamwork effort.

Women in Engineering

Women can succeed in engineering too! For example, Marissa Mayer was the CEO of Yahoo. She was the very first engineer to join Google and invented many applications there. She also helped to design Google's homepage and Gmail (ESILV, 2020). Stephanie Kwolek invented Kevlar, one of the strongest materials ever. She also was one of the first female chemical engineers (Shepherd, 2021). Hedy Lamarr was both an engineer and an actress. She invented a remote-controlled communications system for the US military that made WIFI technology possible (Shepherd, 2021).

For ages 15+: Careers in Engineering

If you think engineering is boring, I am going to give you one name that will change your opinion: Elon Musk. If you know who he is, you probably know about his company SpaceX, and their ambitions to bring people to Mars. And what could be more exciting than that? Truth is, engineering is likely one of the most exciting branches to be in right now. Every day, new machines are developed that bring us close to a life outside this planet. And if you like Earth, you can also use an engineering career to re-invent transport in a way sustainable forever. The possibilities are endless!

4. Mathematics

Instructor Presentation

No doubt that mathematics is the queen of science. We use it to explain all theories, patterns, and events. The history of maths starts in the stone age, and nowadays it is used to predict the future, explain the past and show behaviour of tiny invisible particles. In fact, scientists are trying to make the theory of everything. They are searching for fundamental patterns and formulas which are found in every part of the Universe. And formula seems to be one of those fundamental things. This equation sets a connection between everything in our everyday life. For example, the behaviour of animals' populations, tapping water and connections between neurons (cells in the brain) have the same pattern which is predicted by this formula (Veritasium, 2020).

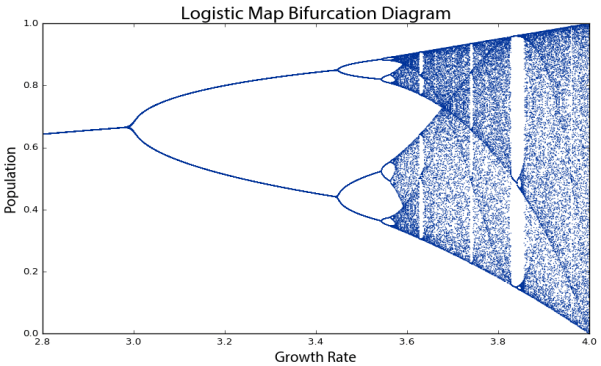


Figure 2.Bufurcation diagram (Kuznetsov & Levitin, 2017)

Figure 2 shows how the graph of the formula behaves if it is repeated thousands of times. The reason why it looks so similar and symmetrical is that it is fractal, which is a never-ending pattern. Many processes can be 'written' in the mathematical language by this formula. For example, we respond to light in a way this graph shows (Crevier & Meister, 1998). This

equation predicts many things in our life. For example, humans' eyes are flashing at the frequency predicted by the given formula (Crevier & Meister, 1998). Moreover, changes in animal populations over time and the way how our nervous system works can be explained by this formula. (Bing et al., 2012).

Workshop Activity:

Ages 12-14: M&Ms fractions

In this little experiment, participants learn about what M&Ms have to do with mathematics. Each team gets a bag of M&Ms, and they learn to make tables of how many of each colour are inside. The instructor then tells them how to convert these numbers into data, such as fractions or shares. It is also a great way to teach them about the basics of charts. For instance, they can put their findings into an M&M bar chart!

Ages 15+: M&M statistics

Older students already learned about fractions in school. Instead, they can use M&Ms to learn about statistics, something they most likely cannot avoid later in life. With their bag of candy, they can learn about simple statistic concepts in a simple manner.

- Populations → The bag of M&Ms
- Samples → A representative fraction of the bag of M&Ms
- Hypotheses and Predictions → What colour represented the most?
- Frequencies → How many red M&Ms are in the bag?
- Average → What is the average size of the M&Ms?

By discussing simple concepts in an illustrative manner, the participants learn about math's applicability to real life. This way, statistics are not an abstract riddle, but something they can grasp and comprehend.

Women in Mathematics

According to Aurora University (2019), Sofia Kovalevskaya was the first woman to receive a doctorate in mathematics. She studied partial equations, the dynamics of Saturn's rings, and elliptic integrals. Maryam Mirzakhan is the only woman to have received the Fields Medal for proofing the Witten conjecture, the most prestigious award in mathematics.

For ages 15+: Careers in Mathematics

Why would you ever enter a career about a subject you hated the most in school? Let me give you the answer: It pays well. And in addition, once you overcome your fear of math, you will see that it is actually a very exciting field, as we have seen during this workshop. There is a wide field in business, that requires good mathematicians. Economists or financial analysts predict where the economy is headed, whether investing is smart, or if we are about to enter a crisis (and all at a salary of more than 80.000$ a year) (Burnham, 2019). Does not sound bad, right?

2. Second level: Prevent future damage

As discussed in earlier sections, it is vital that the internalised self-doubt of young children, primarily young girls, are brought to light through the "Girls can do science, too" workshop. Equally important is delving into the STEM fields and exemplifying the interdisciplinarity amongst them and how they relate to our everyday life decisions. Taking into consideration that young girls develop self-doubt already at a young stage in life, it begs the question of how the social environment of young girls can be tackled and put under a focal point of investigation to localise and thus prevent further damage and perpetuation of stereotypes.

Parents as well as teachers, and any mentor that children engage with has the ability to help children grow their self-esteem and discover their inner passions and talents by also giving them the necessary tools to do so. As a result, focusing on the role of parents and teachers and what they can do to tackle this problem is a complementary step to the first one. In an optimal scenario, it will make the first solution superfluous in the future. This solution aims at the root cause for the internalised self-doubt of young girls, opposed to the treatment of its symptoms in the first solution. The cause can be tackled through the two ways. In the next section, a research-based program will be presented. First, there will be training for teachers to make them aware of their own implicit bias towards girls when teaching STEM classes. They shall eliminate unfair treatment in answering questions, grading, and endorsement of potential and interests. The training should target all teachers of STEM subjects in primary and secondary schools to achieve the highest achievable decline of biased teaching possible.

Firstly, the teacher workshop will initiate with a lecture, talking about the gender gap in STEM and the overall problematic of gender bias and stereotypes. Furthermore, awareness will be

raised of possible individual gender biases that teachers may exert on students, and the importance of rectifying them by explaining the influence that teachers have on nurturing, and valuing girls' STEM interests. The latter part will emphasize relevant studies. Secondly, teachers will engage amongst each other to discuss their implemented ideas of STEM subjects in their classes giving rise to the sharing of ideas to promote STEM in classrooms. Thirdly, teachers will be introduced to the important individual attitudes and behaviours that they need to implement to aid in the overall aim to get more girls into STEM. Furthermore, they will become acquainted to the 5 fun STEM activities that they can introduce in their classrooms. Parents will also be given the opportunity to become involved with their young daughters with the 4 fun STEM activities and workshops that RocketGirl has created.

STEM friendly teacher attitudes:

1. It is prime that teachers ensure that their students, primarily girls understand that work and effort and prior experiences and a healthy nurturing environment, rather than innate talent are the primary drivers of success in STEM fields. Consequentially, teachers must give value the effort, interest and logic that is put into work in class regardless of the response.
2. Teachers will be explained how to foster and maintain high standards and expectations for their students and thus and promote and support, all female STEM students. This means that teachers should equally interact with girls in the classroom. For example, girls should be asked as often as boys to answer questions and help with demonstrations. Girls should also be asked higher-level questions and be expected to exhibit thinking and reasoning, and make sure they participate actively and meaningfully in small-group work. Importantly, teachers should foster a supportive aid for girls that need help understanding exercises instead of merely having a student answer the question right.
3. Teachers will be advised to use a range of student-centred teaching techniques to promote a "safe" classroom setting. For example, teachers should use collaborative instead of competitive group work to create teamwork where all opinions and help is respected and valued.

4. RocketGirl will also focus on the aspect that teachers should be taught to focus on the process of learning rather than the product. Females should be encouraged to solve problems in a variety of different ways which spark creativity and thought process, and back up their work by explaining and defending themselves. For example, teachers should initiate STEM related talks and ask questions such as how can we solve climate change? This will have students try to solve problems in a variety of ways and explain why they feel their answers are reasonable in light of the problem scenario.
5. Another vital characteristic that RocketGirl will implement is that the use of posters, videos, guest speakers, class projects, and other means to introduce various historical and present female role models (and their work) in STEM are necessary in order for young females to be aware that they have many role models in STEM fields. Here we would speak about the Matilda effect. Additionally, teachers will be given the necessary tools to arrange or assist females in locating opportunities to network with adult and peer role models and mentors.

STEM friendly parent attitudes:

As a parent, do you want to get involved in nurturing, valuing, and promoting your daughter's curiosity in STEM related fields? RocketGirl will promote a family learning environment that challenges Parent-Daughter connections to solve interesting STEM challenges.

At our Parent-Daughter Workshops, you will:

1. Participate actively in hand on STEM experiments, challenges and activities that will spark further curiosity for young girls.

2. Be taught how to deal with the failure during the process of solving challenges and using this as a learning incentive to understand why certain design processes have not successfully solved the STEM challenges. This will teach the young girl as well as parents the interplay of STEM fields.
3. Children will be given the opportunity to meet female parents who are scientists, engineers, mathematicians, and technologists and ask questions an become acquainted with the fascinating importance of these careers in the world.

4. Most importantly, gaining a valuable connection and learning experience with between parents and daughters!

The 4 STEM challenges which teachers can implement in their classrooms and parents can solve with their daughters are the following.

Experiment 1: Oil spill cleanup (Similar to an experiment in the STEM introduction workshop)

Category: Environmental science (+ interdisciplinarity of sciences)

Why not try something that is relevant to real-world issues? For this activity, just combine oil and water in a large container and add a few feathers to the mix. Then give the children sponges, paper towels, or tiny spoons and instruct them to use them to try to remove the oil from the water and feathers.

Allow the youngsters to attempt to remove the oil while avoiding removing too much water. This activity teaches students about the environmental impacts of oil spills and how chemical and environmental engineers may help. They can also observe how the oil harms the feathers and how difficult it was to remove the oil from the water.

Experiment 2: Egg drop

Category: Engineering

The idea is to design a container that can hold a raw egg while keeping it from cracking when dropped from a considerable height. This engineering project is a typical STEM challenge since it combines creativity and physics. Engineers typically employ a design approach that youngsters become acquainted with. Inquire, imagine, plan, create, and improve.

Experiment 3: Bottle rocket

Category: Physics and engineering

The bottle rocket is a thrilling scientific project that always results in curious students. In this exercise, we will not only investigate the chemistry of the chemical reaction, but also the physics of the forces that cause the take off. Students are challenged to construct launch pads for their rockets as they prepare for launch.

Experiment 4: Sweet slushies

Category: Technology and chemistry

This scientific sweet slushy experiment especially thrills youngsters since they receive a delicious treat to savour at the end of their science lesson. Students utilize technology to investigate the mechanism of heat transmission, the science underlying how salt and ice interact, and the changing states of matter.

Conclusion

Dear Fatimah,

We hope that you are happy with the proposal that we offer you. If you accept it, you are of course free to change it according to your preferences. This is just a framework, and if you see that certain changes could have a more substantial impact for girl, please implement them. For now, just know that this is only the start. There are more ways to address women's absence in STEM. That is also the benefit of RocketGIRL, you can grow it into many more directions. Once the workshops system is established, you can contact us again, and we can come up with a strategy for institutional change. Our current measures address mainly students themselves, and their teachers. In the future, you can lead RocketGIRL to become a movement for the women that need you. It is up to you.

For now, we wish you the best of luck bringing RocketGIRL to life!

Kind regards,

Margarita, Lily, Uliana and Léon

References

Antecol, H., Bedard, K., Stearns, J. (2016). Equal but Inequitable: Who Benefits from Gender-Neutral Tenure Clock Stopping Policies? Discussion Paper No.9904, Forschungsinstitut zur Zukunft der Arbeit.https://www.iza.org/publications/dp/9904/equal-but-inequitable-who-benefits-from-gender-neutral-tenure-clock-stopping-policies

Arabia, i. (2021, February 23). *Women in STEM Statistics to Inspire Future Leaders*. Retrieved from Big Rentz : https://www.bigrentz.com/blog/women-in-stem-statistics

Asimov, I. (1950). I, Robot (Reprint ed.). Del Rey.

Aurora University. 10 Famous Women Mathematicians. (2019, March 4). Aurora University Online. Retrieved from October 6, 2021, from https://online.aurora.edu/infographics/10-famous-women-mathematicians/

Bing, J., Gu, H., Li, L., Zhao, X. Dynamics of period-doubling bifurcation to chaos in the spontaneous neural firing patterns. *Cognitive Neurodynamics 6(1)*, 89–106 (2012). https://pubmed.ncbi.nlm.nih.gov/23372622/

Burnham, K. (2019, April 29). 10 Careers for People Who Love Math. *Northeastern University*. Retrieved October 9, 2021 from https://www.northeastern.edu/graduate/blog/best-math-careers/

Childers, T. (2019, June 11). Vera Rubin: The Astronomer Who Brought Dark Matter to Light. Space.Com. Retrieved October 6, 2021, from https://www.space.com/vera-rubin.html

Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American Journal of Sociology, 106(6),* 1691-1730. https://doi.org/10.1086/321299

Crevier, D. W., Meister, M. (1998). Synchronous period-doubling in flicker vision of salamander and man. *Journal of neurophysiology, 79(4),* 1869–1878. https://doi.org/10.1152/jn.1998.79.4.1869

ESILV. (2020, July 30). 5 Famous Women Engineers That Shaped The World. *ESILV Graduate School of Engineering*, Retrieved October 6, 2021, from https://www.esilv.fr/en/5-female-engineers-that-shaped-the-world/

Global Goals. World's To Do List | Let's get the #WorldsToDoList done. (2021, September 22). World's To Do List. https://worldstodolist.org

Good, C., Aronson, J., Harderm J.A. (2007). Problems in the pipeline: Stereotype threat and women's achievement in high-level math courses. *Journal of Applied Developmental Psychology, 29(1)*, 17–28.https://doi.org/10.1016/j.appdev.2007.10.004

Heaverlo, Carol, "STEM Development: A Study of 6th-12th Grade Girls' Interest and Confidence in Mathematics and Science" (2011). Graduate Theses and Dissertations. 10056. https://lib.dr.iastate.edu/etd/10056

Inzlicht, M., Ben-Zeev, T. (2000). A Threatening Intellectual Environment: Why Females Are Susceptible to Experiencing Problem-Solving Deficits in the Presence of Males. *Psychological Science, 11(5)*, 365-371.https://www.jstor.org/stable/40063543

Jacobs, J. E., Eccles, J. S. (1992). The Impact of Mothers Gender-role Stereotypic Beliefs on Mothers' and Children's Ability Perceptions. *Journal of Personality and Social Psychology, 63(6)*, 932-944. https://doi.org/10.1037/0022-3514.63.6.932

Johns, M., Schmader, T., Martens, A. (2005). Knowing Is Half the Battle: Teaching Stereotype Threat as a Means of Improving Women's Math Performance. *Psychological Science, 16(3)*, 175-179.https://www.jstor.org/stable/40064197

Knobloch-Westerwick, S., & Glynn, C. J. (2013). The Matilda Effect—Role Congruity Effects on Scholarly Communication: A Citation Analysis of Communication Research and Journal of Communication Articles. *Communication Research*, *40*(1), 3–26. https://doi.org/10.1177/0093650211418339

Kuznetsov, Y. A., Levitin, V. V. (2017, December 23). A multiplatform environment for continuation and bifurcation analysis of dynamical systems. Retrieved October 6, 2021, from https://www.researchgate.net/post/How-to-interpret-the-bifurcation-diagram

Ledward, Y. (2020, September 8). 10 of the Most Famous Women Who Changed the World. *Women in Technology*. Retrieved October 6, 2021, from https://www.womenintech.co.uk/10-famous-women-technology-changed-world

Massachusetts Institute of Technology. (2011). *Department of Electrical Engineering and Computer Science 6.007 – Applied Electromagnetics Spring 2011 Lab 3: Liquid Crystal Displays* https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-007-electromagnetic-energy-from-motors-to-lasers-spring-2011/lab-videos/MIT6_007S11_lab3.pdf

Mason, M. (n.d.). Physics: The Science of the Universe and Everything in It | Environmental Science. Retrieved October 9, 2021, from https://www.environmentalscience.org/physics

Meyer, M., Cimpian, A., Leslie, S. J. (2015). Women are underrepresented in fields where success is believed to require brilliance. *Frontiers in Psychology, 6(235),* 1-12. https://doi.org/10.3389/fpsyg.2015.00235

Michelle. (2016, February 16). Coding a LEGO Maze. Research Planet. Retrieved October 15, 2021 from https://researchparent.com/coding-a-lego-maze/

Miller, D. I., Eagly, A. H., Linn, M. C. (2015). Women's Representation in Science Predicts National Gender-Science Stereotypes: Evidence From 66 Nations. *Journal of Educational Psychology,107(3)*, 631-644. https://doi.org/10.1037/edu0000005

Moe, A., Hausmann, M., Hirnstein, M. (2021). Gender stereotypes and incremental beliefs in STEM and non-STEM students in three countries: relationships with performance in cognitive tasks. *Psychological Research-Psychologische Forschung, 85(2),* 554-567.https://doi.org/10.1007/s00426-019-01285-0

Mueller, C. M., Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology, 75(1),* 33-52. https://doi.org/10.1037/0022-3514.75.1.33

O'Brien, L.T., Garcia, D.M., Blodorn, A., Adams, G., Hammer, E., Gravelin, C. (2019). An Educational Intervention to Improve Women's Academic STEM Outcomes: Divergent Effects on Well-Represented vs. Underrepresented Minority Women. *Cultural Diversity and Ethnic Minority Psychology, 26(2),* 163-168. http://dx.doi.org/10.1037/cdp0000289

Park, G., Lubinski, D., Benbow, C. P. (2007). Contrasting intellectual patterns predict creativity in the arts and sciences - Tracking intellectually precocious youth over 25 years. *Psychological Science, 18(11)*, 948-952. https://doi.org/10.1111/j.1467-9280.2007.02007.x

Shepherd, M. (2021, January 29). 7 Famous Female Engineers in History. *Workflow MAX*. Retrieved October 9, 2021, from https://www.workflowmax.com/blog/7-famous-female-engineers-in-history

STEM Women. (22 January, 2021). *Women in STEM | Percentages of Women in STEM Statistics*. Retrieved October 4th, 2021 from https://www.stemwomen.co.uk/blog/2021/01/women-in-stem-percentages-of-women-in-stem-statistics

The Editors of Encyclopaedia Britannica. Ada Lovelace | Biography, Computer, & Facts. (n.d.). *Encyclopaedia Britannica*. Retrieved October 6, 2021, from https://www.britannica.com/biography/Ada-Lovelace

The Editors of Encyclopaedia Britannica. Lise Meitner | Biography & Facts. (n.d.*). Encyclopaedia Britannica*. Retrieved October 9, 2021, from https://www.britannica.com/biography/Lise-Meitner

The Nobel Prize. Elizabeth H. Blackburn - Nobel Lecture. (2021). From NobelPrize.Org. Retrieved October 6, 2021, https://www.nobelprize.org/prizes/medicine/2009/blackburn/lecture/

The Nobel Prize. Marie Curie - Biographical. (n.d.). NobelPrize.Org. Retrieved October 6, 2021, from https://www.nobelprize.org/prizes/physics/1903/marie-curie/biographical/

Tiedemann, J. (2000). Parents' gender stereotypes and teachers' beliefs as predictors of children's concept of their mathematical ability in elementary school. *Journal of Educational Psychology, 92(1),* 144-151. https://doi.org/10.1037/0022-0663.92.1.144

Tsui, L. (2007). Effective Strategies to Increase Diversity in STEM Fields: A Review of the Research Literature. *The Journal of Negro Education, 76(4),* 555-581. https://www.jstor.org/stable/40037228

Twig Education. (2021). *10 Exciting STEM Careers for 2021 and Beyond*. https://twigeducation.com/blog/10-exciting-stem-careers-for-2020/

UNCF. (n.d.). *Leaving a Mark on the World: How to Become an Environmental Scientist*. Retrieved October 9, 2021 from https://uncf.org/the-latest/leaving-a-mark-on-the-world-how-to-become-an-environmental-scientist

Valla, J. M., & Ceci, S. J. (2014). Breadth-Based Models of Women's Underrepresentation in STEM Fields An Integrative Commentary on Schmidt (2011) and Nye et al. (2012). *Perspectives on Psychological Science, 9(2)*, 219-224. https://doi.org/10.1177/1745691614522067

Veritasium. (2020, January 29). This equation will change how you see the world (the logistic map). [YouTube]. Retrieved October 9, 2021, from https://www.youtube.com/watch?v=ovJcsL7vyrkfrom

Wang, M. T., Degol, J. L. (2017). Gender Gap in Science, Technology, Engineering, and Mathematics (STEM): Current Knowledge, Implications for Practice, Policy, and Future Directions. *Educational Psychology Review, 29(1),* 119-140. https://doi.org/10.1007/s10648-015-9355-x

Zaleski, A. (n.d.). Why information technology careers make more sense now than ever before. *Northjersey*. Retrieved October 9, 2021 from https://eu.northjersey.com/story/sponsor-story/eastwick-college/2019/07/31/why-information-technology-careers-make-more-sense-now-than-ever-before/1815058001/